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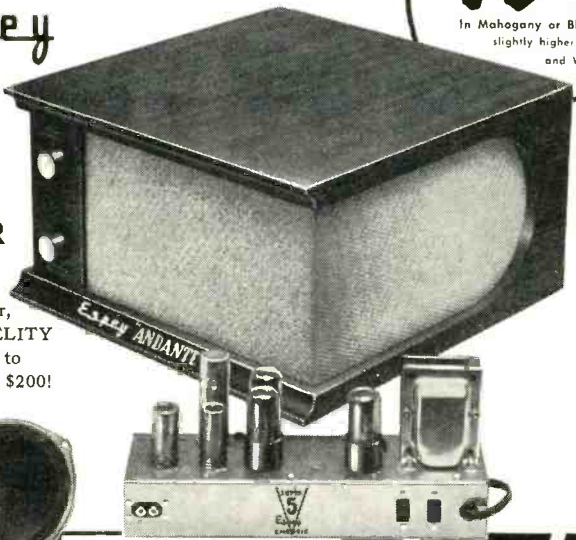

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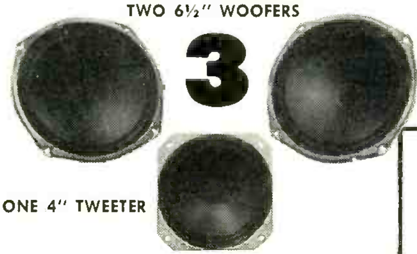

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POPULAR ELECTRONICS

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MAY 1955

VOL. 2 - NUMBER 5

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H. Bennett, R. P. Turner
R. Legge, H. Pollack

ART
Frank Sayles (Director)
A. J. Reich, M. Whelpley
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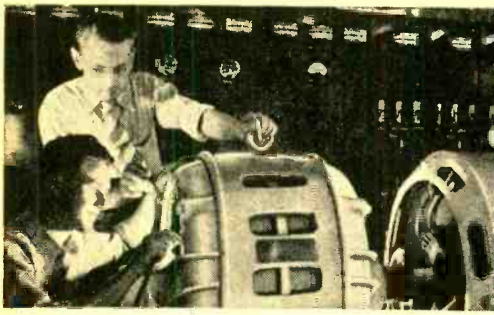

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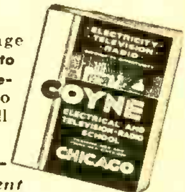

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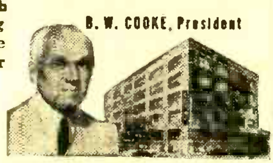

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ITEMS OF INTEREST

NEW PRODUCTS

If you are unable to find these listed products locally, write directly to the manufacturers at the addresses given. Also see the monthly review of new items of interest to the electronics hobbyist in "Tools & Gadgets" appearing on pages 107 and 108 of this issue of POPULAR ELECTRONICS.

COMING NEXT MONTH

POPULAR ELECTRONICS

Build Your Own Metal Locator
Market Survey on Treasure Locators
Picking Your Pickup
Talking With a Light Beam
Distortion in Your Hi-Fi System
Transistor Sine Wave Generator
Heat Without Flame
Our R/C Monster

Plus More on

High-Fidelity Audio ▪ Kits ▪ Radio Control ▪ 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

(May)

Campus Carrier-Current System
Practical Transistor Preamp
A Most Unusual Oscillator
An R/C Receiver for Model Boats

This Month's Cover

Although most R/C fans prefer to install their equipment in swift-flying gas-powered model airplanes or water-churning model boats, the glider is also available for radio control. The month of May, with its gentle breezes, is ideal for the launching of these graceful, swooping birds. One of the most suitable gliders for radio control is the one shown, which is a slightly modified "Thermic 100." This 100-inch wing-spread job (8 ft., 4 in.) is manufactured by the *Junior Aeronautics Supply Co. (Jasco)* and is available at most hobby shops for about $10.00.

The transmitter being used to control the flight of the glider is a home-built unit, as are the receiver and the glider itself. We will bring you a complete construction article on this transmitter by Murray Feigenbaum (who appears on our cover) in next month's issue. We may bring you plans for the receiver too.

Although it may appear to some of our beginning R/C readers that construction and flying of a glider would be a good way to break into the field, it really isn't so. It takes an old hand to build up a glider that will fly successfully, since it is much more sensitive in flight than gas-powered models. However, there are few sports as satisfying as the flying of R/C gliders. EDITOR

(Ektachrome by Jay Seymour)

LETTERS FROM OUR READERS

ATTENTION SWL FANS!

"WE ARE now operating with a 2 kw. long-wave transmitter in the 346.8 meter-band and we are receiving different reports from the States on how our station (Radio Curom) is heard. We plan to operate a new *RCA* 5 kw. transmitter on the same wavelength very soon, and would like to know how this is received in the U.S.A. For this reason I ask you if it is possible to draw your readers' attention to this station, and when heard, to drop us a line telling us their opinions. Wave-length is 346.8 meters, or 865 kc. Curacao broadcasting times are: 0700 to 0800; 1030 to 1300; and 1700 to 2230. We use a non-directional antenna, 35 meters high. Please write to: A. C. Quast, Hoogstraat 27, Curacao, Netherlands Antilles."

A. C. Quast
Curacao, Neth. Ant.

★ ★ ★

R/C FLYING

"I AM interested in R/C flying and would like to know if there are any clubs in this area. . . . Where could I see some R/C flying?"

Edward Medvitz
Clifton, N. J.

We suggest that you write to the Academy of Model Aeronautics, 1025 Connecticut Avenue, Washington 6, D.C.

★ ★ ★

C.W. TRANSMITTER MODIFICATIONS

"IN REGARD to the Novice C.W. Transmitter (February issue, pages 26-29), I was wondering if it would be okay to use a 200-volt power supply on the set. At present I am slightly short on funds, but would like to get on the air. I have most of the parts so it wouldn't cost too much. Would you suggest using a different tube or don't you think I will cut down on the wattage too much?"

Fred Bretsch
Milwaukee, Wisconsin

Your 200-volt supply may be used on the transmitter, but you should expect that the set's power output will be reduced by about one-third. You need not change the tube merely because you are using a lower rated power supply. However, you can use a type 6V6GT in place of the 6AQ5, if desired. The 6V6 is the electrical equivalent of the 6AQ5 but requires an octal socket and its pin connections differ from those of the 6AQ5. Other tubes may be used too, but the chances are they would require corresponding changes in the values of circuit components.

★ ★ ★

METAL LOCATOR

"I NEED the circuit for a metal locator. In my work it is often necessary to locate underground pipes. Also, I would use it to locate

FROM THE M.Ed. OF POP'tronics

WHAT could be more appropriate than to have the first few words in this column devoted to the many hundred readers who have commented on POPULAR ELECTRONICS. Through their efforts the editorial staff has been able to formulate a program which we feel will be of interest to the greatest audience. To those who wrote in, as well as to those who phoned and telegraphed, our sincere thanks.

The June issue of POP'tronics will contain a number of features with particular emphasis on metal locators. Full construction details will appear on a very sensitive unit that has been tested by the POP'tronics staff. In addition, a "market survey" of commercially available low and medium price equipment will be specially prepared and published. Many readers will also be attracted to our light beam communicator for short-range signaling.

July will be considered the most important issue of the year by some readers when they see the special material on uranium and Geiger counters. In this issue we will also prepare a detailed "market survey" of equipment that may be purchased. One of the principal construction items will be a home-built Geiger counter. Actually, this unit will be so designed that after the basic circuit has been wired, a meter and amplifier may be added at a later date.

And, of course, in both issues we will have many other valuable features on electronics.

o.p.f.

objects in our local lake. Please send me any information you have on hand."

H. R. Bentley
N. Syracuse, N.Y.

Our June issue will be devoted, in large part, to this very subject.

★ ★ ★

RECORD CLEANERS

"RECENTLY ('Record Noise,' February issue) you mentioned a liquid concentrate 'K-33.' Where do you get it and how much does it cost?"

Don Wolfe
Arlington, Texas

"I AM interested in where I can purchase the radio-active dust collector for a phono pick-up mentioned in 'Record Noise' (February issue)."

Wm. S. Typinski
Pittsburgh, Pa.

According to record reviewer Bert Whyte, both these items can be ordered from the Harvey Radio Co., Inc., *103 West 43rd Street, New York 36, N.Y. A jar containing approximately 4 ounces of "K-33" liquid concentrate costs $2.50. The dust collector attachment sells for $4.50.*

★ ★ ★

NOVEL "TROUBLE" LIGHT

"I HAVE a small idea that has been helpful to me that you might like to pass on to other readers: I have an old 25-watt soldering iron with the screw-in heating element (those old wood-burning pencils). The heating element is shot, so I put a 115-volt bulb in the thing and use it for a small trouble light. It's small enough to get into tight places, and is in general a lot easier and more convenient; those large pilot lamps just fit if you scrape a little plastic from the top of the socket. The lamp can be painted with a couple of coats of silver dope if you want to keep light from the sides."

Jerry M. Taylor
Perrin AFB, Sherman, Texas

★ ★ ★

PREAMPLIFIER PLANS

"PLEASE try to squeeze in a plan for a simple preamplifier in a future issue. . . ."

Sam Bennett
Kerens, Texas

We shall.

★ ★ ★

SWITCHES FOR TEST BOX

"IN THE test-box in your January issue, you used an s.p.d.t. switch to cut out the bulb and give power to the circuits. Instead, a s.p.s.t. switch could be used to short out the bulb. This would work just as well and be easier on the pocketbook."

Frank Gentger
Springfield, Missouri

True, the s.p.s.t. switch would cost about ten cents less than the one used in the article. It may be used if the following wiring changes are

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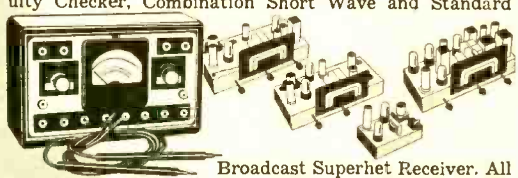

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VETERANS: Give date of discharge ____________ *made in the original circuits: wire the bulb directly to the sockets, and connect the switch in parallel with the bulb. Then, with the switch closed open, the bulb will light for "test" position; with the switch closed, the bulb is shorted out of the circuit for "operate" position.*

★ ★ ★

NEW USE FOR TUBE CHECKER

"YOUR article on using a tube checker to test flashlight bulbs (January issue) was good because it showed the versatility of the tube checker. Another good stunt is this: put two leads into the tube socket as you did with the above, but this time push down one of the buttons on the tube checker. If you touch the leads together now, the neon glow lamp indicating shorts will light up. Thus, in effect, you have a continuity tester for fuses, etc."

Donald Jonas
Brookfield, Illinois

★ ★ ★

ELIMINATING INTERFERENCE

"PLEASE tell me how to eliminate radio interference from electrical appliances such as fluorescent lights, motors, etc., as they have been causing much static lately. . . ."

John Linde
Vancouver, B. C.

A request for information such as this could not possibly be answered adequately in this department. Many good books on the subject are available, however. A recent one that comes to mind is "How to Locate and Eliminate Radio and TV Interference" by Fred D. Rowe, published by John F. Rider Publisher, Inc., *480 Canal Street, New York 13, New York, and listing for $1.80.*

★ ★ ★

R/C FREQUENCY CONVERSION

"I'M SURE there are a vast number of R/C fans who own 52 mc. *Aerotrol* equipment. We would appreciate an article showing how to convert this equipment to the citizen's band, 27.255 mc."

John A. Schum
Rochester, N. Y.

We agree, and are making every effort to secure such an article for a forthcoming issue.

★ ★ ★

PHONO IN YOUR CAR

"I HAVE read that you could enlarge the glove compartment of your car so as to fit one of those little 45 rpm record players in it.

"That's fine, only how do you run it? It is built to run on 110 volts a.c., and the car has 12 volts (in my case), or 6 volts d.c. What do you have to do: buy a special-made player built to run on 6 or 12 volts? A transformer used to step up the power might do it, but this would be too expensive. Do you have an answer?"

David Faulkner
Nutley, N.J.

Unfortunately, the only solution is more expensive than the "transformer" idea you have *already rejected as too expensive. What you need is an inverter or converter designed to change low d.c. to 110 volts a.c. Different models of this type of unit are available on the market, such as the* ATR *inverters, the* Cornell-Dubilier *converters, and the* Terado *converters. Prices range from about $10.00 to $50.00 depending on the model's capacity and other features. We suggest a trip to your local parts jobber or a study of his catalogue. Regarding the "transformer used to step up the power," a transformer can act only on a.c., or on the ripple component of pulsating d.c., neither of which is available from the battery in your car, which furnishes pure d.c.*

★ ★ ★

EDITORS' HOBBIES

"AS EDITORS of a hobby-type magazine, you people must have interesting hobbies of your own. Mind telling what they are?"

Hal Kimball
Des Moines, Iowa

Aside from everyone's abiding interest in electronics, each of us has a pet hobby. Oliver Read collects old cylinder and disc phonographs. As a matter of fact, he would like to hear from anyone having equipment, parts, horns, accessories, or catalogues relating to any of the following: early Edisons, Graphaphones, Berliner Gramophones, and early Victor talking machines.

O. P. Ferrell is concerned with wave propagation. John K. Frieborn busies himself with "designing electronic circuits, and growing up with five children." Hi-fi and chess are among Norman Eisenberg's chief interests, as well as "raising a big poodle who hasn't yet learned he's only a dog." Charles Tepfer is a veteran R/C enthusiast as well as an amateur tape recordist. Marie Alpert makes her own greeting cards and sculptured pieces; also mounts cartoons on the walls for the amusement of hard-working editors.

★ ★ ★

ZERO OHMS EQUALS SHORT CIRCUIT

"IN 'After Class' (March issue, page 110), the quiz showed (b) as the answer to question no. 4. The answer should be (a)."

Frank Klein
Philadelphia, Pa.

"WITH reference to 'After Class' (March issue), the answer given on page 128 to question no. 4 is wrong. The answer should read $8\frac{23}{38}$ ohms."

H. Trochei
St. Jean, P. Q., Canada

Sorry, fellows, but our answer is correct. "Zero ohms" is a short circuit, not an open circuit. With "zero ohms substituted for the 7 ohm resistor," as the question specified, the entire circuit is shorted out, and its resistance becomes zero ohms, answer (b). End

For other letters containing technical questions of general interest, see our new department, "What's The PE Answer?" on page 102.

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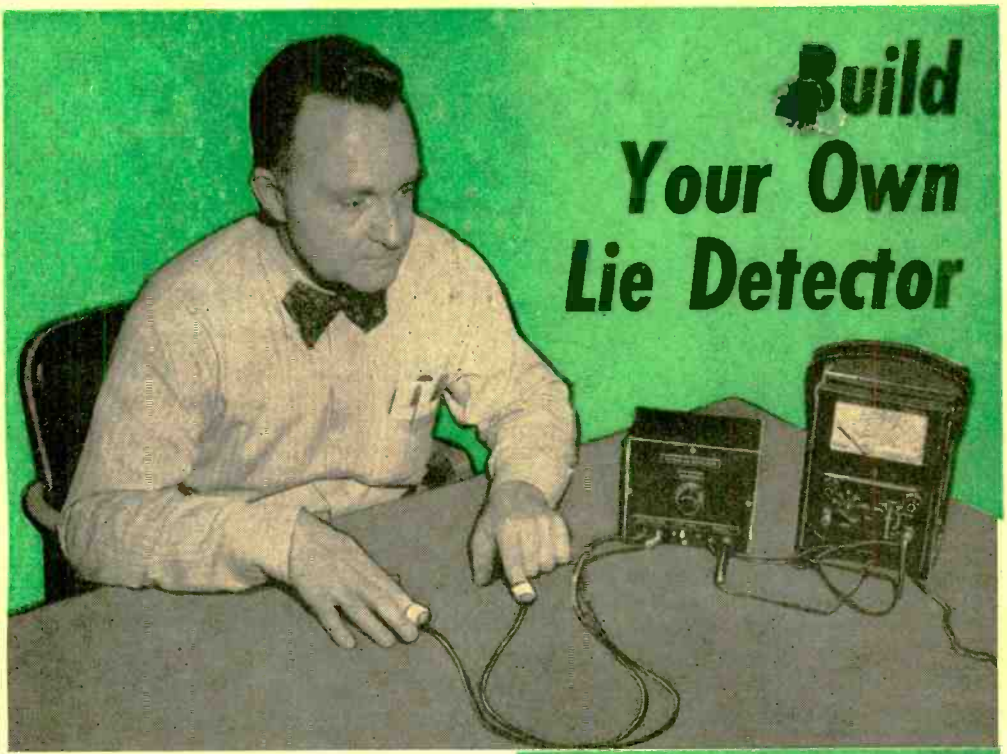


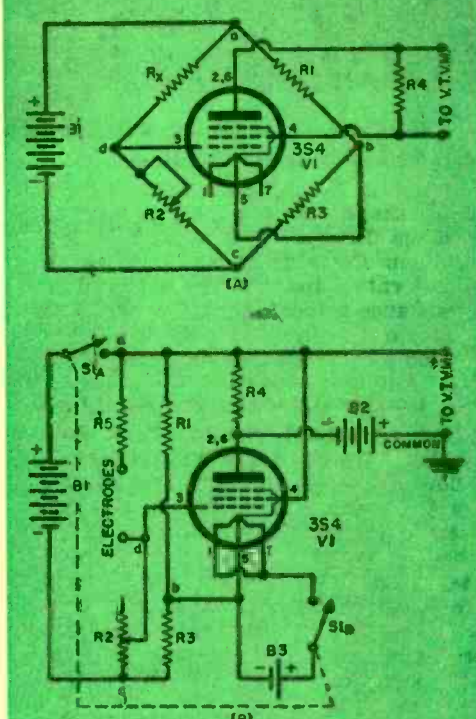


Fig. 1. See text for details on wiring.

INTERESTED in a gadget to take to a party? How about something for the classroom? Studying experimental psychology? Want to see what else can be done with electronics? Then here is an interesting answer. A simple circuit consisting of one tube, three batteries, four resistors, and one potentiometer that will convert a v.t.v.m. into a lie detector.

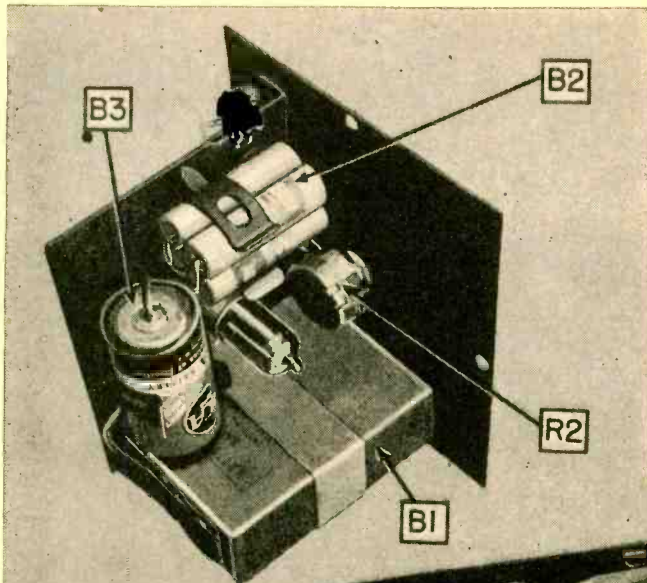
How It Works

Practically every experimenter possessing a v.t.v.m. has measured his own skin resistance. Unknown to many is the simple fact that this resistance is an important part of the usual lie detector.

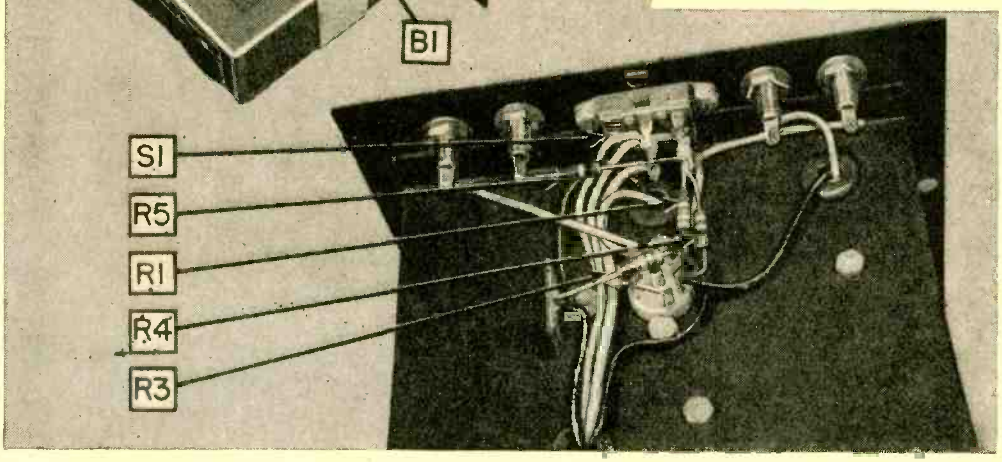
Skin resistance is the measurement in ohms of the actual resistance from one part of the body to another. Usually the measurement is made from hand to hand. Major changes may be easily noted simply by holding the probes in the two hands. If the ohmmeter were sensitive enough, the operator could detect small changes that are related to emotional stresses and which can be used as a so-called lie detector.

To observe these small changes in the skin resistance an amplifier circuit is required. Because this circuit must be sensitive, a v.t.v.m. must be used as the indicating device.

The basic circuit of the lie detector amplifier is shown in Fig. 1(a). Note that the



Above chassis view showing the location of the batteries. Note that the instrument is laying on its side in this photo.



Under chassis photo with callouts indicating some of the important components. The switch mounted between the phone tip jacks may be either slide or toggle.

four resistors, R_1, R_2, R_3, and R_x form a diamond shape, or the properly called Wheatstone Bridge. This circuit is balanced when R_x is to R_2 as R_1 is to R_3. These are ratios and not necessarily absolute resistance values. The tube wired into the center of the circuit is used as a detector to find any unbalanced condition of the bridge.

If R_x is made the skin resistance of the body and the variable resistor, R_2, is carefully adjusted—then there will be no current flow through the tube and no reading across R_4 by the v.t.v.m. Should the skin resistance decrease the point shown as "d" will become positive with respect to point "b" and current will flow through the tube and be read on the v.t.v.m. as a voltage drop across R_4. As the skin resistance increases, or returns to a normal value, the reverse situation occurs and the voltage reading across R_4 drops.

Actually the operation of the circuit is slightly more complex since we have neglected the factor of grid bias. This is considered in the final wiring schematic of the lie detector which is shown in Fig. 1(b).

Batteries are used in the lie detector in order to insure freedom from voltage changes that might upset the balance of the bridge. Battery, B_1, is a 67½-volt unit that supplies the bridge and plate voltages. Resistors, R_1 and R_3, are adjusted so that they draw about 1.0 milliampere when switch, S_{1a}, is closed. Battery, B_2, consists of four penlite cells in series. These are used to "buck" the voltage drop across R_4 so that the v.t.v.m. may be set upon a sensitive "plus d.c. volts" scale.

The operating voltages of the bridge may be checked by the v.t.v.m. before the unit is fully enclosed in its case. They should measure: plate-to-cathode 23 volts, screen-to-cathode 30 volts, and grid-to-cathode — 6 volts.

Construction

The mechanical layout of the parts and components used in the final wiring diagram Fig. 1(b) and the pictorial schematic Fig. 2. is relatively unimportant. In other words, they can be placed at the discretion of the builder. Some may want to "breadboard" the bridge-style lie detector, while others may want to follow our suggested layout in a *Bud* utility cabinet with the self-contained chassis deck. The two behind-the-chassis photographs show how the parts were laid out. The only exceptional piece of material is the mounting bracket for the 67½-volt battery. The bracket is shown in Fig. 3. It may be cut from copper, brass, or aluminum.

Batteries, B_2 and B_3, are soldered into the circuit. Both of these batteries are held to the chassis by *Mallory* capacitor mounting brackets type TH-25.

The electrodes that attach the lie detector to the "subject" are wired using insulated flexible wire similar to *ICA* #307. At one end of each piece attach an insulated phone tip, *ICA* #868 and #869. At the other end of each length of wire attach a small copper disc about ⅜" in diameter. Solder all of these connections and make sure that the underside of the copper electrode contact is bright and shiny.

Operation

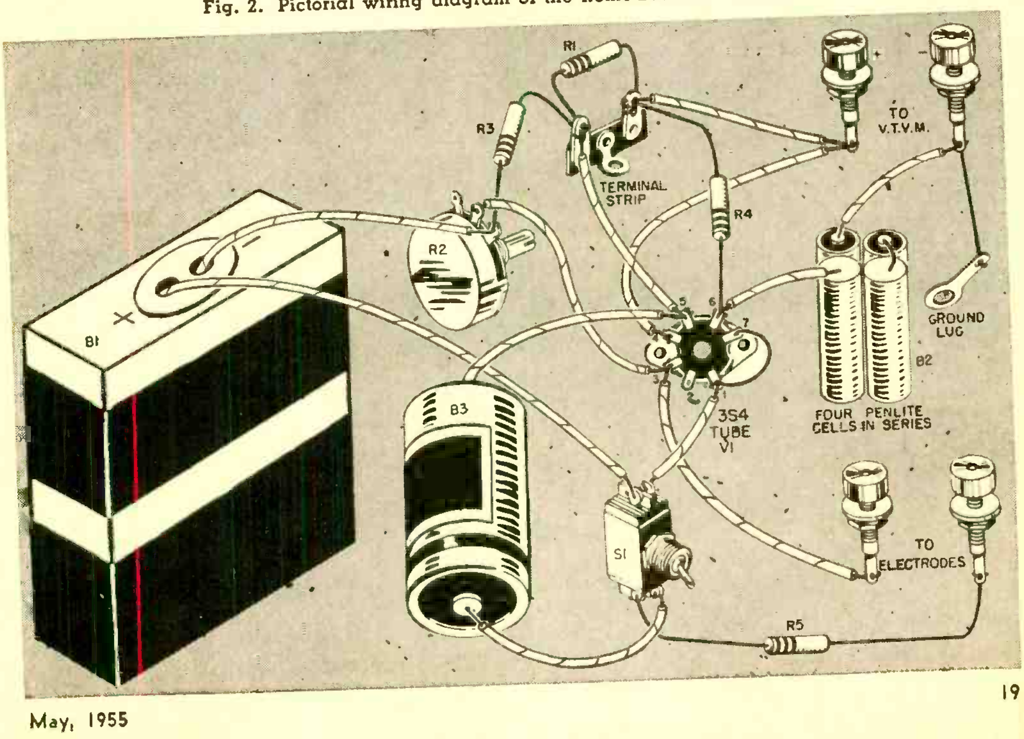
Carefully tape the electrodes to the two index fingers of the "subject." The electrodes must be held firmly in position while the lie detector is in use. If the "subject" attempts to jar the electrodes, or move about, the skin resistance will change violently. Normally with this instrument the skin resistance will be about 250,000 ohms at 70° and 100,000 ohms at 90°. The operator may find it interesting to experiment with the position of the electrodes once he has become familiar with the operation of the lie detector.

After the electrodes have been fully secured to the "subject," turn on the lie detector and at the same time set the v.t.v.m. on the 0 to 5 volt scale. With the "subject" breathing easily, adjust the "balance" control on the lie detector until the meter needle rests in the lower third of the scale. If the room is warm, or if the "subject" is perspiring, it may be necessary to use the v.t.v.m. scale of 0 to 15 volts or

R_1—39,000 ohm, ½ w. res.
R_2—1.0 megohm pot, Centralab C-1 taper
R_3—47,000 ohm, ½ w. res.
R_4—10 megohm, ½ w. res.
R_5—100,000 ohm, ½ w. res.
B_1—67½-volt battery, Eveready #467, or equiv.
B_2—Four penlite cells wi[illegible]in series, Eveready AA #915
B_3—Flashlight cell, 1½ vo[illegible]
$S1_{a,b}$—D.p.s.t. slide switch, Birnbach #6247
V_1—3S4 tube
1—Battery plug for B_1, Cinch-Jones #5MFA
2—Capacitor mounting clips, Mallory TH-25, see text
1—Utility cabinet, Bud #C-1797
1—Seven pin miniature tube socket
4—Insulated phone tip jacks, two in red, two in black, ICA #1889 and #1890.
2—Insulated phone tips, ICA #869 and #869.
Hookup wire, grommets, tie-points, etc.

Total cost of parts should be about $9.50.

Fig. 2. Pictorial wiring diagram of the home-built lie detector.



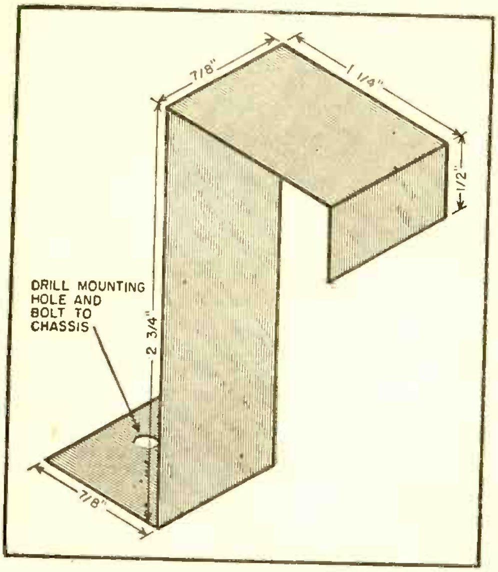
higher. The "subject" may be aware of a very slight tingle under the electrodes. This is not harmful and in most cases will not be felt.

Carry on a normal conversation with the "subject" and note the minor variations of the meter needle. It is often best not to let the "subject" see the meter readings as these may have some influence on the skin resistance.

Ask the subject to take ten or twelve very deep breaths. These should cause the meter needle to swing gradually upwards across the scale. This action will be slow and the operator must be ready to re-balance the lie detector after each upward swing. This simple test will assure the operator that the equipment is in operation and that the electrodes are properly attached.

If the operator is aware of some question which might confuse or embarrass the "subject" without being insulting, he might try springing it suddenly on the "subject." If the "subject" has strong emotional feelings, the meter needle will again swing upward after only a moment's hesitation. The strength of the response can be judged by the extent of the swing and how rapidly it occurs. The operator must be ready again to re-balance the lie detector as the skin resistance will not return immediately to its normal value.

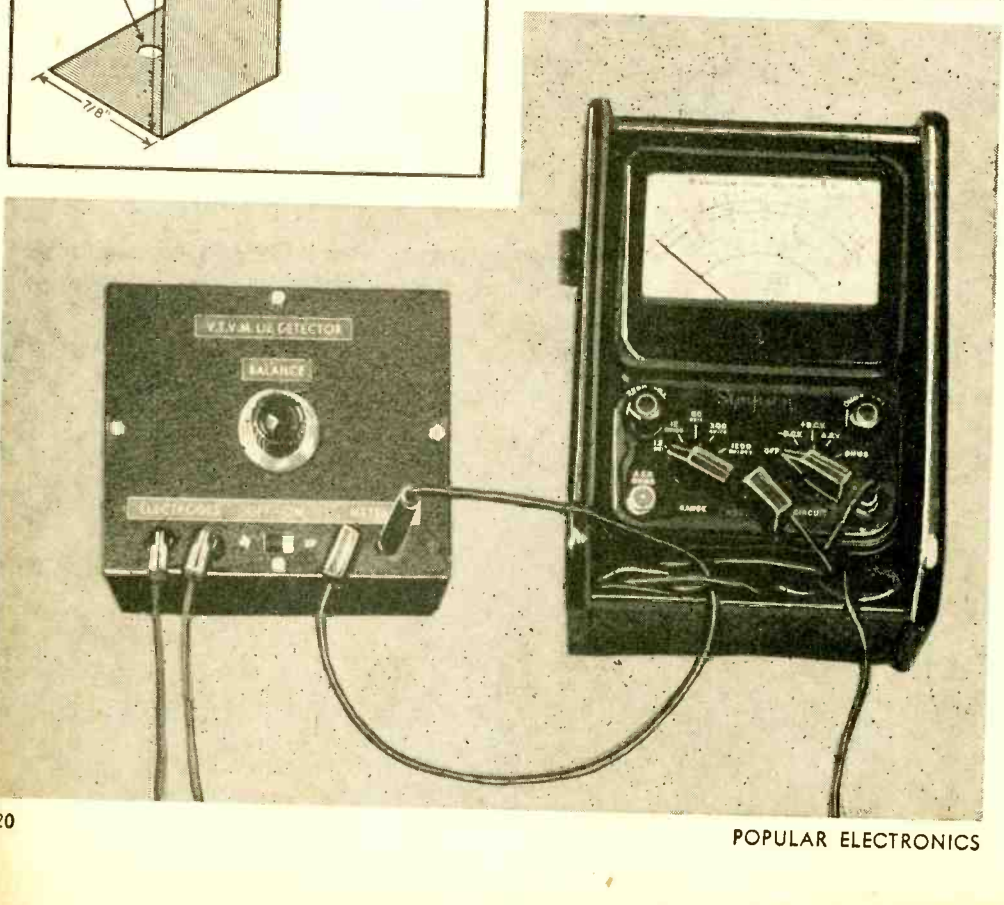
Fig. 3. Bracket for holding the B battery.

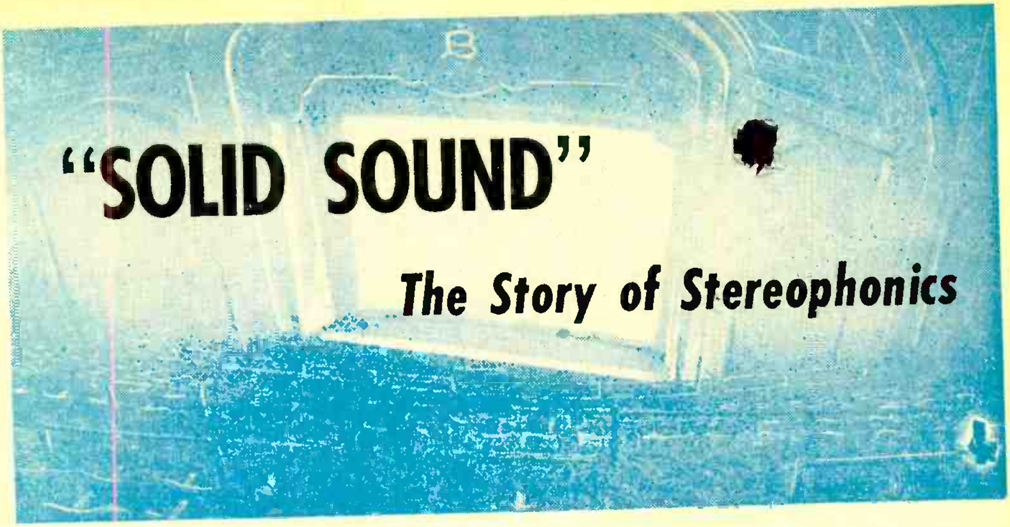


Acknowledgement

The original plans for the lie detector were suggested by Joseph A. Fiederer. Additional construction and photographs by Edwin T. Kephart. END

Front panel view of the lie detector. Any one of the readily available v.t.v.m. units may be used. The common 1000 or 20,000 ohms-per-volt meter will not permit efficient operation of the detector.





"SOLID SOUND"

The Story of Stereophonics

By NORMAN EISENBERG, Feature Editor

MOST current interest in stereophonic sound began with the impact of *Cinerama* on September 30, 1952 on Broadway, New York, when the wonders of a new vision in cinema and a new dimension in sound burst upon a startled and unbelieving audience. A year later, in November 1953, *Fox-Cinemascope's The Robe* was shown. To this day, as then, movie audiences have been thrilled and intrigued by the stereophonic technique.

Embodying "something old, something new," it came about as a result of the movie industry's attempts to revitalize itself, as well as the efforts of *Altec Lansing* to provide the movie industry with a means of enhancing film entertainment.

Before stereophonic sound, motion pictures employed "single point" sound. A single sound track, recorded onto the film, reproduced all audio over one loudspeaker system. Suitable for the small size screen, this method was inadequate for wide-screen presentations.

But even before the advent of the wide screen, technicians were experimenting with multiple channel sound. On April 27, 1933 at Constitution Hall in Washington, D. C., Dr. Harvey Fletcher used stereophonic sound to demonstrate the quality of the new telephone channels developed by the *Bell Telephone Laboratories*. Three such channels carried a concert by the Philadelphia Symphony Orchestra to three specially designed speaker systems in Constitution Hall. The demonstration was a complete success.

"Stereosound" was next heard in Carnegie Hall in New York City in 1937 when *Bell* again demonstrated its potentialities, this time from three sound tracks recorded on motion picture film, but with no picture. Then in 1940 the film public was introduced to stereophonic sound in Walt Disney's *Fantasia*. Wide-screen techniques had not yet been developed; the new "stereosound" was very expensive; and there was a war—so "stereosound" disappeared from the public ear, although technicians continued to work on techniques and equipment. Early in 1945, a group of motion picture studios, sound recording firms, and *Altec* conducted experiments in stereophonic recording and reproduction for the movies. Dr. Fletcher's speaker systems were shipped to the West Coast and analyzed. Out of this study came further developments in *Altec's* equipment.

The Higher Hi-Fi

In 1947 a group of film makers undertook to produce a film that utilized a gigantic screen and a stereophonic sound system with *seven* sound tracks. Five tracks powered five speaker systems behind the screen; two sound tracks fed a multiple of "surround" speakers. The first complete installation of this system was made by *Altec* in an enclosed tennis court in Oyster Bay, Long Island. It worked perfectly—and *Cinerama* and stereophonic sound were a reality.

Cinemascope, termed by filmdom "the poor man's *Cinerama*," enables wide-screen techniques to be used on an economical and practicable basis, while still incorporating the benefits of stereophonic sound.

Anyone who has seen such *Cinemascope* productions as *The R[illegible]* or *Demetrius and the Gladiators* cann[illegible]ail to recall the intense realism of the films' soundtracks: the voices of actors seemed to move across the screen with the performers; far-off shouts actually seemed to come from a distance; drum-rolls and other non-human sounds flooded the theatre with a crisp realism and "presence" that were startling in their resemblance to a live performance. This was high fidelity plus! This was real! This was—literally—*solid sound!*

The new dimension imparted to sound reproduction by stereophonic techniques involves two well-known principles. The first is that the realism of sounds reproduced in connection with a visual presentation can be heightened if the audience can identify the source of the sound. To accomplish this illusion successfully in wide-screen presentations involves different loudspeakers placed in different spots.

But this automatically involves the second principle, which is: the more speakers used to reproduce a given set of sounds, the less work any single unit will have to do, the more efficiently it can operate, and the closer it can be designed to perform its particular job well . . . *provided* the speakers, their enclosures, their crossover points, their phasing, their placement, and the entire chain of components and techniques used to feed sound into them are all properly engineered and set up.

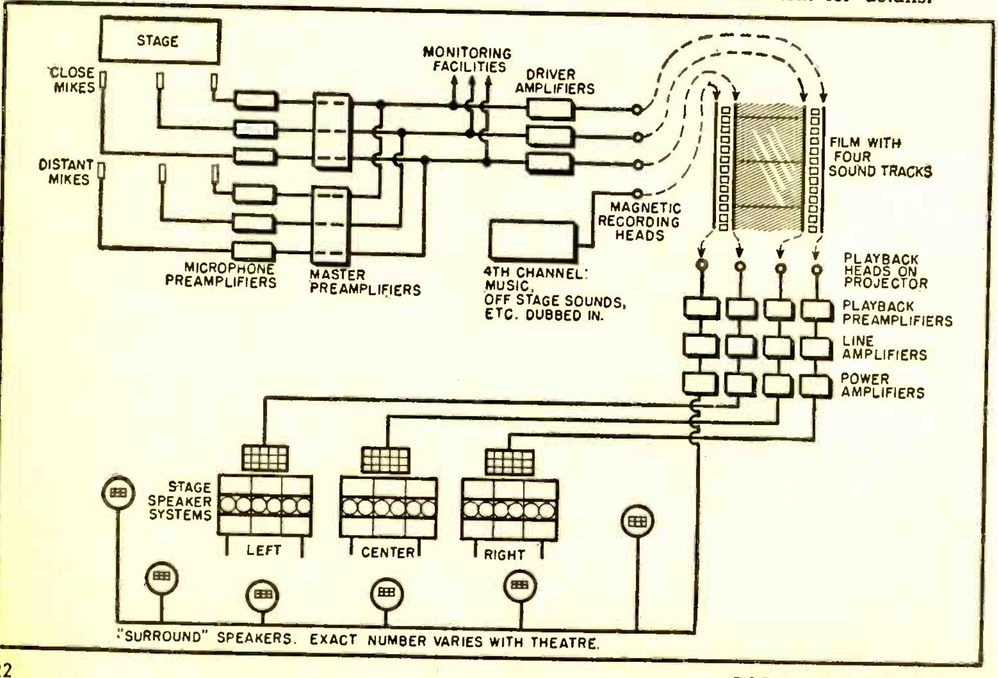
This, of course, is what is involved in true stereophonic sound. Anything less—to the extent that it is less—is not stereophonic sound, but a modified version of it, such as the much-abused term "binaural."

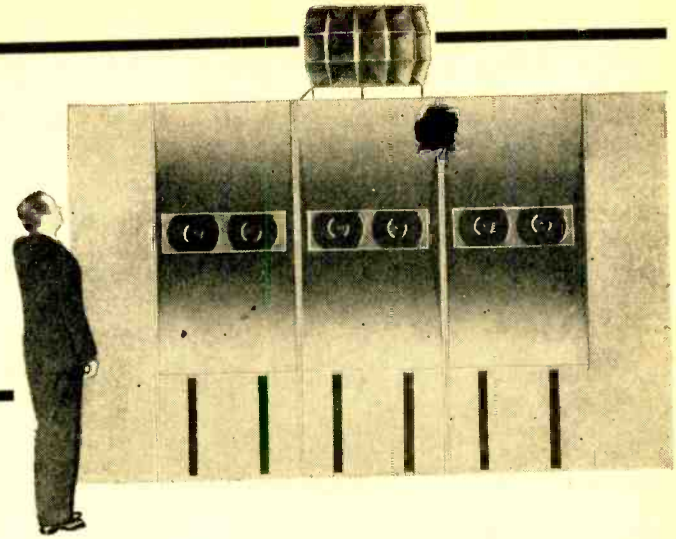
True stereophonic sound encompasses all the advantages of single-channel high fidelity sound (wide range, minimum distortion, balanced highs and lows, etc.) *plus* the use of several channels to create the directional or point-of-origin illusion with respect to left, center, right, and background sounds. *Altec's* version of stereophonic sound uses four channels. The accompanying block diagram illustrates this, and suggests the multiplicity and complexity of equipment and acoustical know-how that go into a good stereophonic sound system.

Recording

To pick up the voices and immediate sounds present on the stage, the scene is divided into three sections: left, center, and right. Each of these sections has its own sound channel. One microphone may serve for each channel, but two or more—strategically placed—for each channel may provide better results. (Two microphones for each channel were used to record *The Robe*.) A fourth channel is created by a fourth group of microphones so placed as to pick up such background sounds as mu-

Block diagram of typical stereophonic sound system, showing how the four sound channels are recorded, impressed onto film, and played back in theatre. See text for details.





Altec's "Voice of the Theatre" speaker system includes multicellular high frequency horn that sits atop baffle housing six low frequency units. System is over 10 ft. high.

sic, off-stage sound effects, and noises that are supposed to be distant with reference to the scene being recorded. Or, this fourth channel may be created by previously recorded sound effects. Sometimes both live and recorded sound are fed through this fourth channel.

Sounds picked up by the microphone (or microphones) set up for each portion of the stage are then fed to separate preamplifiers, one for each microphone used. The outputs of the group of preamps for the "close" microphones are fed to a "master preamplifier." Similarly, the output signals from the "distant" microphones are fed to another "master preamplifier." Each "master preamplifier"—sometimes called a "line amplifier"—has three channels to handle signals corresponding to left, center, and right stage.

The outputs of both "master preamplifiers" are then combined and fed to driver amplifiers which generate the power to run the magnetic recording heads. These, in turn, impress three magnetic sound tracks onto the film. The fourth track may be dubbed in at this point from previously recorded sounds. The final film has four separate sound tracks. Provision for monitoring the stage sounds is made between the line amplifiers and driver amplifiers.

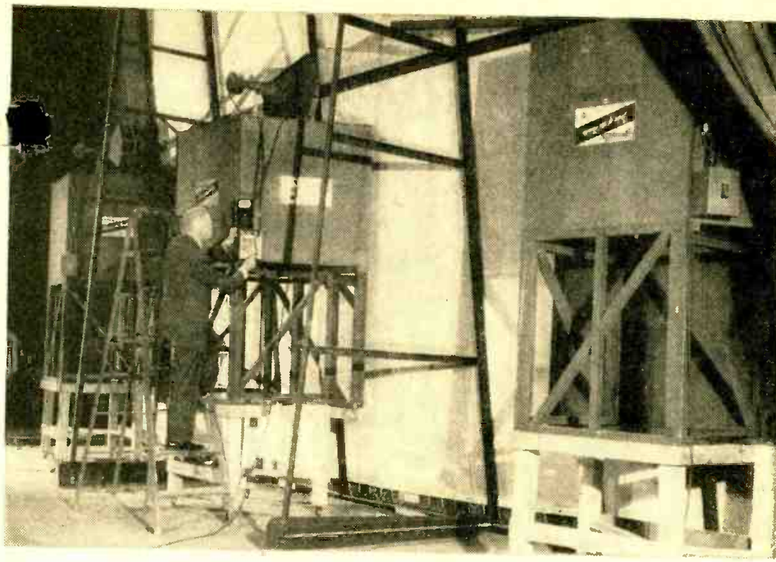
Playback

During playback, the film passes through four magnetic playback heads installed above the projector head in the movie projector. Each playback head feeds into its own playback preamplifier, thence to its own playback line amplifier, and finally into its own playback power amplifier. Each power amplifier drives a separate loudspeaker system.

Three loudspeaker systems are set up on the stage, directly behind the wide screen. The size of the playback speaker system varies with the size of the theatre, from a single woofer and tweeter such as *Altec* Model A-7 to the largest "Voice of the Theatre" system—an imposing reproducer which uses six woofers and a 15-unit multicellular horn for the tweeter. Three such complete systems face the audience from behind the movie screen: one on the left, one in the center, and one on the right. Thus, the three channels, originally recorded from the live action on the set, are reproduced. Simultaneously, the fourth power amplifier drives any number of coaxial speakers placed at strategic spots all about the theatre—sides, top, and rear. These "surround" speakers reproduce all the sound effects, distance sounds, background noises etc. that were recorded via the fourth channel during the original "take". Thus, the total number of speaker units that may be used in a 1500-seat theatre may reach as high as fifty!

However, the important thing to remember about stereophonic sound is not the number of speakers used, but the fact that they are divided into separate groups, each of which handles the sound output of its respective channel. For optimum performance, each group must be capable of handling sufficient audio power to fill the entire theatre, and must meet rigid requirements of power capacity, sound diffusion, and frequency response. In addition, every speaker used in any single theatre must be matched, phased, and balanced with respect to every other speaker unit. And all this must be done with respect to the acoustical and architectural characteristics of the theatre building itself and within

Three "Voice of the Theatre" speaker systems being adjusted behind movie screen. Located at left, center, and right, they help audience identify source of sounds coming from stereophonic sound tracks. In addition to these, several other speakers surround audience for background sounds.



the limitations of economy and simplicity of operation. Martin Bender, *Altec* engineer, has spent as much as five days setting up a stereophonic system in one theatre.

Once the system is set up and tested, the operator takes over—but not until he has received careful instructions. Charged with the responsibility of assembling and installing 75 percent of all the stereophonic sound systems presently used in the United States, *Altec* has instituted a series of instructional clinics at which expert field engineers conduct briefing sessions for theatre owners and projector operators. In addition, *Altec* handles any service and maintenance problems on the equipment.

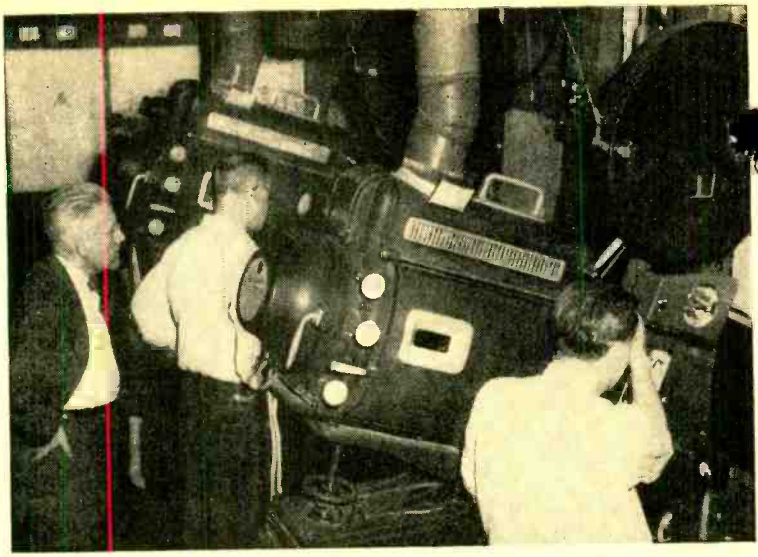
What Is Its Future?

Without doubt, stereophonic sound is here to stay. Like television and high fidelity, it has captured the public. Because it is innately tied with a new movie technique—the wide screen—the chances are it has already been and will continue to be witnessed and appreciated by as many, if not more, than either TV or hi-fi. In one sense, the combination of *Cinemascope* and stereophonic sound is a formidable entertainment giant that embodies the best features of both color television and high fidelity reproduction. And, since it does not depend on individual consumer sales for its life as does television and hi-fi, it is less apt to suffer during any possible periods of economic set-back. As a matter of fact, if we can learn anything from the depression of the 1930's, it is that advances in the mass entertainment field are likely to prosper regardless of what the rest of the world's industry does.

Certainly it is, to date, the best method the movies have found to project the sound portions of films. Furthermore, it is relatively simple to use once installed in a theatre. Booth personnel do little more than they did previously to project conventional film and sound. The operator cannot change the directional effect of stereosound during the running of a film. All he can do is regulate the over-all volume of the four channels simultaneously. Their relative levels are pre-set by the film makers; the playback characteristics of the amplifiers and the theatre speaker systems are all adjusted by installing technicians and sound engineers. The chance for error is reduced almost to nothing; probability of optimum performance enhanced infinitely. But just as the wide screen depends on "stereosound," so does "stereosound" seem to depend on the wide screen for its justification. For without the wide screen the need for three separate speaker systems would be largely negated. The movement of actors on the screen would be limited to the point that one speaker system could be sufficient to maintain the illusion that the sound heard emanates from the point-of-origin seen by the audience. In other words, conventional projection methods do not require the audience to identify the source of the sound beyond the general area of the screen. Which raises a final, interesting question: does stereophonic sound have any application outside the movies?

Sound in the Home

Its place in the movies is assured. But like other movie "firsts," notably the coax-



Close-up view inside projection booth during showing of Cinemascope film using stereophonic sound. Magnetic sound reproducer is installed below upper film magazine, and just above picture mechanism on projector. This position requires the sound to be 28 frames ahead of its corresponding picture.

ial speaker, will it too find its way into the home? What is its relation to high fidelity systems in general? This question divides itself into two parts, concerned with the two reception media used in the home, i.e., video and sound. Martin Bender, *Altec* engineer, is presently conducting research to investigate the possible use of stereophonic sound in conjunction with television shows. Obviously, the advantage of "stereosound" in connection with TV will not become manifest until larger screens are in use—but the germ of the idea is alive.

Perhaps of more immediate concern is the question of stereophonic sound in conjunction with the reproduction of music, either as records played in the home or as radio programs received in the home. Here, the need for combining visual action with point-of-origin sound sources (which is the case in films) does not exist, but the question—as well as several answers—arises of added fidelity by using more than one channel for music. This is not to be confused with using a two-way or three-way speaker system to reproduce one channel. In "stereosound," any number of completely independent speaker systems may be used, one for each channel. The basis for stereophonic sound is that multiple channels are set up at the sound source to begin with. The present so-called "binaural" broadcasts are actually a modified kind of stereophonic technique, limited by certain obvious factors: the chief being that one channel depends on AM reception and is usually heard over an inferior AM set that doesn't compare in quality or capability with the newer FM set that is reproducing the other channel. True stereophonic sound in the home would require pairs, or better, triplets of tuners, amplifiers, and speakers that are matched, balanced, and correctly placed. Such a system might be too big to do any real good in an average size room. On the other hand, true "binaural" involves the use of headphones in which one earphone reproduces only what would be heard with one ear during the live performance.

Nevertheless, listening to the AM-FM "binaural" set-up has made many happy, and listening to two quality systems at once has made others happy. But it should be remembered: what is thus heard is neither true binaural nor true "stereophonic," but a compromise between them. Many authorities maintain that the only valid place for stereosound is in the theatre or large auditorium. And there are still others who will disagree that music sounds better coming from different parts of the room than it does coming from one portion of the room. A good, single channel system is still an expensive goal for many music lovers—it is going to take a lot more *per capita* income, and a lot more sales talk to convince listeners, *en masse,* to go in for complete stereophonic systems in their homes.

But the ferment about it is by no means purely theoretical: several FM stations are contemplating "binaural" broadcasts on two FM channels as soon as additional channels are available. And multi-channel tapes for home recorders may soon appear. Finally, we can be sure that if the public shows promising signs of accepting these new developments, equipment manufacturers will, sooner or later, place on the market the components needed to enjoy them—sized and priced for the home! END

How to "Arrest" Lightning

By ELBERT ROBBERSON

NINETY times a year, lightning hits somewhere around Tampa, Florida. But wherever a person lives, he begins to wonder about his antenna when one of those storm clouds begins to spit fire.

I have watched my own antenna during a lot of thunderstorms, and it looks like it keeps getting higher and higher, the closer the thunder rolls. When the bolts start hitting close, the antenna looks as if it's the highest place around for miles, and it seems to be begging for an electronic visitor.

"Look, now," I tell myself, "with a lightning arrester or a grounding switch, an antenna is perfectly safe during a thunderstorm. Stop worrying!"

Then I answer myself right back. "That may be true," I say, "but does the lightning know it?"

Lightning *does* know about lightning arresters. If one is installed properly, the bolts from the blue will obey the natural law and high-tail it to ground without touching the equipment. But if there has been a slip-up somewhere, a whole basket full of arresters is not going to provide protection.

First, let's prove that lightning is educated to know how it should act around an arrester. A simple experiment which can be hooked up on a workbench will show the principles involved. If it is tried before the installation of any lightning arresters, the constructor will be more likely to do the job right because he will know the principles as well as the lightning does.

A miniature lightning bolt could be made with the ignition coil from a car. It bangs out a shot of high voltage that will leap almost a half inch through the air. To do this, use the hookup shown in the diagram.

The electrode connected to the high-tension coil terminal takes the place of the charged cloud in a thunderstorm. The terminal directly beneath stands for the antenna. The additional gap directly underneath goes to ground, and is the lightning arrester. The coil off to the side represents the lead-in wire going inside the house to the equipment, while the extra spark gap with the close spacing is what I would call an "air-gap voltmeter" because high voltage at this point will cause a spark to appear.

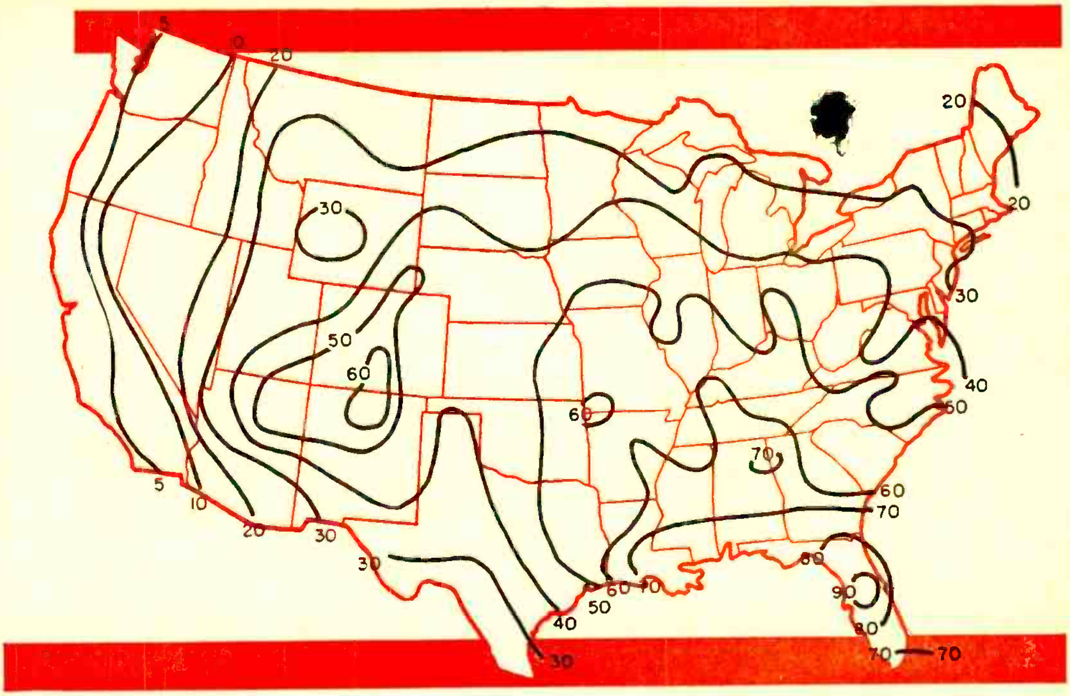
Press the key, then release it quickly. On the release, a spark should jump from the "cloud" to the "antenna" then across the "lightning-arrester" spark gap to ground. No spark will show at the "air-gap voltmeter," *even if this gap is somewhat shorter than the one in the "lightning arrester."* Something has made this shorter gap, which would be thought to be the "path of least resistance", *actually a path of highest resistance.* So the bolt is discharged across the lightning-arrester gap to ground, without ever getting inside the house.

The "something" which has made the path inside the house a high-resistance route is the *inductance* of the wiring and the equipment. Inductance has the electrical property of *reactance* and this looks just like an "open circuit" to the fast-traveling front of the lightning bolt. The more curly and roundabout the wiring is, the greater the reactance.

Likewise, something has made the path through the lightning arrester to ground, even across a longer gap, look like the path of least resistance to the lightning. This "something" is the *lack of inductance.* The straighter and more direct this path to ground can be made the easier it will be for lightning to get through.

There are over twenty different lightning arresters on the market, but all of them depend on these principles for operation. Most arresters are simply a spark gap in a convenient package, although there have been models that use a neon tube which "fires" at about eighty volts, instead of an air gap. The idea behind this is that the arrester path to ground will break down at a lower voltage than an air gap, and so will have still less resistance to the lightning bolts.

One arrester should work as well as another if it is installed right. Suppose we want to protect a TV antenna. First of all, the pipe supporting the antenna elements

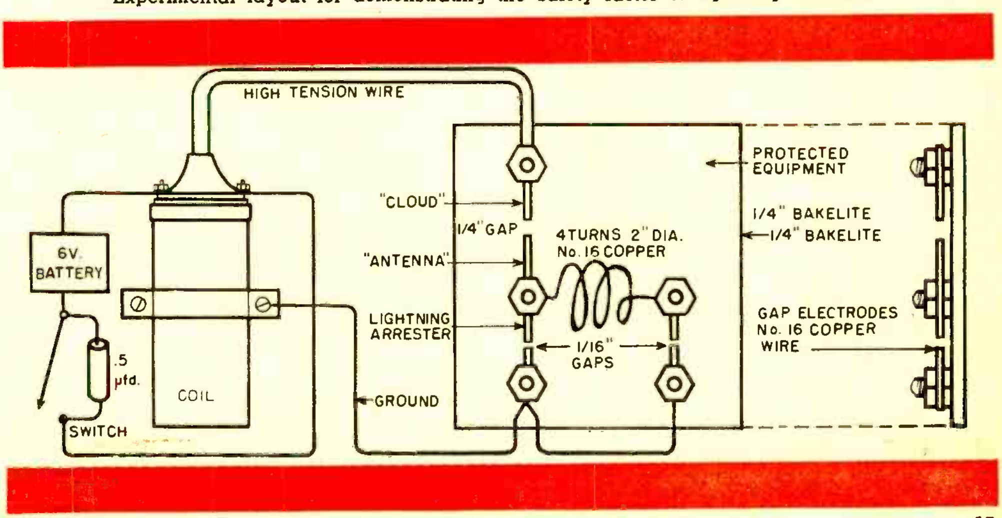


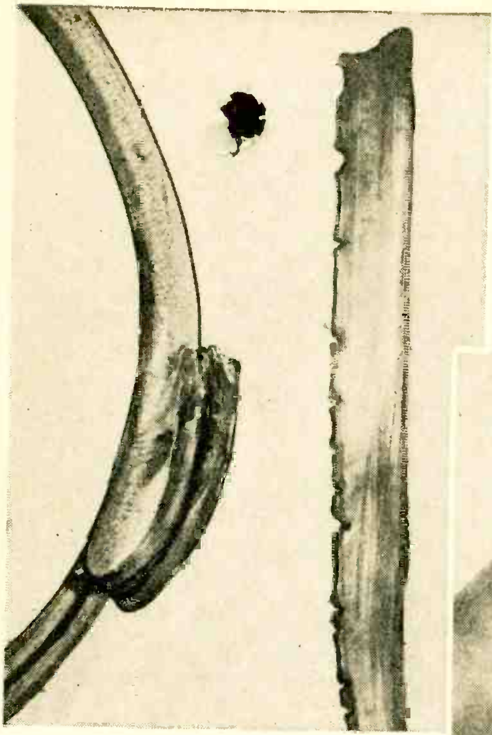
This map will give the reader an approximate idea of how many days each year severe thunderstorms and lightning may be expected. San Francisco readers generally have only 4 or 5 severe storms each year, but readers in New Orleans will experience 70 or more lightning storms.

should be grounded with a wire of 10-gauge or heavier. And no matter how many protective devices there are down below, do not omit this heavy ground wire. If a lightning bolt should decide to come down the antenna, and its only path is a comparatively flimsy "twinlead," the bolt might very easily melt the small wire, then jump to the nearest other object around. In this process, it could blow a hole in the house. *Be safe*: put a heavy ground on the support. Aluminum, copper, or copper-clad steel wire can be used.

Make the ground "run" straight and direct, with no sharp turns or bends. At the bottom, the wire should connect to a water pipe if one is handy—but if the nearest one is around the corner somewhere, forget it.

Experimental layout for demonstrating the safety factor of lightning arresters.

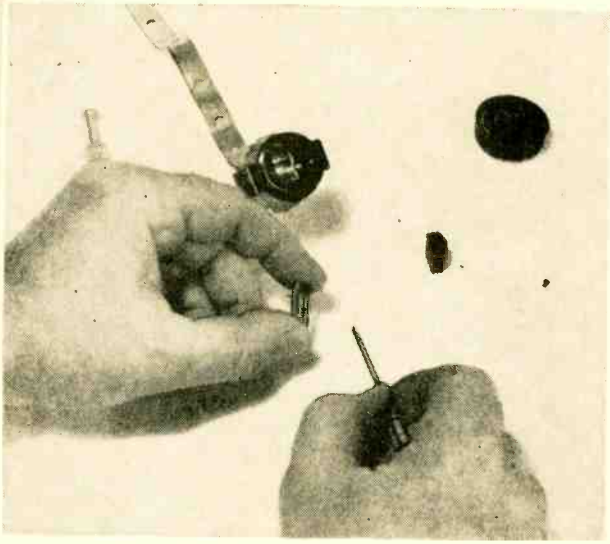




Examples of TV lead-in wires shown above have been attached to antennas struck by lightning. On the left is a short piece of tubular TV lead-in. All that is left is the tube since the copper wire has vaporized. On the right a flat-type TV lead has suffered the same fate, although the copper vapor punctured the wall.

In this case, make a "ground" by driving a pipe or ground rod four or five feet into the earth. Connect the ground wire to the pipe with a clamp.

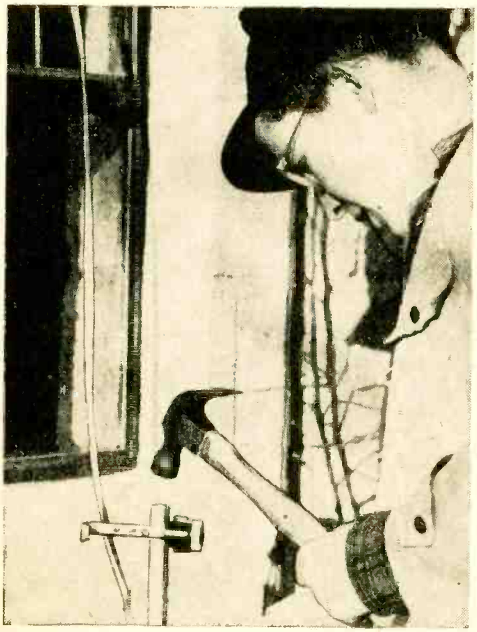
If a water pipe is used make sure it goes into the ground *right now* and does not wander around the cellar before connecting up with mother earth. A pipe that goes through the house before reaching ground can induce voltages in the thousands in any nearby metal—very undesirable in the coal bin! This is not impossible—remember how the *transformer* works; a current in one



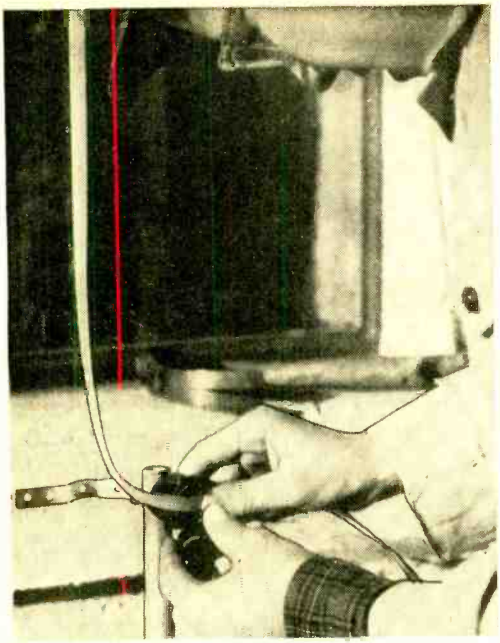
Construction of a typical TV lightning arrester. The metal strap connects to a ground pipe or rod. On top of the strap is a piece of insulation. The TV lead wires are speared by the points of the gap electrodes.

wire induces a current in another one alongside. Well, this principle works quite well outside transformers, too. A high current in the ground conductor can induce voltages in other nearby pipes or wires. Very messy! For the same reason, keep any other wires at some distance (and this means *feet*) from the ground wire down the side of the building.

Many TV antennas have the center of the dipole connected to the support pipe. This automatically protects the antenna cable at this point. If the antenna is not grounded to its support, the transmission line will last longer if an outdoor type of arrester is installed at the very top of the



These are the steps required for safe installation of a lightning arrester. In this photo a pipe is being driven into the ground close to the building where the lead-in will enter the window frame. The photo is for demonstration purposes only, as obviously it is safer to do the hammering before clamping on the arrester.



The TV lead-in at the right is placed in the arrester so that the electrode points pierce the strands of wire. Secure the lead-in with the cap of the arrester.

line, grounding it to the support pipe. This will help keep heavy current in its place—the ground lead.

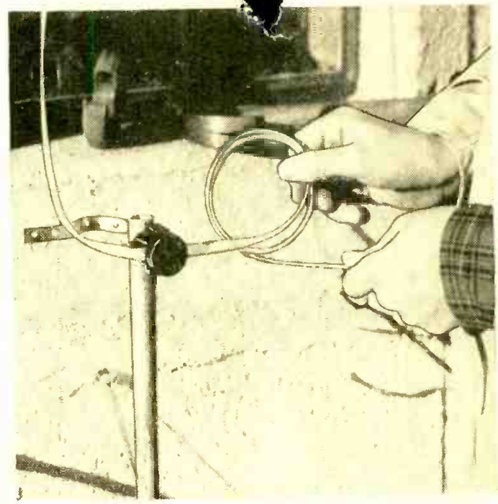
Whether or not an arrester is put at the top of the line, an arrester must be installed at the very bottom, where the lead enters the house. Just be sure that the connection to ground is direct and solid. Most arresters are made with terminal teeth that automatically make the proper transmission-line connection when the wire ribbon is clamped in place. It is not necessary to skin off the insulation.

The protection can be made even more certain by winding about a foot of the lead-in wire *on the equipment side of the* arrester into a 2- or 3-turn "lightning choke." This coil will greatly increase the reactance of the lead-in to lightning strokes; the signal will not be affected except on the higher-frequency channels. Many commercial and military stations use lightning chokes in their lead-ins.

Some arresters are advertised as having a "static" drain. All this amounts to is a high-resistance ground which is permanently connected to the antenna circuit. The idea is that any build-up of electrons from wind friction or induction will leak off instead of growing to the danger point.

Now, what happens when lightning strikes the arrester? It is certain that the

A lightning choke, which adds to the safety of the installation, is easy to make. Loop the lead-in twice on the "protected" side of the arrester and secure with cellophane "Scotch" tape. The lead-in should now enter the building, preferably at a right angle.



sparking electrodes will melt. If there is insulation in the gap, this material will char or vaporize. Any moisure inside will turn to steam. This will happen *fast*.

So if the arrester is a type which is sealed, without large exit holes for the large cloud of gas that is going to be generated in a hurry, it is quite likely to blow up. Install such arresters so flying parts won't damage anything nearby.

With practically any kind a new arrester will be needed if lightning strikes. Be thankful that this one was put in right, and shell out for a new one right away, because lightning *can* strike twice in the same place.

A person can keep it from raining by wearing a raincoat—maybe installing an arrester will do the same for lightning.

Further information on lightning and lightning arresters may be obtained from the U. S. Department of Commerce Handbook 46, Code for Protection Against Lightning obtainable from the Superintendent of Documents, Washington 25, D. C. The latest price is listed at 40 cents. Somewhat similar booklets are also available from various safety agencies and insurance companies. END

Editor's Note: The following concerns manufactured lightning arresters. Our readers are referred to their nearest TV serviceman or radio parts jobber and distributor for information on prices, installation, etc.

Amphenol, Birnbach, ICA, JFD, Radelco, RCA, RMS, Radion, Telco and Ward.

Corresponding by Tape

Above, ham operator Vic Mohrlant of Gladstone, Minnesota, tape records conversations with other hams. Right, Fred Goetz of Tape Respondents International, San Francisco, prepares 3-inch tape reel for mailing.

A NEW twist to the old idea of "pen-pals" in this electronic age is the hobby that involves "tape-pals." Known by such descriptive terms as "tape-responding," this new activity, made possible by tape recorders, has engrossed thousands in this country and abroad who "converse" with each other by means of recorded tapes sent through the mails.

Topics covered include everything in which people might be interested, from personal messages to discussions of scientific subjects. Some enthusiasts record unusual noises for the benefit of fellow-audiophiles and researchers. Many lonely or bed-ridden people are happy just for the sound of a friendly voice.

One recordist, John F. Daley, Jr., of West Haven, Connecticut, includes music from his hi-fi radio to furnish background for his voice on the tapes he sends out.

The great majority belong to clubs that issue newsletters and exchange address lists. Most clubs list a member's special interests after his name to facilitate discussions between individuals who may live thousands of miles apart and who may never meet, but who can benefit from a mutual exchange of ideas.

In addition to the clubs there are many who tape-respond on an individual basis. The big difference between the club members and the individuals is that the former communicate with people they do not know, but with whom they have common interests. The latter use tape as a means of keeping in closer touch with relatives and friends in distant places.

Anyone with access to a tape recorder can get right into the hobby by recording a tape and mailing it to someone else. To contact someone not known, the facilities of one of the tape clubs is recommended. Membership is generally open to anyone interested in the hobby and rarely costs more than a few dollars a year. The names and addresses of the tape clubs are listed below. END

Tape Respondents International
Fred Goetz, Secretary
P.O. Box 1404T
San Francisco, California

World Tape Pals
Harry Matthews, Secretary
P.O. Box 9211
Dallas, Texas

The Voice Spondence Club
John M. Schirmer, Secretary
1614 N. Mango Avenue
Chicago 39, Illinois

Global Recording Friends
Alfred Sferra, D.D.S., Secretary
125 Hamilton Street
Bound Brook, New Jersey

Record-O-Club
c/o Accessory Office Service
Dolores Franco, Sponsor
111 West 23rd Street
New York 11, New York

Tapeworms International
Art Rubin, Secretary
546 Ocean Point Avenue
Cedarhurst, L. I., New York

WIRELESS BROADCASTER

FOR FAMILY RECORD ENTERTAINMENT

By

OTTO FRIED

THE popularity of recorded music as an entertainment medium for all ages—the junior members of the family as well as mother and dad—continues at a high level. The average family usually has several radios about the house or apartment: a set in the living or dining room; perhaps a clock radio in one or more of the bedrooms; and probably a small a.c.-d.c. set in the kitchen.

A compact, inexpensive unit, which will utilize all of these sets to provide phonograph entertainment for all members of the family, is described here. By connecting a microphone to the unit, broadcasts may be made to a radio located anywhere in the house or apartment for party fun, family celebrations, etc. "Special news broadcasts," "signals from outer space," and a host of other gags will liven up any dull party or celebration. The "Broadcaster" can be used with any receiver, even though it does not have a phonograph input. The tedious job of installing and wiring phonograph input jacks on every set in the household is completely avoided.

Another unique, useful application is operating the unit as a radio nurse or an electronic baby sitter. It is only necessary to be within listening distance of a radio set. A high gain microphone or any five-inch PM speaker with its output transformer connected to the unit will monitor the necessary area. The "Wireless Broadcaster" is mounted in an out-of-reach place. Continuous operation over a long period of time will not damage the unit.

The *Knight* "Wireless Broadcaster" (available as a kit from *Allied Radio Corporation*) will work with almost any record player. A high impedance input for a crystal phono cartridge or a tuner and a high-gain input for a magnetic cartridge (*G-E, Pickering, Audax*) are provided. A crystal or high-impedance dynamic microphone may be connected to the high-gain input. A separate modulator stage permits almost

The "Wireless Broadcaster" assembled. Microphone and phono jacks are at left front, knob for volume control and power switch on apron, and frequency adjustment behind middle tube.

For party fun, to "keep an ear" on the baby, or to page the family

100 percent modulation. Negative feedback is used to minimize hum and distortion. The oscillator can be tuned in by any standard broadcast receiver, as it covers the range from 600 to 1600 kilocycles.

It is only necessary to adjust two controls for the proper operation of the unit. The oscillator frequency adjustment is easily accessible on top of the chassis. The volume control is mounted on the front apron.

Radiating the r.f. oscillator signal to any set in the average household presents no problem to the *Knight* "Wireless Broadcaster." FCC regulations provide that no license is needed for this type of device, as long as its working range is about 90 feet or less at the high frequency end of the broadcast band and increases to no more than about 250 feet at the low frequency end.

The complete unit is constructed on a single chassis. The circuit uses a 12AX7 tube for an equalized phono or a microphone preamplifier. This is followed by a 50C5 modulator. Another 50C5 generates the radio frequency carrier. A simple selenium rectifier circuit delivers the necessary B plus voltage.

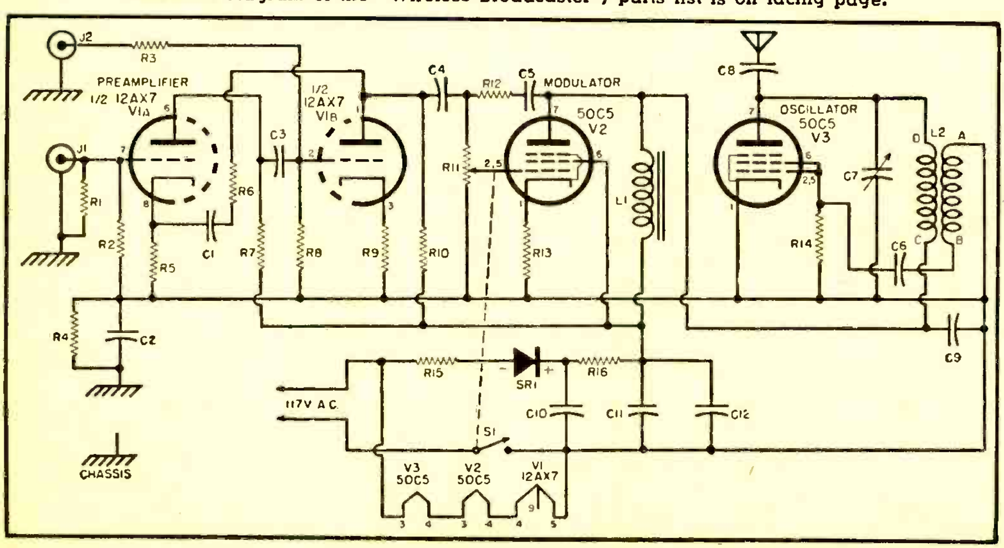
The 50C5 (V_3) stage operates as a highly stable, plate-tuned, feed-back oscillator. It is used as a triode. The r.f. output of the stage is developed across the oscillator tuning circuit, which consists of C_7 and the primary of L_2. C_7 is a special 470 μμfd. trimmer capacitor. This part and the special oscillator coil, L_2, are available from *Allied Radio Corporation.*

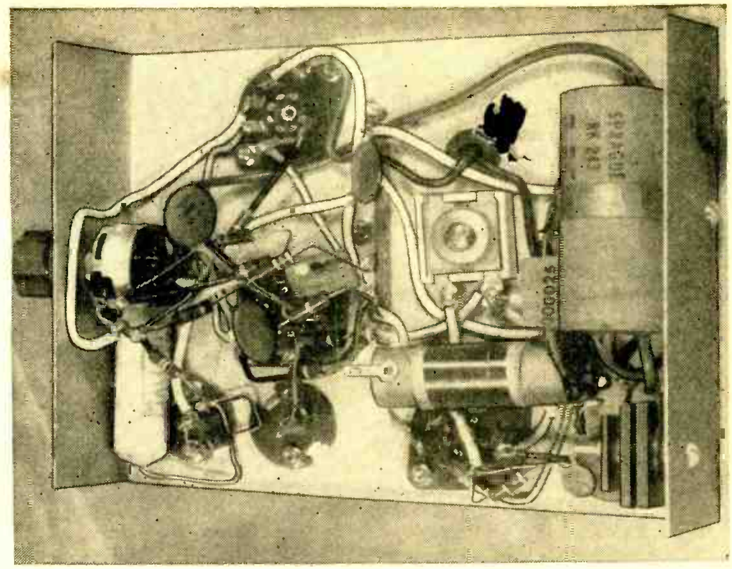
The phono jack, J_1, is used for low output magnetic cartridges (such as *G-E, Pickering, Audax*). R_1 is the cartridge-loading resistor. The gain provided by V_1, the preamplifier stage, and the modulator stage is sufficient to allow almost 100 percent modulation. A crystal cartridge may be connected to input jack, J_2. The 2.2 megohm resistor, R_3, provides sufficient attenuation for crystal cartridges which produce more than three volts output. If a ceramic or late model crystal pickup is being used, the volume may be low. In this case the resistor should be changed to 100,000 ohms. Any AM or FM tuner may be connected to this input. An equalizer circuit, which consists of R_8 and C_1, is connected from the plate circuit of the second section of V_1 to the cathode of the first section. It provides 6 db bass boost per octave.

The audio modulation is coupled from the second audio stage to the modulator grid by means of C_4 and R_{11}. The setting of R_{11}, the volume control, controls the output of the modulator and thus the percentage of modulation of the r.f. carrier. The audio choke, L_1, is connected in a Heising modulation circuit. Because the choke is connected in series between the d.c. power supply and the oscillator, any audio signal that is developed across it is superimposed on the oscillator d.c. supply.

To reduce any hum or distortion in the 50C5 modulator, negative feedback is used. A portion of the output of the modulator is fed back to its own grid through C_5 and R_{12}, the feedback network. Here, instead of allowing the kind of feedback that re-amplifies, as is used in the oscillator, the 4 to 6 db of negative feedback acts to reduce the output of this stage. However, it reduces hum and harmonic distortion very much more. Sufficient extra gain has been built

Schematic diagram of the "Wireless Broadcaster"; parts list is on facing page.





Bottom view of "Broadcaster." All parts can be placed conveniently on chassis approximately 6 inches by 5 inches.

into the circuit so that the small loss in amplification is recovered.

The power supply contains a half-wave selenium rectifier. The output is filtered by C_{10}, R_{16}, C_{11} and C_{12}.

Due to the simplicity of design, the construction of the *Knight* "Wireless Broadcaster" is very easy. A 6"x5"x2" chassis is large enough to accommodate all of the components without crowding. A preformed and punched chassis is available from *Allied Radio Corporation* as part of the complete *Knight* kit.

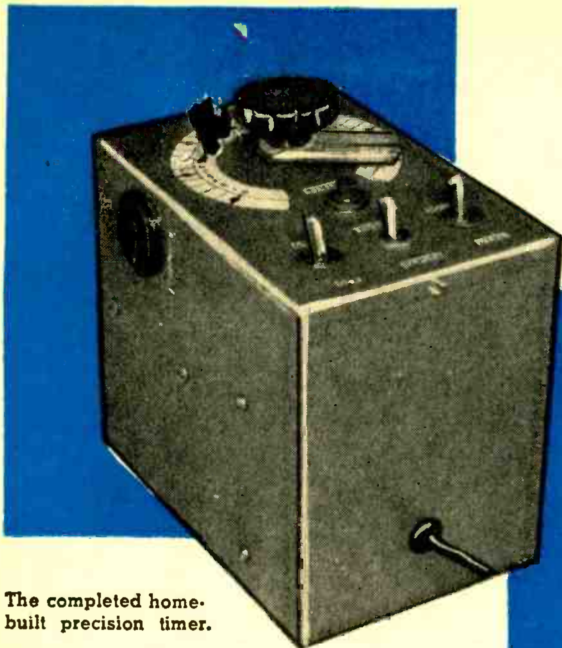
After the chassis wiring is completed, an antenna wire is soldered to C_8. It is advisable to begin with a ten-foot length of wire. When operating the "Broadcaster" close to a receiver, the antenna wire is rolled up. At distances farther away from the receiver, the wire should be unrolled as needed. If more than one set is being used, the antenna length may be changed for best reception with all of the sets. It is best to use as short an antenna as possible to deliver a good signal.

Adjustment and operation is quite simple. First the unit is placed near the receiver being used. The receiver is tuned to any frequency between 600 and 1600 kilocycles where no signal is heard. A record player, microphone, or tuner is connected to the proper input jack. With the volume control set fully clockwise, the oscillator trimmer is adjusted for the clearest reception in the receiver.

Additional receivers which are to be used with the *Knight* "Wireless Broad-

(*Continued on page* 111)

R_1, R_5, R_9—6800 ohm, ½ w. res.
R_2, R_8, R_{12}—1 megohm, ½ w. res.
R_3—2.2 megohm, ½ w. res.
R_4—270,000 ohm, ½ w. res.
R_6—470,000 ohm, ½ w. res.
R_7, R_{10}—220,000 ohm, ½ w. res.
R_{11}—500,000 ohm volume control with switch (S_1)
R_{13}—150 ohm, ½ w. res.
R_{14}—4700 ohm, ½ w. res.
R_{15}—33 ohm, ½ w. res.
R_{16}—1000 ohm, 2 w. res.
C_1—400 μμfd. mica capacitor
C_2—.25 μfd., 400 v. paper capacitor
C_3—.01 μfd. ceramic disc capacitor
C_4, C_9—.005 μfd. ceramic disc capacitor
C_5—.02 μfd. ceramic disc capacitor
C_6—470 μμfd. ceramic disc capacitor
C_7—Trimmer capacitor, 470 μμfd. maximum
C_8—25 μμfd. mica capacitor
C_{10}, C_{11}, C_{12}—40/40/40 μfd., 150 v. triple section elec. capacitor
J_1, J_2—RCA type phono jacks
L_1—5.5 hy. choke, 50 ma. (Allied Radio Corp. Type RK-278) (or Stancor Type C1706, 4.5 hy., 50 ma.)
L_2—Oscillator coil (Allied Radio Corp. Type RK-40)
S_1—S.p.s.t. switch (mounted on volume control, R_{11})
SR_1—65 ma. selenium rectifier
V_1—12AX7 tube
V_2, V_3—50C5 tubes
1—Chassis, 5 x 6 x 2 (Allied Radio Corp. Type RK-376) (or ICA 1546, 7 x 6 x 2, or 29081, 5¾x 4⅞ x 1½)
1—9-prong wafer socket
2—7-prong wafer sockets
1—Knob
2—5-lug terminal strips
1—Line cord and plug
2—⅜" rubber grommets
Screws, nuts, wire, solder, spaghetti
Total cost of separate parts, approximately $12.00
(A kit containing all of the necessary parts and an instruction manual can be obtained from Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.)



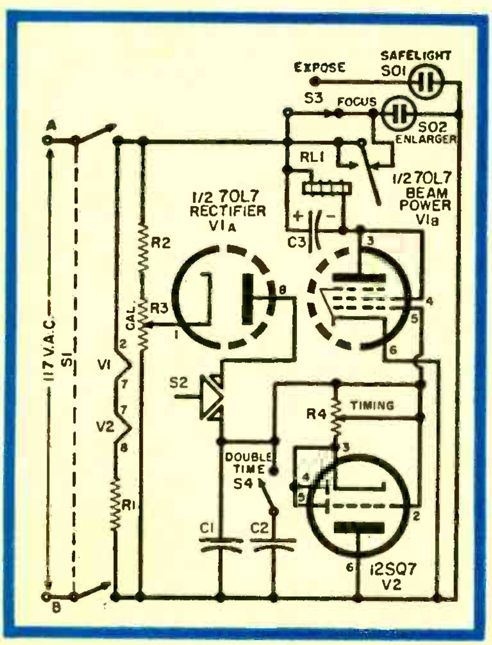
The completed home-built precision timer.

Accurate timing for enlarger or contact printer exposures up to sixty seconds.

A PRECISION PHOTOGRAPHIC TIMER

By HARVEY POLLACK

THIS is a really precise enlarging or contact printing photo-timer that will hold its calibration year after year. As compared with relatively expensive commercial models and most home-grown types, this timer has several very important advantages: (1) There isn't a single resistor in it over one megohm in size, which makes for permanency of calibration because large resistors tend to change value with time more quickly than small ones. (2) The timing range is from 1/10 of a second



Parts List for the Precision Timer

R_1—250 ohm, 20 w. wirewound fixed res.
R_2—20,000 ohm, 1 w. res.
R_3—20,000 ohm wirewound pot.
R_4—1 megohm carbon pot., linear taper
C_1, C_2—1.0 µfd. oil-filled capacitors, Cornell-Dubilier DYR-6100 (or one DYR-6110)
C_3—8 µfd., 450 v., elec. capacitor
RL_1—S.p.d.t. relay, 5000 ohm coil, Potter and Brumfield LS5
S_1—D.p.s.t. toggle switch (a.c. "on-off" switch)
S_2—S.p.s.t. push-button switch, normally open, Switchcraft 101
S_3—S.p.d.t. toggle switch ("expose-focus" switch)
S_4—S.p.s.t. toggle switch ("double time" switch)
V_1—70L7GT tube
V_2—12SQ7 tube
1—Chassis box, 6" x 5" x 4", Bud CU2107, ICA 29420 or 29442, or Premier Metal Products Co. PMC-1007
1—Piece of aluminum, approximately 6" x 5", to be bent for chassis
2—A.c. receptacles
1—Pointer knob, to fit 1/4" shaft
1—Two-lug terminal strip, neither lug grounded
1—A.c. linecord and plug
2—Octal sockets
Screws, nuts, wire, and solder
Total cost approximately $20.00

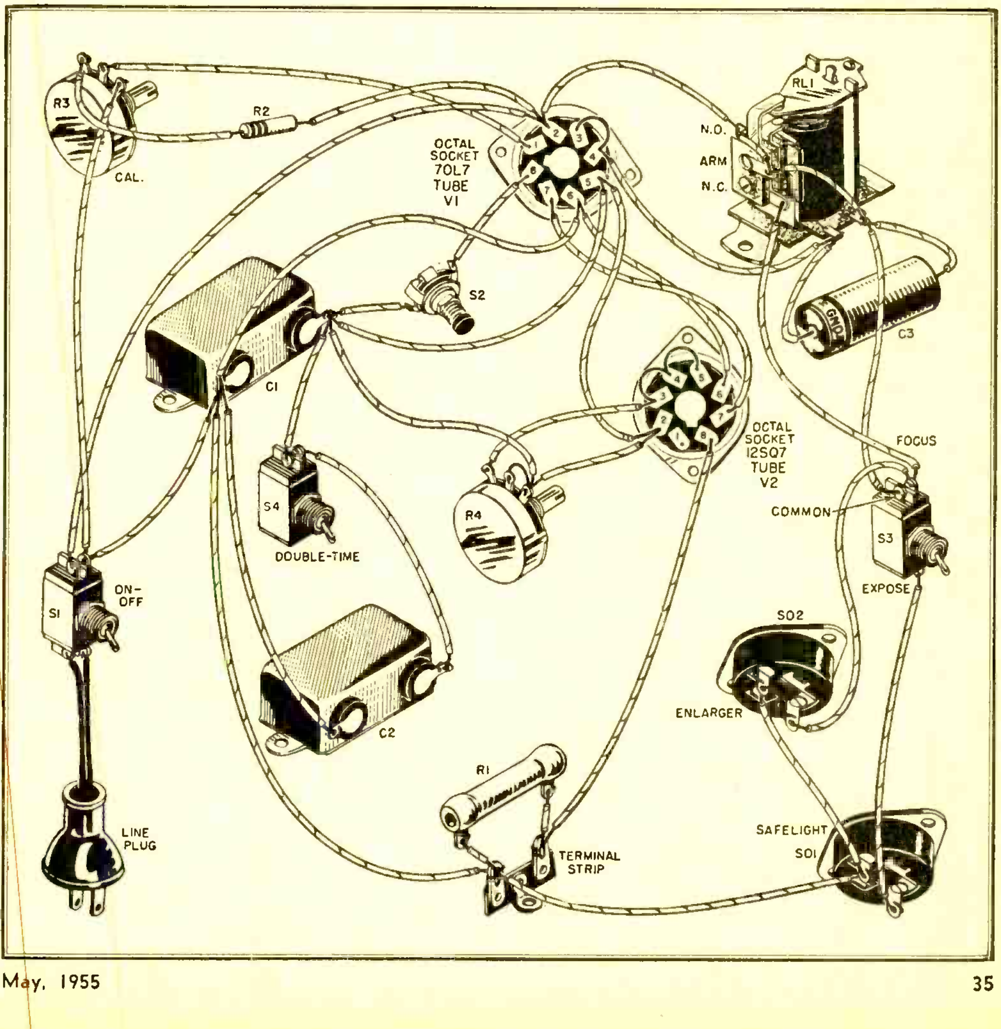
all the way up to a full minute so it can handle any type of negative from the thinnest to the densest. (3) No precision parts are required—a feature which keeps the cost low. (4) There is absolutely no tendency for the relay to chatter, the pull-in being snappily positive in action. (5) It is provided with a focusing switch which turns the enlarger on and the safelight off simultaneously, leaving an undiluted projected image. (6) The *"Double-Time"* switching arrangement makes for a better spread of the calibrations, hence improves the accuracy of setting the timer within the much-used interval from zero to thirty seconds.

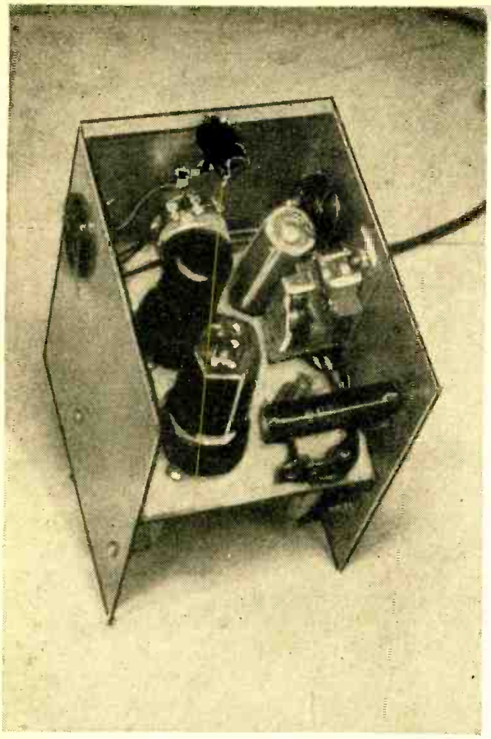
Construction

Whether the parts are new or from the ubiquitous "junk-box", it is false economy to be thrifty about the 1.0 μfd. capacitors finally selected. These are critical components, the quality of which determines the accuracy of the finished instrument. Regardless of the manufacturer, they should be oil-filled or oil-impregnated, hermetically sealed units with very low leakage.

To begin the construction, bend a small chassis to fit snugly into the little utility cabinet and drill the holes needed to secure it as shown in the photographs. Lay out the other large parts (the 1.0 μfd. capacitors, the relay, the switches, the a.c. output receptacles, the tube sockets, and the two potentiometers) so that there is ample space left for easy wiring. Notice that all parts are mounted on *only one of the two cabinet half-shells*. This eliminates interconnecting wires between the two halves and makes for very convenient assembly. As a further planning consideration, remember that three components—the two vacuum tubes and the dropping resistor

Follow this pictorial wiring diagram carefully when connecting the timer components.





This top view of the chassis shows placement of most major parts. Note the slotted shaft for the calibration control between the relay and the 20 watt resistor. The tube near the rear of the chassis (the lower tube in the photo) is the 70L7GT.

for the heaters (R_1)—must be well ventilated, so all three must have access to air circulation. Ventilating holes in the top of the cabinet will take care of this if R_1 is mounted above the chassis well up in the box.

Now the builder may go ahead with the actual wiring. No special precautions need be taken here except the usual ones: bare wires are not to touch the chassis or inside of the cabinet and all joints must be properly soldered; the correct polarity of the electrolytic capacitor (C_3) must be observed as shown in the schematic diagram; and the upper and lower relay contacts must be chosen to conform with the drawing. When the wiring is finished, trace it all through once again to make certain that there are no short circuits or other errors that might damage the parts when power is applied. As a final step, wipe the timing capacitors (C_1 and C_2) clean with a dry cloth, especially between terminals.

Testing the Timer

Before attempting to calibrate the instrument, a performance test should be given the unit. The following steps are suggested:

(1) Plug the enlarger or any other 120 volt lamp into the *"Enlarger Socket"*; plug the safelight into the *"Safelight Socket;* move both S_1 and S_4 to the down or "Off" position and S_3 to the "Expose" position. In the author's model, all three switches are *down* when set this way.

(2) Set R_3 so that the wiper is all the way over toward the junction point of R_2 and R_3; set the wiper of R_4 so that it is closest to the control grid of the beam power section of the 70L7GT. If the wiring is identical with that of the pictorial diagram, both of these controls will now be fully clockwise.

(3) Turn S_1 to the "On" position and allow about a minute for heating. When S_1 is turned on, the enlarger lamp should light and when the tubes heat sufficiently, it will go out.

(4) Press the push-button and then release it. The enlarger should come on and stay on for considerably more than 30 seconds. Now rotate the *"Timing"* control (R_4) fully counterclockwise and again press the push-button; now the enlarger lamp should light for a very short time (much less than one second) and automatically extinguish.

(5) Return the *"Timing"* control (R_4) to its fully clockwise position. Move S_4, the *"Double-Time"* switch, to its "On" position and press the button. Now the enlarger should stay on for a time well over one minute.

(6) Throw S_3 to the "Focus" position. The enlarger lamp should now go on and remain lit all the time S_3 is in this position (for focusing unhurriedly), while the safelight should be out.

Calibration

The timer is most easily calibrated in the single-time position of S_4 (switch open so that C_1 is out of the circuit). The timing potentiometer and knob should be secured to the panel so that the pointer is up when the wiper is set at its central position (500,000 ohms). With the knob this way, adjust the *"Calibration"* control (R_3) for *exactly* 15 seconds of timing. The *"Calibration"* potentiometer should not be disturbed from this time on. Using only the *"Timing"* control (R_4), calibrate the rest of the dial in 5 second steps. Later on these may be subdivided into one second marks.

Once the dial is calibrated for single-time, closing S_4 automatically doubles each reading. Thus for exposures which need a timing of 30 seconds or less, a more accurate setting is obtained by opening S_4 and using the single-time scale. Negatives that are too dense to receive proper exposure with 30 seconds or less are easily handled by the double-time setting of S_4.

For extremely precise calibration, the timer should be allowed to warm up for about 15 minutes before beginning the process. The author found that only about 5 minutes was required for stabilization but suggests that calibrating after an even longer warm-up period should provide very dependable settings. This is not a handicap to the photographer because the timer may be turned on as soon as he enters the darkroom and left running while he prepares the enlarger, trays, chemicals, etc.

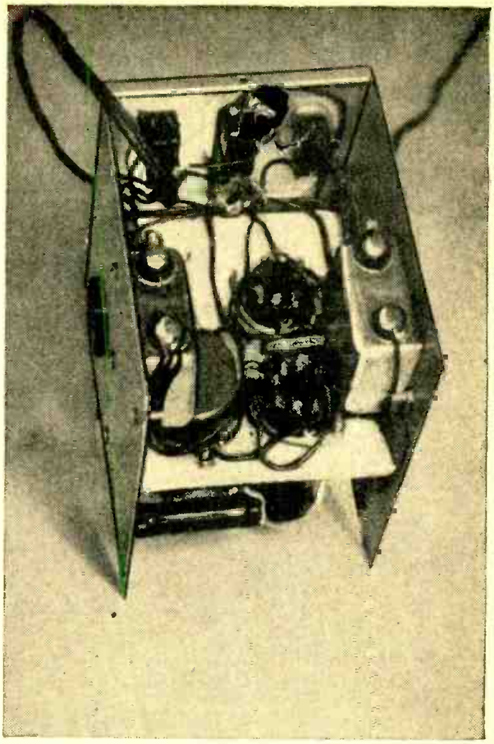
How It Works

When the *"On-Off"* switch is first turned on, the enlarger lamp will light because the enlarger socket is connected directly across the a.c. lines, one leg directly to line B and the other through the upper contact of the relay to line A. As the tubes heat, irrespective of the setting of any of the controls, sufficient plate current will pass through the beam power section of the 70L7GT to pull in the relay and turn the enlarger off. (This assumes that the *"Expose-Focus"* switch is in the "Expose" position). The relay arm has moved to the lower contact.

Assume that the wiper of the *"Timing"* potentiometer is at the top (full resistance) and that the wiper of the *"Calibration"* potentiometer is all the way up (closest to the junction of R_2 and R_8). Assume that *"Double Time"* switch is "Off."

Upon depressing the bush-button, a negative charge from the rectifier section of the 70L7GT is fed into the 1.0 μfd. capacitor, charging it practically to the peak value of line voltage almost instantaneously. The charging current originates at line A, passes through the lower contact of the relay, through the rectifier, down to the capacitor. As the negative end of the capacitor is tied directly to the control grid of the beam power section of the 70L7GT, the plate current is instantly cut off by the high negative bias. The relay opens and the enlarger lamp extinguishes. This is the beginning of the timing cycle.

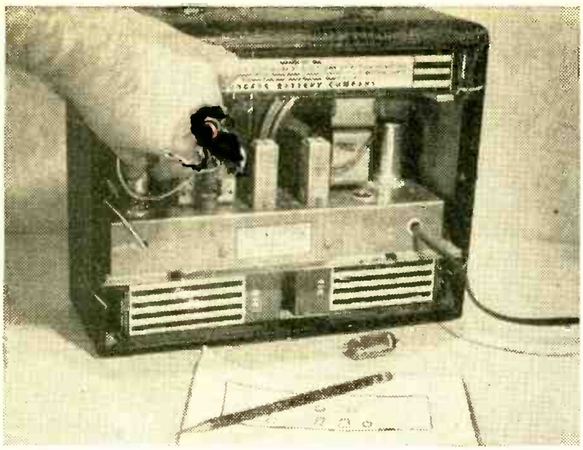
The only discharge path which exists for the capacitor consists of the *"Timing"* potentiometer in series with the plate circuit of the 12SQ7. The tube should be viewed as a resistor whose resistance depends almost entirely upon the magnitude of the bias voltage between its grid and cathode. As the capacitor begins to discharge, a very large voltage drop occurs across the *"Timing"* potentiometer, which makes the grid very negative with respect to the cathode thereby raising the plate resistance of the tube to an enormous figure—about 100 megohms. Hence, at the beginning, the capacitor discharges extremely slowly.



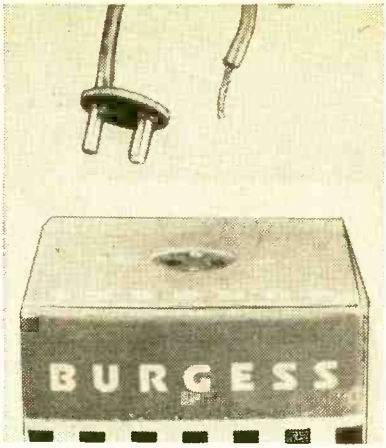
The bottom of the chassis. Timing capacitors, C1 and C2, are mounted on sides of cabinet and all switches are on front panel (shown in upper part of this photo). The potentiometer just visible behind the capacitor at left is the calibration control.

As discharge proceeds, the voltage across the capacitor drops slowly. This voltage constitutes the plate voltage for the 12SQ7, so that as it decreases, the plate current decreases in proportion. This lowering of plate current reduces the voltage drop across the *"Timing"* potentiometer and, consequently, the bias becomes less negative, permitting the plate resistance of the triode to drop. As the plate resistance drops, the capacitor discharges more rapidly. This interchange of effects proceeds until a point is reached where the capacitor has discharged sufficiently so that the beam power section of the 70L7GT is no longer cut off, the relay pulls in, and the enlarger goes out.

The important advantage of this circuit is the high rate of change of current through the relay as pull-in time approaches, due to the degenerative effect of the *"Timing"* control resistance. Indecisiveness or chatter is completely eliminated. END

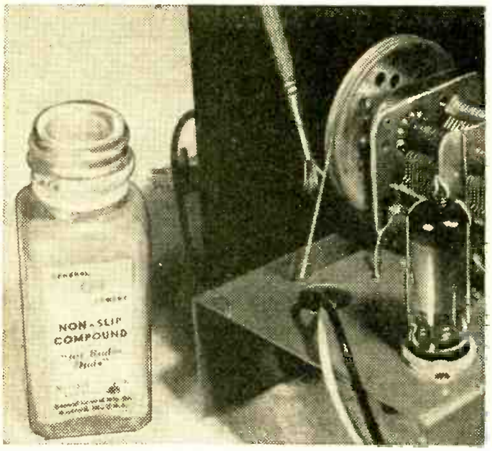


The very first step is to remove the back cover and remove the tubes. Note their positions on a piece of paper. Check all of the tubes on a tube checker. Replace those that read "Bad" and obtain spares for those that check "Weak." Return the tubes to their sockets.

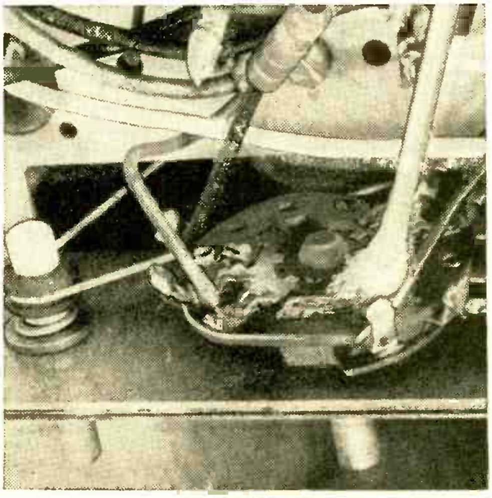


Remove batteries from the portable and check the plug. Tug lightly on the wire leads as they enter the plug. If one is loose, resolder it in place. Check the voltage of the batteries when the portable is not playing. Check again when the portable is playing; if there is a 10% drop the batteries should be placed.

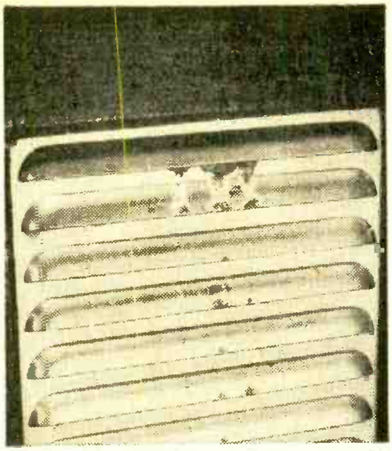
CHECK YOUR PORTABLE FOR SUMMER FUN



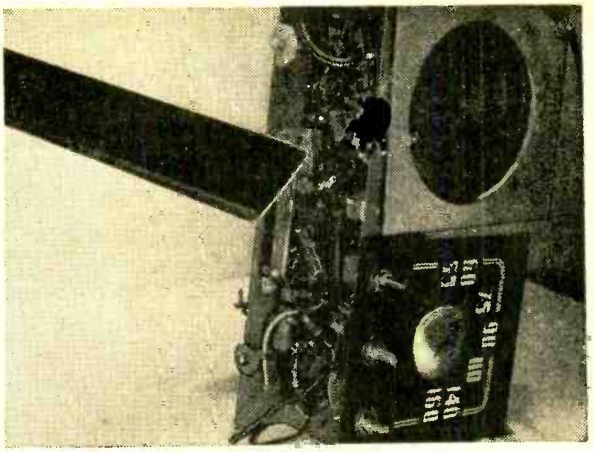
A slipping dial cord may be cured easily by dusting it with finely powdered rosin, or with a "Non-Slip Compound" sold by all radio parts jobbers and distributors. The solution pictured above is being painted on with a small paint brush. It is a "General Cement" Product.



Dirt and dust may also affect the selector or bandswitch. Generally speaking, the control may be cleaned with a few drops of carbon-tet on a pipe cleaner wiped across the contacts.



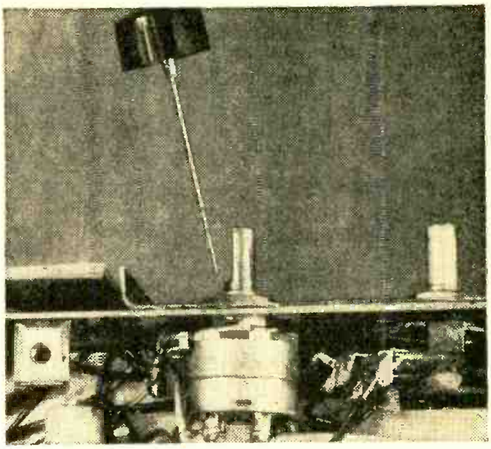
Watch for corrosion inside the portable if the batteries were not removed while the set was in winter storage. A leaky battery can cause damage to the internal wiring. If corrosion is visible, wipe off with a wet cloth using a knife blade to scrape away hard residue. Corroded wires and components must be replaced.



Slip the receiver chassis from the case and look for excessive dirt or dust accumulations. A vacuum cleaner with reversed air flow may be used to dust the chassis, if the suction is not strong enough to pick up the dirt. A brush is helpful in tight spots.

Summer's coming—and during those bright outdoor months you'll want music at the beach, lakeside, or picnic. This is the month to get out the portable and clean and check it.

This photo story illustrates the checks that should be made. If it is a 3-way portable, try it on both batteries and the power line. Should the set appear to work sufficiently well it may not be necessary to check the tubes or clean out the chassis. However, to be on the safe side, the reader will find it valuable to check the portable before it requires a major overhaul. END



Noise in the speaker as the volume control is rotated can often be cleared up by injecting a few drops of carbon-tet. Run the carbon-tet down the shaft of the control. Rotate the control to spread the cleaner. If the noise continues, replace the control.

Knobs on most portables are either held in place by small set screws or by springs. If the knob is loose, a replacement spring or screw may be obtained from your radio parts jobber.

PROJECT TINKERTOY

Modular units, machine made and automatically assembled, may revolutionize electronics.

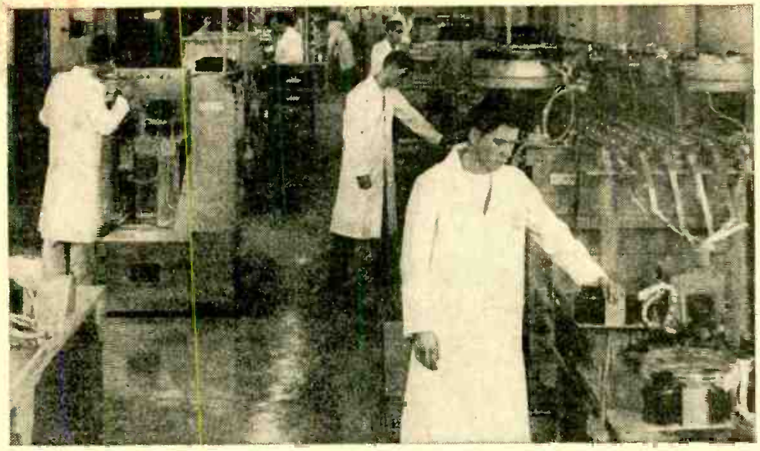
Basic concept of the new method of fabrication and assembly. See text for details.

"PROJECT TINKERTOY"—the revolutionary modular design and mechanized production of electronic parts—may well comprise the building blocks of the electronic world of the future.

Developed by the National Bureau of Standards, Washington, D. C., this new approach to electronic fabrication involves the "modular design concept" of mounting adhesive carbon resistors, printed circuits, and other miniaturized components on standard, uniform steatite (ceramic) wafers. The wafers are then stacked together, like building blocks, to form a "module." This module will perform all the functions of one or more electronic stages. It is a standardized, interchangeable subassembly with all the requirements of an electronic circuit, plus the factors of ruggedness, reliability, and compactness.

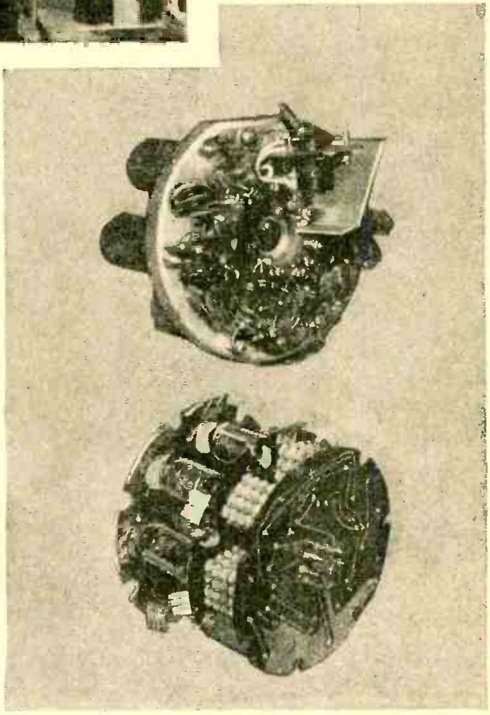
Individual modules may be combined to form major electronic subassemblies.

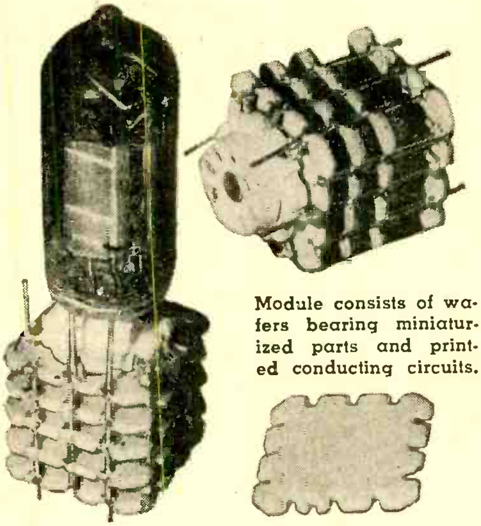
Until recently, the modules were assembled by hand. In fact, several private industrial plants are experimenting with this method. But recently, scientists at the National Bureau of Standards have enhanced this approach to electronic manufacture by setting up a completely mechanized production line not only for making the small parts and the wafers, but for putting them together to form the modules. A machine has been developed which stamps out 2800 wafers every hour. The wafers then receive the prefabricated parts automatically. Resistors, capacitors, etc.,



Machines make ceramics, process and apply parts to wafers, assemble modules, and perform complete inspection.

Photo below compares conventionally made piece of equipment (upper unit) with same piece made by "Tinkertoy" methods. Latter was made in less time at lower cost. Resultant savings can be passed on to public.





Module consists of wafers bearing miniaturized parts and printed conducting circuits.

are being made by completely new methods, involving special chemicals and ingenious mass-production techniques. For example, resistors are made by coating a long roll of paper tape with a special adhesive powder. After further processing, the tape is slit and cut to produce desired resistances of from 10 ohms to 10 megohms. A 75-foot roll of tape will produce over 10,000 resistors!

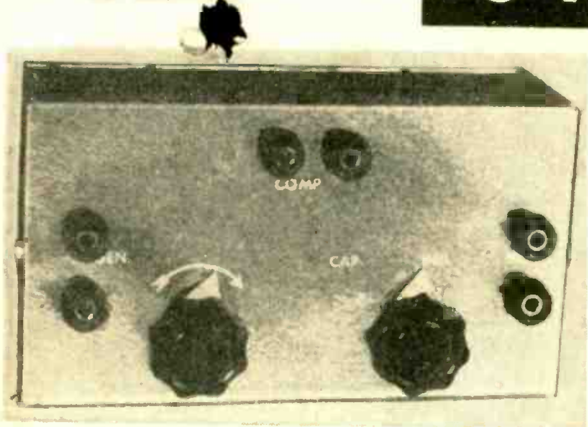
During the automatic mounting of resistors, capacitors, coils, tube sockets, etc., onto the wafers, photo-electric devices along the line control flow and assembly.

Tubes are mounted in their sockets by a machine which places the tube pins in their correct holes. A wafer is then riveted to the socket. Automatic soldering of all parts requiring solder is provided.

Uniform wafer-mounted parts are then combined into a functional electronic unit, or module, by a single machine, which automatically wires and solders the wafer units into a complete module. These module assemblies are then hand-mounted on base plates to form different types of radio and other electronic equipment. One base plate with six modules, for instance, contains all the circuitry needed for a 6-tube radio receiver.

Studies of these methods made by private industry indicate that the "Project Tinkertoy" approach may prove to be cheaper and superior in many other ways to existing production methods. Originally developed for U. S. Navy equipment, these new methods may result in better built, less expensive consumer goods for all. END

The use of this simple instrument permits accurate measurement of unknown values of capacitance and inductance.



SIMPLE L OR C ADAPTER

By RUFUS P. TURNER

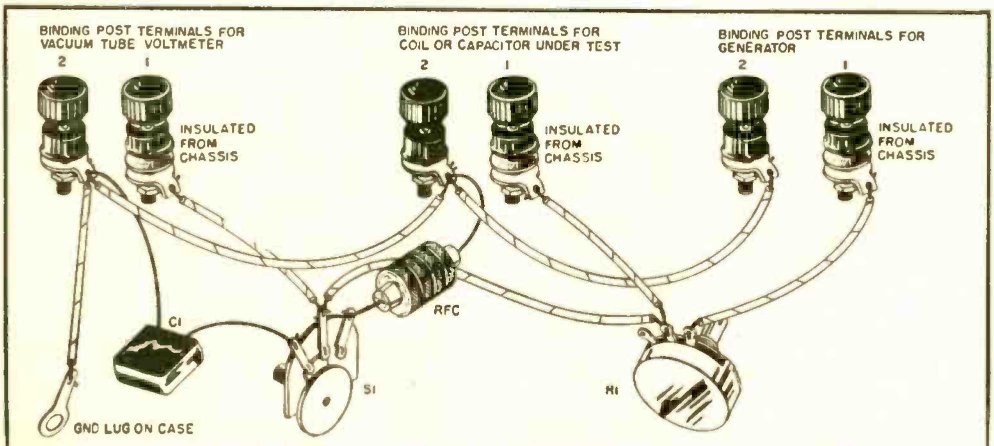
RESISTANCE measurements made with an ohmmeter are accurate enough for ordinary, practical purposes. Almost everybody interested in electronics has a meter that measures ohms.

Testing coils and capacitors is another story. Usually a bridge circuit is needed for this purpose. The most common bridges for checking the inductance of coils and capacitance of capacitors are fairly expensive. But with an oscillator (signal generator) and a vacuum-tube voltmeter, it is possible to build a simple, inexpensive adapter which allows coils and capacitors to be checked accurately and easily. The only parts needed for this adapter are a volume control-type potentiometer, switch, r.f. choke, mica capacitor, 6 binding posts, and a box.

The adapter will check coil inductance values from 1 millihenry to 50 henrys, and the capacitance values of *non-electrolytic* capacitors from 0.0001 to 2 microfarads. It will not handle electrolytic capacitors.

The oscillator (signal generator) must tune from 200 cycles to 350 kc. Low-priced, wide-range audio generators like the *Heathkit* Type AG8 will cover this range.

Pictorial wiring diagram of the adapter shown in the diagram on page 43.



Experimenters who don't own an oscillator with this coverage will have to use an audio oscillator up to about 50 kc. and an r.f. oscillator from 50 to 350 kc.

The adapter works on the principle of tuning (resonance) in the following manner: To measure capacitance, the unknown capacitor is connected across a *known* inductance (coil) contained in the adapter. The oscillator and vacuum-tube voltmeter (set to its lowest a.c. scale) are connected to the adapter. The oscillator then is tuned carefully until a sharp upswing of the meter needle shows that the adapter is in tune with the oscillator. The frequency then is read from the oscillator dial, and this figure used with Chart 1 to find the value of the unknown capacitance.

Checking inductance involves almost the same procedure. The unknown coil is connected across a *known* capacitor contained in the adapter. Again, the oscillator is tuned until the meter swings up to its highest reading. The frequency then is read from the oscillator dial and this figure used with the Chart 2 to find the value of the unknown inductance.

In the adapter, the known inductance is a 2½-millihenry choke coil, and the known capacitance is an 0.01 μfd. silvered mica capacitor.

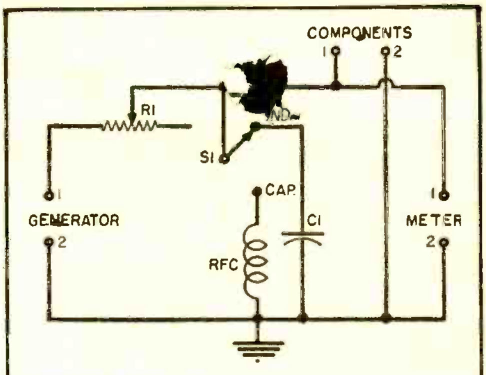
Circuit Details

The circuit of the adapter is shown in Fig. 1. The oscillator is connected to the pair of binding post terminals labeled *Gen* (generator). The coil or capacitor under test is connected to the pair marked *Comp* (component), and the voltmeter to the *Meter* pair. In each pair, terminal No. 2 is grounded; that is, it is connected to the metal box in which the adapter is built. The ground terminal of the oscillator must be connected to *Gen* terminal No. 2, and the ground terminal of the voltmeter must be connected to *Meter* terminal No. 2.

The potentiometer, R_1, is called an "isolator." It must be set, when checking a particular coil or capacitor, for the sharpest swing of the meter. (It is hard to recognize the highest point of a *broad* swing, and this causes errors.)

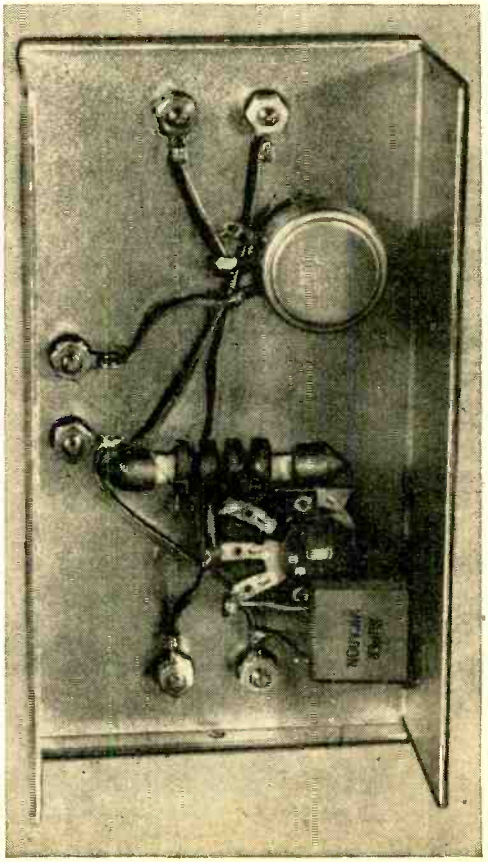
When checking a coil, switch, S_1, is thrown to its *Ind* (inductance) position. When checking a capacitor, switch, S_1, is thrown to its *Cap* (capacitance) position. In the *Ind* position, an 0.01 μfd., high-quality, silvered mica capacitor is cut into the circuit. In the *Cap* position, a 2½-millihenry r.f. choke, RFC, is cut into the circuit.

The photographs show how the adapter is built. It is housed in a small aluminum chassis box, 6½" long, 3½" wide, and 2⅛"



R_1—250,000 ohm pot.
C_1—0.01 μfd. silvered mica capacitor, Cornell-Dubiler Super-Micadon Type 1A
RFC—2½ millihenry, pi-wound r.f. choke, National R100
S_1—S.p.d.t. wafer switch, Centralab 1460 tone-control type
1—Chassis box, 6½" x 3½" x 2⅛"
6—Insulated binding posts
7—Solder lugs
2—Pointer knobs

Fig. 1. (Above) Wiring schematic of the adapter. Note that capacitor C_1 is a silvered mica. (Below) Bottom view showing the layout of the components.



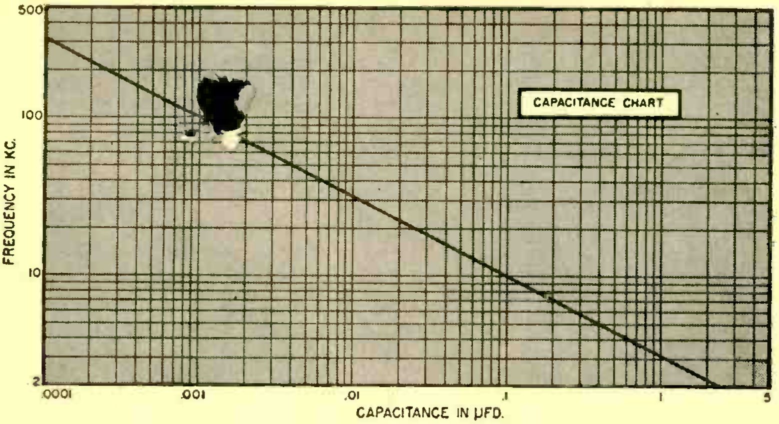
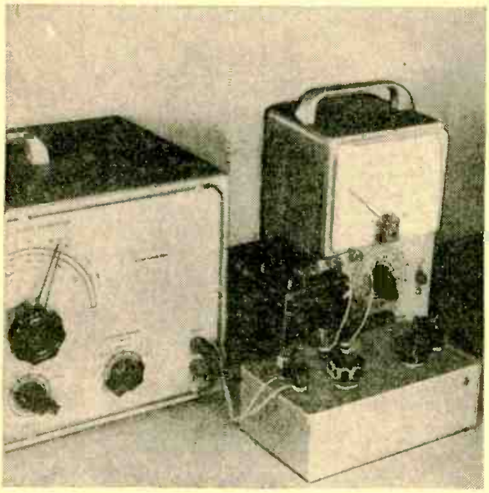


Chart 1. To find an unknown capacitance value, read the resonant frequency across the graph until it intersects the heavy diagonal line. Read down to find value of the capacitor.



The simple L or C adapter in use. The principle of operation is to feed a known frequency from signal generator (at the left) into the adapter. Rotate the generator dial until a maximum reading is noted on the v.t.v.m. (at the right). Use the graphs accompanying this article to find the unknown value of inductance or capacitance.

deep. The left hand knob controls potentiometer, R_1, and the right knob switch, S_1. Mounting of the parts can be seen in the photograph, which may be compared with the pictorial diagram to identify the parts.

Use of Device

The first step is to connect the oscillator and vacuum-tube voltmeter to the adapter. Connect the oscillator to the *Gen* terminals and the meter to the *Meter* terminals. Set the meter to its lowest a.c. range, and the oscillator to its highest output. Switch on both the oscillator and meter.

To Check Capacitance: (1) Connect the unknown capacitor to the *Comp* terminals, using the shortest possible leads. (2) Set switch, S_1, to its *Cap* position. (3) Tune oscillator throughout its frequency range. (4) When a sharp upswing of the meter is noticed, carefully retune for the highest point in the swing. Adjust potentiometer, R_1, during this final tuning, to sharpen the meter response. (5) Read the frequency from the oscillator dial. (6) Using Chart 1, find the capacitance value corresponding to this frequency.

(*Continued on page* 105)

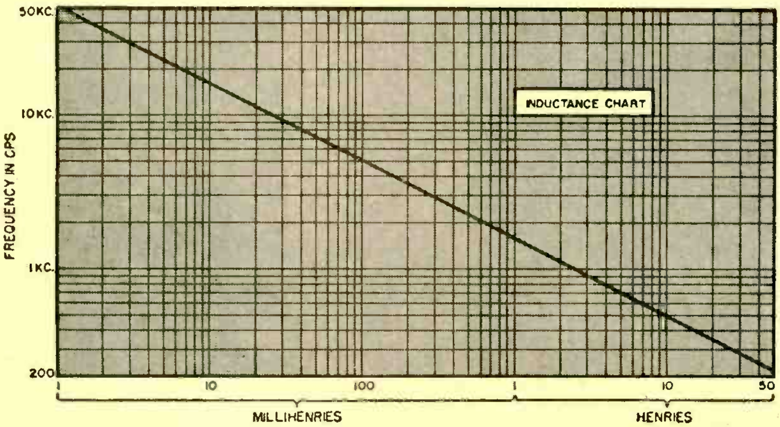


Chart 2. To find an unknown inductance value read the resonant frequency across the graph until it intersects the diagonal line. Read down to find the value of the inductor.

New Military Phone System

Repeater, above, amplifies conversations which may be transmitted over distance of 100 miles.

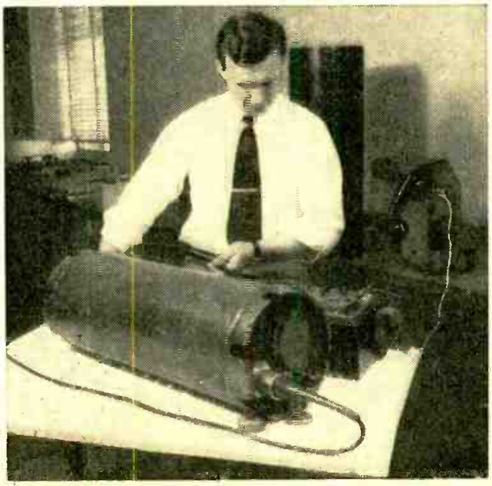
A NEW, portable, GI telephone system, which can handle three times as many conversations over a single cable as comparable Korea and World War II systems, has been developed for the U.S. Army Signal Corps by *Bell Telephone Laboratories.*

Basic equipment for the new telephone system is contained in units about the size of large suitcases, which can be handled by only one or two men and can be stacked. The "carrier" principle used for the new system allows twelve conversations to share the same cable by using a different frequency for each channel.

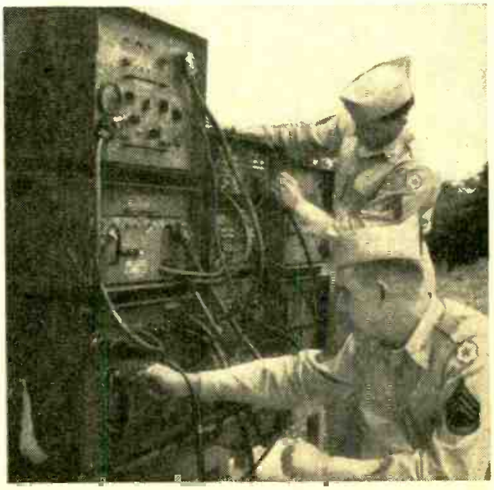
The system, providing for twelve simultaneous conversations, can be used for distances up to 200 miles. Another, a four-channel system, can be used for four simultaneous conversations at distances up to 100 miles. Several of these wire systems linked together can form a communication system of about a thousand miles. They may also be operated in conjunction with a GI radio relay system developed at Bell Laboratories.

Miniaturized Parts Reduce Size

Recently developed miniaturized parts



Bell Labs technician tests repeater housed in water-tight cylinder. Unit restores level of transmitted signals every six miles.



These "stackable" units are part of system which can carry twelve conversations simultaneously up to distances of 200 miles.

can be credited with the sharp reduction in size and weight of the new equipment. The earlier, four-channel unit, for example, weighed 47[illegible] pounds and occupied twenty cubic feet [illegible] space. Complete with its power supply the new four-channel terminal weighs 178 pounds and occupies only five and a half cubic feet of space. The cable used for the systems can be strung on poles, laid on the ground, or buried.

New types of repeaters also have been designed to be used at intervals in order to restore the level of the transmitted signals and extend the range of the systems.

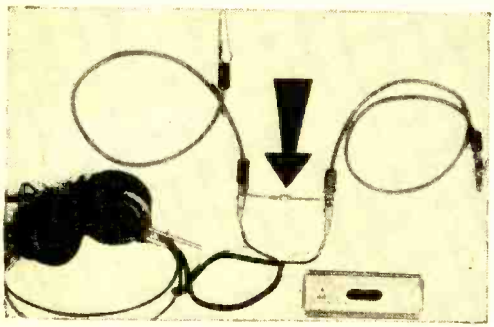
Important new features facilitate testing and maintenance while all regular channels are in service. A portable test set provided with the twelve-channel system contains a transistor oscillator.

Field equipment designed by *Bell* for the Army is tested for its ability to withstand desert heat and arctic cold. It is subjected to vibration, bounce and shock tests, 100 percent humidity, and wind and rain.

The new military carrier systems have recently been placed in production by the *Western Electric Co.*, manufacturing unit of the *Bell* System. END

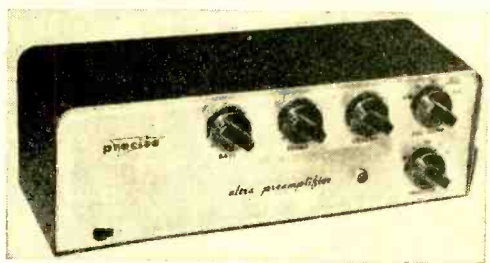
Five-Minute First Radio

DEMONSTRATING the mystery of radio is an easy task with a pair of earphones, some wire, four alligator clips, and a common germanium diode type 1N34A. Fasten the four alligator clips to the ends of two-foot lengths of hookup wire. Bend the wire leads of the 1N34A crystal and clamp them under the screws on two of the clips. Then grip the earphone tips in the same alligator clips. Attaching one of the remaining clips to a radiator for a ground and the other to a wire or bedspring will provide an antenna. Since the crystal set has no provisions for tuning it will be unable to separate stations, but if you live near a standard broadcast transmitter reception will be quite strong. Simple as it is, this is a better radio than many with which a pioneer started. E.R.

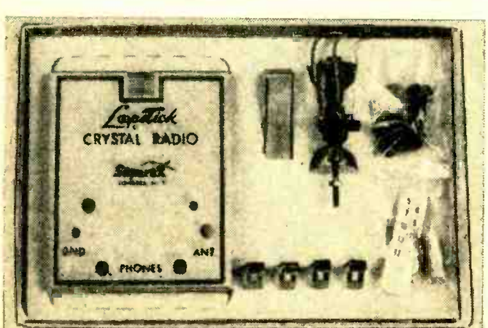


Low Cost Hi Fi Preamplifier

THE new "Ultra Preamplifier" includes facilities and controls needed for a high fidelity preamplifier-equalizer. A selector switch connects to one of four inputs for a choice of phono, radio, TV, microphone, tape, etc. Cabinet is mahogany with brushed brass panel. The unit is available in kit or wired form in either of two circuits: one with its own power supply and the other without a power supply. Prices range from $19.95 to $39.95. For complete information, write the manufacturer, *Precise Development Corp.*, Oceanside, L. I., N. Y.

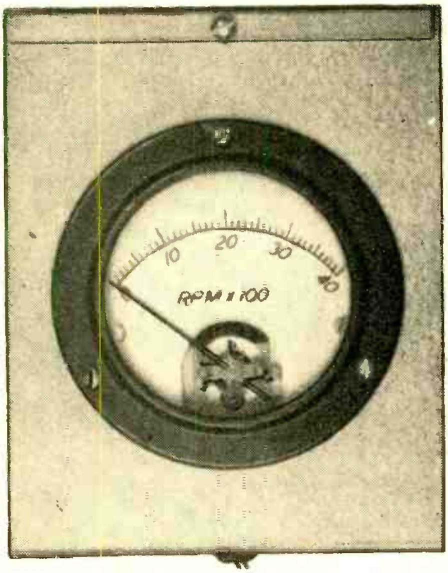


Crystal Receiver Kit Features "Loopstick" Coil



A NEW crystal receiver kit, featuring the *Superex* "Loopstick," can be assembled with only a screwdriver and possesses very high sensitivity. Complete with all components, the kit includes a metal chassis, the "Loopstick" coil which serves as a tuned loop antenna, Fahnestock clips, wire, capacitor, crystal, tuning dial and knob, and all screws and washers needed to assemble the set. A detailed instruction book is furnished with the kit. Available at most dealers for $2.95, the kit is manufactured by the *Superex Electronics Corporation* of Yonkers, N. Y.

PORTABLE ELECTRIC TACHOMETER



By
H. J. CARTER

This simple, inexpensive tachometer can be built and calibrated at home. It will measure the speed of any type of motor or engine.

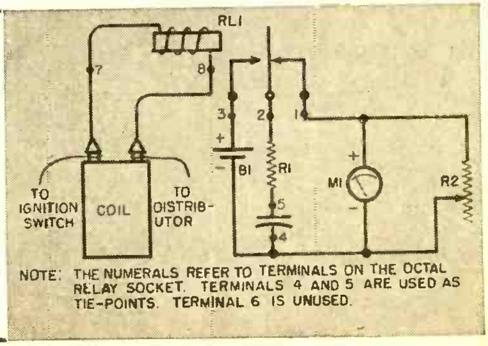
EVERY experimenter who has tuned engines or adjusted rotary mechanisms appreciates the value of an accurate tachometer. Unfortunately, good tachs cost at least $50 and have limited application because of installation difficulties and large driving power requirements. The simple electric tach described here can be assembled for about $19, and used interchangeably on R/C airplane motors, boats, and automobile engines.

To install the tach on electric ignition engines, it is necessary merely to connect two wires in parallel with the coil primary; other mechanisms may require the addition of a contact, as described later. The driving power is supplied by the ignition battery, so the loading effect on the engine itself is negligible. Accuracy is limited only by the quality of the meter used, since the instrument is calibrated against the 60-cycle power frequency.

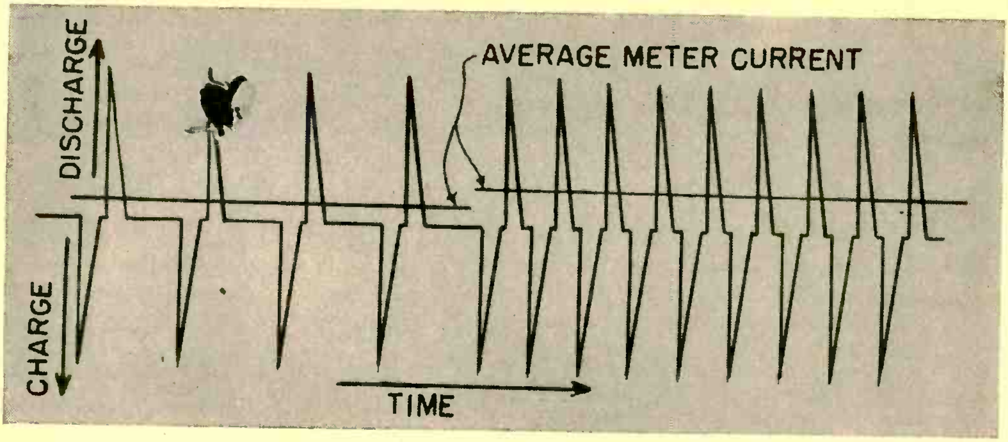
How it works

The relay shown on the circuit schematic is a high-speed type arranged to transfer the single armature contact between the normally open and normally closed contacts once for each shaft revolution. When the relay is energized, the armature contact connects the storage capacitor, C_1, in series with resistor, R_1, to

R_1—120 ohm, ½ w. carbon res.
R_2—500 ohm, 1 w. pot.
C_1—1 µfd., 200 v. paper capacitor (Aerovox P82)
B_1—45 volt radio "B" battery (Burgess XX30)
M_1—Meter, 0-5 ma. d.c.
RL_1—S.p.d.t. relay, 6-volt coil (Stevens-Arnold Type All Millisec Relay: obtain from Stevens-Arnold Inc., 22 Elkins St., South Boston 27, Mass.)
Miscellaneous: 3 x 4 x 5 aluminum box; ¼-inch rubber grommet; octal socket; two ¾-inch insulating standoffs threaded each end for 6-32 screws; 3000-ohm, 5-watt resistor (for calibration)



Schematic diagram and parts list for the tachometer.



Increasing the number of pulses-per-second increases the average current through the meter.

the positive battery terminal. The battery charges the capacitor to the indicated polarity during the dwell time of the contacts. The resistor limits the charging current to prevent burning the relay contacts. When the relay is de-energized, the armature contact connects the capacitor to the discharge circuit consisting of the meter and shunt resistor, R_2, in series with R_1.

The meter time constant is large enough to prevent the pointer from responding to each individual current pulse, as depicted in meter current diagram (above). Instead, the pointer indicates the average current. As the engine speed increases, so does the *frequency* of contact operation, thus increasing the number of pulses in a given interval and increasing the average current. The diagram shows the average current at two different engine speeds. The meter shunt resistor is a rheostat which is adjusted during calibration, as described later.

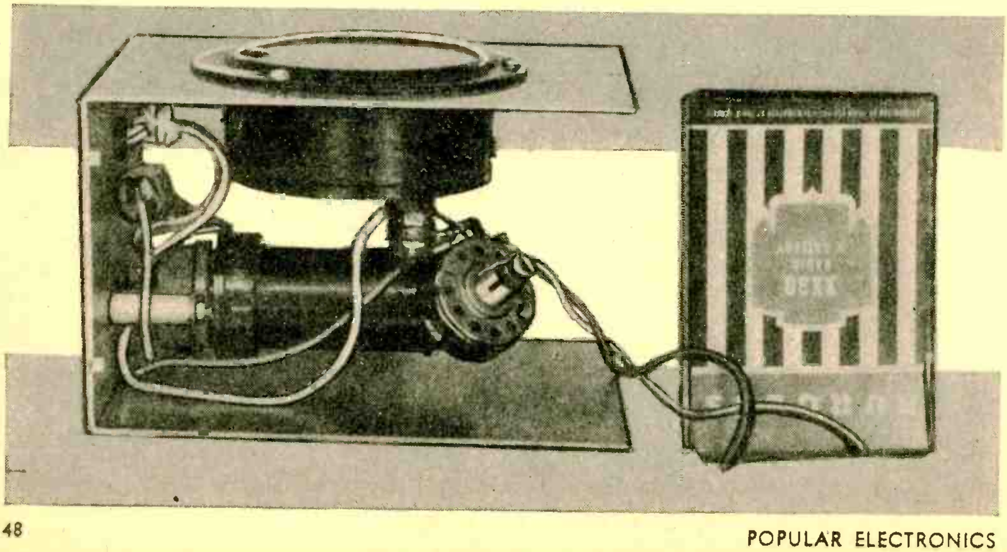
Assembly

A 3" x 4" x 5" aluminum box chassis is used to house the parts. Drill all mounting holes before mounting the meter.

Carefully remove the case from the meter and remove the two screws holding the scale plate. On heavy, white paper, prepare a new scale with the same length as the original scale. Mark off five equally spaced lines and label them 0, 10, 20, 30, and 40. Divide each space between lines into ten parts. Glue the new scale onto the back of the original scale plate, and reassemble the meter.

Solder all connections before mounting the parts in the box. Spare pins 4 and 5

The tachometer with cabinet disassembled; leads at upper left connect to the relay coil.



on the relay socket are used as tie points. The rheostat is supported by stiff bus-bar leads attached to the meter terminals. If this rheostat is mounted in the conventional manner with the shaft protruding through the case, the calibration may be accidentally destroyed. Be sure to knot the relay coil wires leaving the box to provide strain relief.

Mount the socket and meter. Check the wiring and then snap the battery connectors into place. A piece of tape covering the terminals of the battery will prevent shorts to the case. The battery fits snugly in place next to the meter when the box is assembled.

Calibration

Since the relay operates on each half-cycle, the 60-cycle house current is equivalent to 120-cycle interrupted d.c. The house current is used because the frequency error is usually less than 1 percent. At a certain engine speed, depending on the number of cylinders and type of engine, the distributor is interrupting the coil circuit at a frequency of 120 cycles per second, so we calibrate the tach by adjusting the meter shunt until the meter indicates this particular speed.

Ordinarily, the tach should be calibrated for a particular engine type, choosing the appropriate calibration point shown in the table. However, it is not necessary to recalibrate for different engine types; simply multiply the scale reading by a factor computed from the formula accompanying the table.

CALIBRATION TABLE
Use with 60-cycle current and four stroke engines.

No. of Cylinders, N	Calibration Point, rpm
4	3600
6	2400
8	1800

To use for different No. of cylinders, multiply reading by N/n, where N is No. for which meter is calibrated and n is actual No. To use for two-stroke engine, divide by 2.

For example, to calibrate the tach for an automobile engine of the V-8, four-stroke type: Connect a 3K, 5-watt resistor in series with the relay coil leads, attach a line cord and plug, and plug into a 115-volt outlet. Adjust R_2 until the pointer indicates 1800. Now, to use the tach on a two-stroke, single cylinder model airplane engine having distributor ignition, connect the relay coil leads in parallel with the ignition coil primary and multiply the indicated rpm by *four* to obtain the true speed.

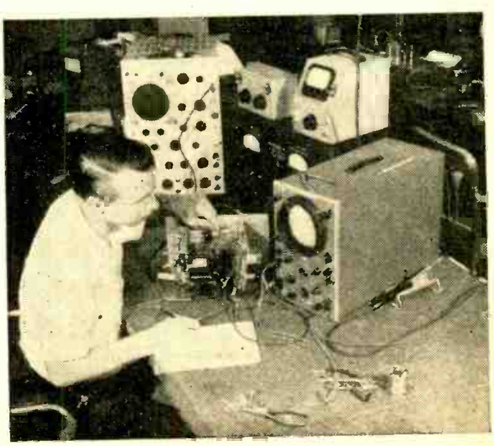
To measure the speed of a shaft not connected to an electric ignition motor, it is necessary first to install a simple contact which will connect the relay coil to a six-volt battery once each shaft revolution. The contact may be a piece of springy wire arranged to touch a screw, or a micro-switch actuated by a cam attached to the shaft. END

P. H. S. Test Bench

RESEARCH scientists of the U.S. Public Health Service work at benches that would do justice to any electronic workshop. The technician in the photo, shown testing an amplifier with two cathode-ray oscilloscopes, is part of a team whose job it is to design and improve aids to medical research and treatment.

The table is one of several flexible units that may be grouped according to the needs of the laboratory. Measuring 40 by 48 inches, each table is equipped with a series of electrical outlets along the rear edge of the surface, where a brass grounding strip is inlaid. A layer of copper sheeting under the pressed-wood top prevents hum pickup and also shields the sensitive electronic instruments from stray fields. The copper sheet is connected to the grounding strip. When tables are joined, the brass grounding strips are connected together and lead off into the main ground. The pressed-wood top makes an ideal working surface, being itself an insulating body with a high resistance to heat and scratches from tools.

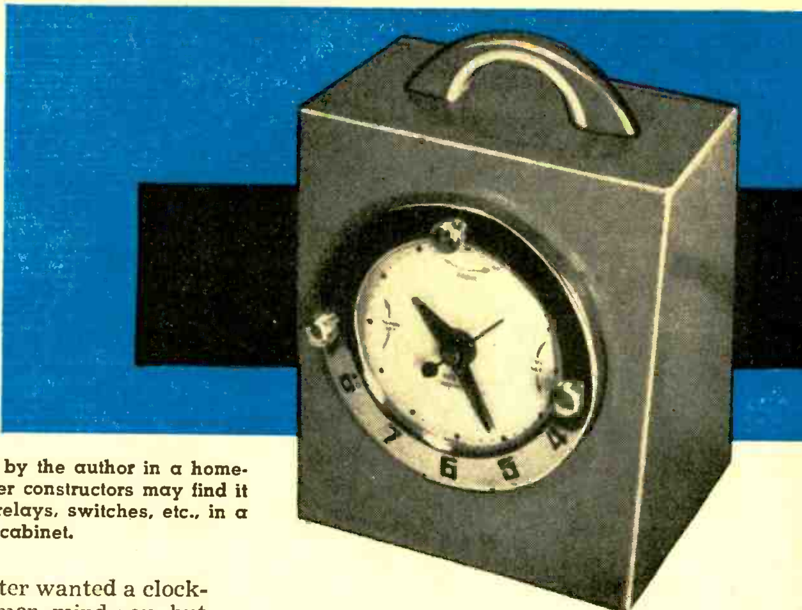
Shelves beneath the tables, mounted about ten inches from the floor, hold power supplies and other equipment. These tables were made to the specifications of the laboratory's personnel. END



By 

JOHN T. FRYE

W9EGV



The timer was mounted by the author in a home-made wooden box. Other constructors may find it useful to put the clock, relays, switches, etc., in a metal cabinet.

FOR a long time the writer wanted a clock-timer—not just any timer, mind you, but one to fit certain definite specifications he had in mind. It had to: (1) be small, compact, and attractive in appearance; (2) handle any load up to 15 amperes at 115 volts a.c.; (3) permit a device plugged into it to be switched on or off at any time up to twelve hours; (4) provide a choice of leaving the device in this switched condition indefinitely or returning it to its former state after an hour or so; (5) allow one device to be turned on at the same time another is turned off; and (6) be available for about ten dollars!

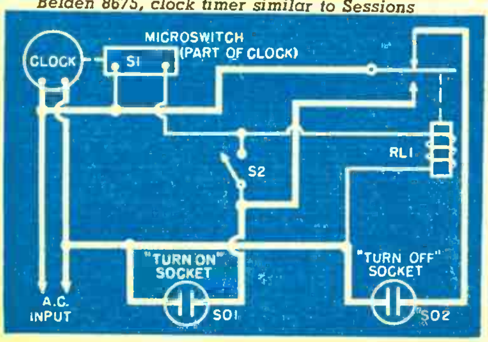
Since a commercially-built timer with all these qualifications was never found, one was constructed at home. This compact little unit was simplicity itself to build; yet it fulfills completely the six requirements mentioned.

During the six months since its assembly, the timer has been in constant use. It turns on the TV set and the radio so that favorite programs are not missed; it switches on the receiver and transmitter of W9EGV a few minutes before every important schedule; on hot summer nights it keeps an exhaust fan running until the house is cooled down in the wee small hours and then stops the fan; it turns on the house lights just before we get home from a show so that we do not have to enter in the dark; it doubles as an electric alarm clock; it—but it is pointless to try to list all the uses for such a versatile unit.

A *Sessions* electric clock with a built-in time switch mechanism, may be purchased from a radio parts distributor for slightly less than four dollars. Three small control knobs are located on the ornamental gold rim of the clock. The one on the right sets the time-telling hands. The one on the left sets a red hand to the time at which you want the built-in time switch to close. The knob at the top has three settings: "On" in the counterclockwise position; "Off" in the clockwise position; and "Auto" in the center. In this middle position, the self-contained Microswitch is closed when the clock reaches the hour indicated by the red hand; and an hour to an hour and a half later, this switch is opened by the progress of the clock hands. In either the "On" or "Off" positions, the knob permits the automatic time switch to be overruled manually.

Fig. 1. Wiring schematic of the clock timer circuit. Note that the heavy wires in the schematic indicate a large current flow. They should be at least #14 flexible copper with good insulation.

RL_1—S.p.d.t. relay, 15 ampere contacts, Advance PC/1C/L15VA
S_1—Microswitch (part of clock mechanism)
S_2—S.p.s.t. toggle switch
Also required: 2 chassis-type a.c. sockets similar to Cinch-Jones 2R2, heavy duty line cord similar to Belden 8675, clock timer similar to Sessions



A simple construction project that can be assembled in a single evening. Useful around the house and costing o[illegible] ten dollars.

Build Your Own Clock Timer

Now look at wiring diagram, Fig. 1, or the pictorial drawing, Fig. 2. Assume light bulbs are plugged into both the "Turn On" and the "Turn Off" sockets, the red hand is set at twelve o'clock, and the time indicated by the clock is 11:50. Switch, S_2, is in its open or "Cycle" position. When the clock is plugged in, the clock motor begins to run. Switch, S_1, is open; so relay, RL_1, remains in the unenergized position shown. Current flows through the moving and upper relay contacts, through the light bulb in the "Turn Off" socket, and back to the other side of the line. While this bulb lights, the other will remain dark.

When the clock reaches twelve o'clock Microswitch, S_1, closes. This allows current to flow through the relay coil and pulls in the relay. Current flows through the relay contacts to the "Turn On" socket, and this lamp glows. At the same time the current path through the upper relay contact to the "Turn Off" socket is broken, and this lamp goes out. Sometime between one and one-thirty o'clock, S_1 will open again and stop the flow of current through the relay coil, permitting the moving relay contact to return to its normal position. At this instant the lamp in the "Turn On" socket will go out and the one in the "Turn Off" socket will light. To light the lamp in the "Turn On" socket before the clock hands reach twelve o'clock, simply turn the knob at the top of the rim to "On"; and to turn off this lamp between twelve and one o'clock, turn this knob to "Off."

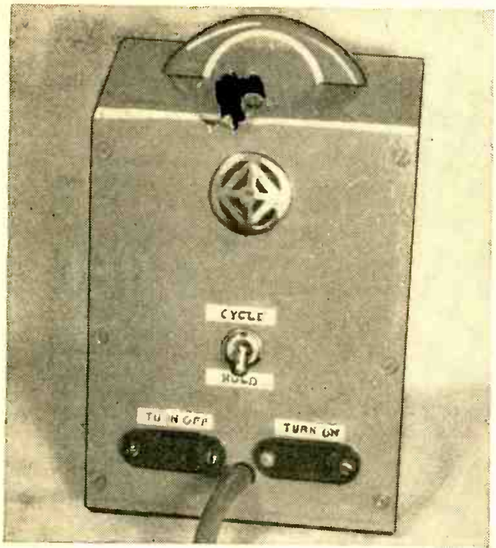
Now let's put S_2 in its closed or "Hold" position. Everything will perform just as it did up until the time when the progress of the clock hands opens S_1. This time the relay will not be de-energized, and the "Turn On" lamp will not go out. The only way it can be de-energized is by opening both S_1 and S_2, as can be done by moving the top control knob to its "Off" position and by throwing S_2 to "Cycle."

The timer may be built in a case of ¼-inch plywood. The two side sections fit between the front and back pieces. The top and bottom sections fit inside all the way around. The case is fastened together with small brads and wood glue. The back is not glued on, but is fastened with small brass countersunk screws so that it can be removed. Extra small pieces of wood are glued inside the back of the case to hold these screws, as is shown in the photographs. Switch, S_2, one of the ornamental ventilating hole plugs, and the two a.c. sockets all mount on the back. The sockets are mounted with the flange outside the case. The two ornamental hole plugs simply push into one-inch diameter holes cut into the back and bottom of the case. The latter hole cannot be seen, but it is just in front of the clock-holding bracket. The purpose of these holes is to provide ventilation for the relay and clock motor.

Do not make the hole in the front of the case, given as a nominal diameter of 3½ inches, any larger than necessary or some of this opening will show around the rim of the clock and spoil the appearance. On the other hand, if the opening is not big enough, the edge of the case will interfere with the clock mechanism.

After the case is finished, sand off the sharp corners and give it about three coats of good enamel. The one shown in the photographs is painted an apple green which shows the gold trim to advantage. Four rubber tack bumpers placed near the corners of the bottom serve as non-marring feet and raise the case so air can enter the ventilation opening. A suitable handle, obtainable at any hardware store, is fastened to the top.

The mounting bracket, which comes with the clock, is fastened by two 6-32 screws through the bottom of the case, so that when the clock is attached to it, the bracket is sprung forward slightly, causing the rim



Rear view shows the ventilation cutout cover mounted above switch, S_2. Another hole in the bottom of the box provides air circulation.

of the clock to be held snugly against the front of the case. A small cable clamp underneath the nut of one of the bracket screws will hold the line cord.

Two screws up through the bottom of the case hold the relay in position. Be sure the contact portion is toward the rear opening so that the solder connections may be easily reached. If the coil is equipped with solder-lug connections instead of flexible leads, solder a few inches of wire to each lug before mounting the relay.

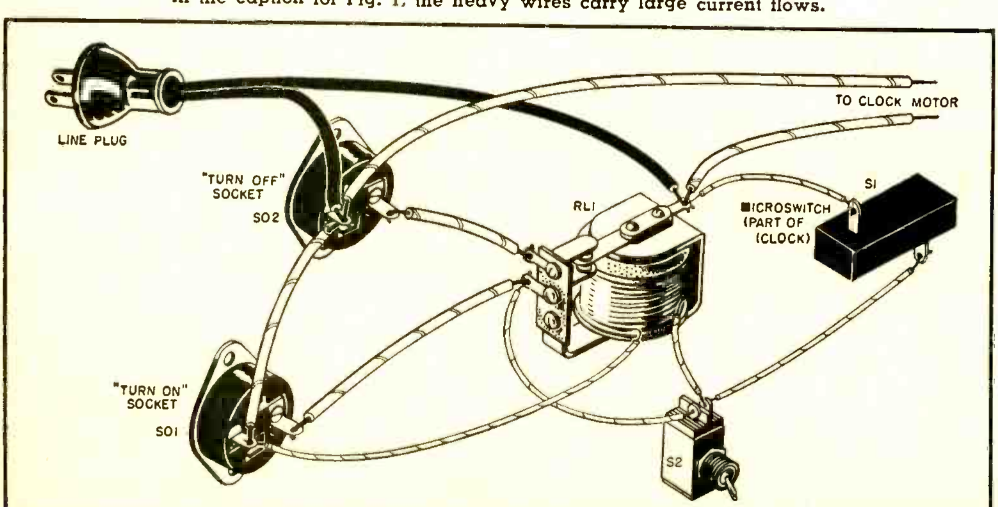
Note that the heavy lines in the diagram and the large diameter wires in the pictorial indicate paths of heavy current and should be of #14 flexible copper wire or heavier. Other wires carry only low current and can be any ordinary well-insulated wire. Remember heavy current must flow through the clock line cord. Do not employ ordinary lamp cord if the timer is to control motors, coffee-makers, toasters, and similar heavy current devices.

It is handy to turn on the TV set. For this use the TV set is plugged into the "Turn On" socket and the red hand is set to the time the program begins. With a little practice, this hand can be set so the TV set will be turned on within two or three minutes of the time desired. If just one program is to be watched, leave S_2 at "Cycle." Then the set will be turned off about an hour and a quarter after it was turned on. The time at which the Microswitch opens is not as exact as the time at which it closes, although some rough adjustment of the duration of the "On" time is had by a screw adjustment on the switch-tripping mechanism. The TV set can be turned off at any time by turning simply the upper knob to "Off." By the same token, the clock can be kept from turning off the set by moving this knob to "On" or by switching S_2 to "Hold."

If the radio is to lull the listener to sleep, plug it into the "Turn On" socket, leave S_2 at "Cycle," and move the red hand slowly counter-clockwise toward the hour hand. As the two hands coincide, if the upper knob is set at "Auto," the relay will click and the receiver will be turned on. It will automatically turn itself off about an hour and fifteen minutes later.

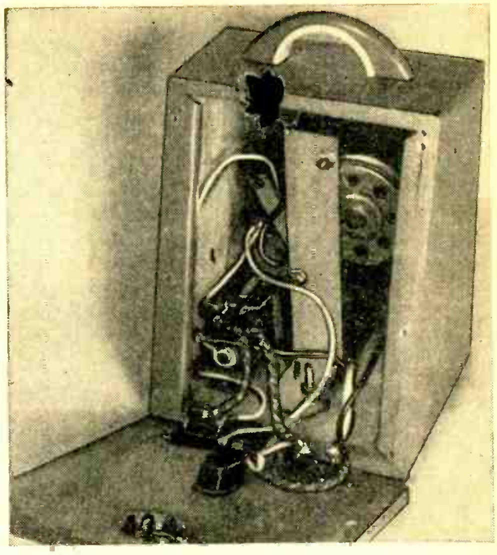
When the exact time a device is turned off is important or when the turn-off time is several hours later, plug the device into

Fig. 2. Pictorial wiring diagram of the clock timer. As mentioned in the caption for Fig. 1, the heavy wires carry large current flows.



the "Turn Off" socket. It will operate there until the clock reaches the pre-set time and then be cut off. For example, an exhaust fan can be connected in this manner, with S_2 set to "Hold." When the clock reaches the shut-off time, the fan is stopped and kept turned off indefinitely.

Finally, suppose a housewife wants to have Boston-style beans for dinner, but must be away from the house all day. This dish should simmer six to eight hours. She can put the beans into her deep-fryer and plug it into the "Turn Off" socket about seven and a half hours before the dinner hour. Set the timer for seven hours later. Place the automatic coffee maker plug in the "Turn On" socket. When she comes home the beans will be cooked and the coffee will be ready to pour! END



A rear view of the clock time with the cover unfastened. The relay is in the lower left-hand corner of the cabinet.

Basic Electricity Book Series

John F. Rider releases two five-volume sets of books on basic principles of electricity and electronics.

THE first part of a new ten-volume set of books covering the fields of elementary electricity and electronics has just been released by *John F. Rider Publisher, Inc.*, 480 Canal St., New York 13, New York. The initial five volumes dealing with *Basic Electricity* are to be supplemented by five more volumes on *Basic Electronics.*

The text and illustrative material in both series were derived from a "basic" course currently used by the U. S. Navy to teach trainees the rudiments of electricity and electronics. According to the publisher and Van Valkenburgh, Nooger and Neville, Inc., who prepared the material, over 25,000 trainees have used the course with outstanding success.

The five-volume series on *Basic Electricity* opens with interesting text, drawings, and cartoons on how electricity is produced. Many readers may be surprised to find that these sources include friction, pressure, heat, light, chemicals, and magnetism. The sequence of subjects then moves on to current flow and measurements, the direct current laws and electric power, alternating current, and resistance, inductance, reactance, etc., as the third volume closes. The fourth volume illustrates impedance, series and parallel circuits, and transformers. The last volume in the *Basic Electricity* series is a discussion of generators, motors, and power control devices.

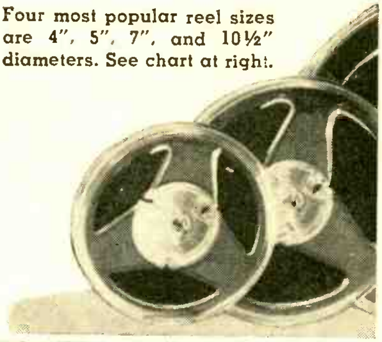
The five volumes total 574 pages of valuable information and approximately 700 drawings and illustrations. Each volume is carefully indexed. It is obvious from the excellence of the illustrations and the planning in laying out the subject matter that the original cost of the series must have been in the hundreds of thousands of dollars. Many of our readers may have seen or heard of the Naval training books in electricity and electronics and thus will be able to appreciate the value of this series.

The reader desiring a broad background in electricity can use these volumes to good advantage. The material is excellently arranged and so amply illustrated that even the rank beginner can readily grasp the full import of any subject under discussion.

The second five-volume series (titled *Basic Electronics*) will be reviewed next month in greater detail. The publisher is also offering the five-volume sets on a 10-day, money-back guarantee. The total cost of either set of five volumes is $9.00. Arrangements have been made for Canadian purchasers who must pay about 5% more. The publisher will be glad to supply further information. END

Tape Types and Timing

This run-down on the standard kinds of recording tape available, as well as the advice on timing them, should prove valuable to the home recordist.



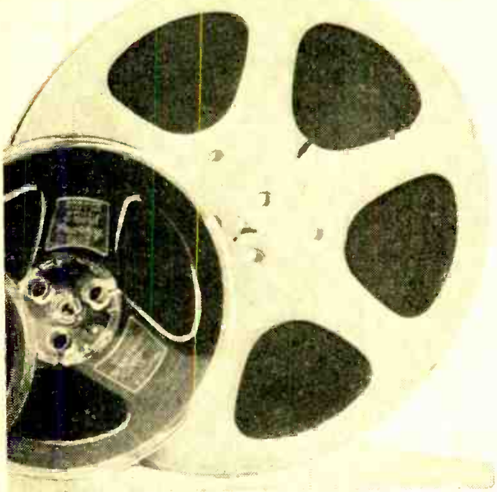
Four most popular reel sizes are 4", 5", 7", and 10½" diameters. See chart at right.

IN ADDITION to the familiar type of recording tape widely used by some recordists, other types are available to meet special requirements. One manufacturer, *Minnesota Mining and Manufacturing Company,* produces several types, of which their *Scotch* No. 111 magnetic tape is the most generally used.

Similiar to No. 111, but of higher strength for special applications where improved resistance to temperature and humidity is required, is *Scotch* brand No. 111 AM with a polyester film backing (or No. 111 BM, according to the method of winding).

A more potent magnetic coating is available on No. 120 "High Output" tape. Featuring a distortion-free signal-to-noise ratio of 8 to 12 decibels greater than conventional tape, No. 120 is designed for recording applications where greater signal strength is needed, ranging from low intensity pulse recording to wide-range high fidelity music recording. No. 120 is also available with the polyester backing. Des-

Photography fans who take colored slides have found their tape recorders an excellent means of adding sound to presentations.



REEL SIZE	TAPE LENGTH	TAPE SPEED (inches per-second) 3¾	7½	15
		(All tim[illegible]	low in minutes)	
3"	150'	7½	3¾	
4"	300'	15	7½	3¾
5"	600'	30	15	7½
5"	*900'	45	22½	11¼
7"	1200'	60	30	15
7"	*1800'	90	45	22½
10½"	*2400'	120	60	30
10½"	*3600'	180	90	45

This table shows the uninterrupted recording times for the tape speeds and tape lengths listed. Times given are for single track recording only. For dual track, double the times shown. Starred tape lengths apply only to Scotch brand "Extra-Play" Magnetic Tape No. 190.

ignated as No. 120 AM "High Output" magnetic tape, this type has features similar to No. 111 AM tape.

A magnetic tape that automatically increases by 50 percent the recording and playback time of any tape recorder as well as extends the high frequency range is No. 190 "Extra-Play" tape. This tape is made only half as thick as standard tapes, but has the equivalent magnetic properties, and actually boosts response at high frequencies.

For magnetic tape editing, *Scotch* No. 41 Splicing Tape is a pressure-sensitive adhesive tape that does not ooze or slip when used to splice recording tape. It makes possible noise-free splices.

No. 43 Leader and Timing Tape, another *Scotch* product, makes it possible to utilize the full length of the recording tape without running it off the reel. When spliced to the beginning and end of a tape, it protects the ends from flapping action when the reel completely unwinds. Exact spacing between different selections on one reel is also provided for by using a length of No. 43 tape. This tape is marked off in sections that represent actual recording time.

Identification of tape recordings is made easier with a pressure sensitive labeling tape called *Scotch* Write-On Tape No. 48. This accessory provides a roll of 40 printed labels that stick at a touch to the reels themselves.

Timing Your Tapes

The length of recording and playing time obtained on a recorder depends upon several things. One important factor is the length of tape used. Most tapes come in set standard lengths—150, 300, 600, and 1200 feet lengths are most common for home recorders. Professional machines and some of the new high fidelity recorders can take tapes of longer lengths which are also available. The longer the length, the longer the recording time.

To meet the demand for more playing time on a reel of tape is the "Extra-Play" tape described above. These tapes extend the limits of many home recorders which cannnot hold larger reels.

The other determining factors in tape-playing time are the type of recorder used, the playing speed it offers, and whether it has a full track or half (dual) track record head. Some of the tape recorders most commonly used run at 3¾ inches per second, others at 7½ inches per second and some offer a choice of both. Professional machines are apt to use the 15 inches-per-second speed. Some go up to 30 ips. The faster the speed, the less recording time obtained on the same length of tape.

A full track recorder records the entire width of the tape, making it easy to edit and splice recordings without losing any part of the recorded portion. While less economical than dual-track recording, this method assures complete accuracy and is generally preferred for professional applications.

Tape recorders which are equipped with half-track record-playback heads enable the tape to be recorded on only half its width at a time. This doubles the playing time simply by reversing the tape and recording on its unused half-width.

The accompanying tape timing table lists the most widely used standard tape lengths, both regular and "Extra-Play" and shows the recording and playback time of each at the three standard speeds. END

CARL & JERRY

Transistor pocket radio causes some discussion and a tornado provides an interesting experiment with TV receivers and Yagi antennas.

A FEW minutes ago Carl had dropped into the basement laboratory and thrown himself down on the workbench while he chatted with Jerry, stretched out on the battered old couch across the room. Suddenly Jerry became silent and heaved himself to a sitting position.

"Say," he said, trying to sit quietly so the couch springs would stop their squeaking protest, "do you hear music?"

"Music!" Carl repeated in wide-eyed surprise. "What's the matter with you, old buddy? You flipped your lid?"

"I hear music," Jerry stubbornly insisted as he got up and padded around the room, checking the receivers, hi-fi amplifier, record player, and similar equipment strewn about the room. Every few steps he stopped to listen intently. "It seems to be louder over here by the bench," he observed. "Hey! It's coming out of you!" he exclaimed and began to "frisk" him in the professional manner of a TV whodunit detective.

"Get your cotton-picking hands off me!" Carl shouted as he planted a big foot in the middle of Jerry's chest and shoved him across the room to a sitting position on the couch. "If you must know, this is what you've been hearing," he went on as he unbuttoned his shirt pocket and pulled forth a flat little bakelite case not much larger than a pack of king-size cigarettes. He turned a small knurled knob that protruded through a slot in the case, and the whisper of music rose to a volume that filled the room.

"Hey," Jerry exclaimed with mounting enthusiasm, "I'll bet that's the transistor radio I saw in the January POPULAR ELECTRONICS."

"Right!" Carl proudly admitted. "You're feasting your blue eyes on the very first transistor radio put on the market. This is the real thing, with a built-in loop, i.f. stages, and even a.v.c. There are no tubes—just four little transistors and a crystal diode to take their place."

"I know all that," Jerry interrupted, "but how does it work?"

"What station you want to hear?" Carl asked confidently.

"Try Chicago; that's a hundred and twenty miles away."

Carl moved the little dial at the top of the case, and one after another five Chicago stations were picked up with ample volume. "And just for good measure, here's Cincinnati, a couple of hundred miles away," he said as WLW rolled in strong and clear.

"I'll be jiggered," Jerry marvelled. "That sure is keen reception for the middle of the day. It changes my thinking about those new transistor receivers that are coming on the market. Before hearing this one, I thought they were clever toys. You know, a sort of glorified crystal set that would pick up strong local stations and not much else."

"You ain't heard nothing yet," Carl boasted. "This set came from my uncle in New York yesterday, and he sent a hearing-aid type earphone that plugs into this little hole in the side of the case. When it's plugged in, the speaker's cut out. Last night after I went to bed I was using the earphone to do some DX-ing. It must have been a hot night on the broadcast band. New York, Atlanta, New Orleans, and Dallas rolled in like our local station; but I was really floored when I picked up two stations in Mexico City. I stayed with them until they announced to be sure. It made me feel kind of funny to be sitting there in the middle of the bed, holding in the palm of my hand a complete receiver on which I was hearing Spanish singing commercials from 2500 miles away whooping it up for *Coca Cola*—especially when I knew the loop antenna was no bigger than a stick of chewing gum."

"If I remember right," Jerry mused, "that set draws about four mills from a 22½-volt battery. Two thousand five hundred miles on something less than a tenth of a watt of power consumption is pretty good mileage. Say, we could put on a real mind-reading act with that thing. You could wear the earphone under a turban, and I could go out in the audience with a small concealed transmitter. Then you could hear and answer the questions people whispered to me. We gotta work on that."

"Okay," Carl agreed, "but that's not really what I came over to talk about. Get a load of that static. It's building up so

"I hear music," Jerry stubbornly insisted.

bad on 75 meters that I had to QRT on a QSO I was having with W9YVS up in Garrett. Bert was telling me about tornado static. He says that for several years he's been able to tell whenever there's a tornado within three or four hundred miles just by listening to his receiver. He says that when a tornado is doing its stuff, it makes a peculiar kind of static. Instead of individual crashes, he describes it as being sort of a continuous noise, like the sound of loose gravel falling on a tin roof."

"And he's right!" Jerry exclaimed. "That fits in with an article I was reading in the newspaper. A professor by the name of Dr. H. L. Jones at Oklahoma A. & M. has been studying tornado static since 1947. Those high voltage lightning discharges he calls sferics, from the word 'atmospherics.' As a storm goes up in intensity, the frequency of the discharges increases; and the number of them that takes place in any second can be used as a guide as to whether or not a tornado is in the thunderstorm. Fifteen strokes a second indicates hail and that the storm is building toward a tornado. Twenty-three strokes per second means tornado activity is going on and when twenty-six strokes are recorded, the tornado has been spawned."

"How did he count the strokes?" Carl asked.

"By displaying the lightning discharge on an oscilloscope and taking a picture with an automatic camera every time there was a lightning stroke. At the same time another camera took a picture of a radar scope that showed where the storm center was located. With this gadget going twenty-four hours a day, all Professor Jones had to do was to wait until a cyclone passed near the radar station and then look at the pictures when the tornado was in business. In Oklahoma you sometimes don't have to wait too long; and he got some dandy pictures. One funnel was obliging enough to start forming right over the station!

"He found that not only the number of strokes was important, but also their nature. A tornado turned out a large percentage of high-frequency sferics with scope pictures altogether different from the low-frequency patterns seen during an ordinary thunderstorm. These high-frequency jobs appeared *only* when there was tornado activity—Hey! You're not listening to me."

"I was just thinking," Carl said slowly. "A thunderstorm is a comparatively small-diameter affair, isn't it?"

"Yes, but what do you have in mind?"

"Did you ever notice that when a thunderstorm is coming on you can see the effect of each lightning stroke as lines across a TV screen?"

"Sure."

"Well, why couldn't we use the directional characteristics of your Yagi-type TV antenna and your antenna rotating motor

" . . . I just want to make sure that the tracks don't get too fresh . . . "

to get a rough idea of the location of a storm and the direction in which it was moving?"

"Hm-m-m," Jerry said with a thoughtful frown on his round face, "I can't seem to think of any good reason. Let's try it."

(*Continued on page* 110)

HEADPHONE ADAPTERS FOR TV AND RADIO

Two adapters, easy to make and convenient to use, provide shock-free headphone connections

By
LLOYD B. HUST

HEADPHONE connections for a television set or a radio are convenient for a number of reasons. Often it is desirable to be able to operate such a set for one or two listeners without disturbing others who are nearby. Headphone connections are particularly desirable in apartment houses where late evening operation of radios and television receivers is frowned on, if not prohibited entirely. Such connections are also advantageous if a person, who is hard of hearing, happens to be one of the listeners. Ordinarily, in such a case, either the hard-of-hearing member of the audience misses much of the program, or the set must be operated at such a high volume level that it is unpleasant to those listeners whose hearing is not impaired. With the right kind of headphone hookup, all can listen comfortably.

However, if headphone connections to either TV or radio are not made properly, a definite shock hazard can exist. A little time and care taken in the construction of a suitable headphone adapter can eliminate this hazard. In addition, such an adapter can be made to suit the particular needs of the builder. The cost needn't be high and extensive changes do not have to be made in the radio or television set with which the unit is to be used. Two separate adapters will be described here, one slightly more complicated than the other. Either of them can be built easily and used safely.

Two possibilities of shock exist when headphones are connected directly across the voice coil of a speaker. The first is the possibility of 117 volt a.c. line shock, which is present if one of the voice coil connections is grounded to the chassis, which, in turn, may be connected, either directly or through a capacitor, to one side of the power line. The other is the chance for severe shock from high voltage d.c. if the output transformer primary should short to the secondary. Both possibilities can be eliminated if the phones are connected to the secondary of the output transformer through a small step-up transformer. The additional transformer also serves to match the impedance of the output to the impedance of the phones and to increase the volume.

As shown in the schematic diagrams, the secondary of the transformer feeds the headphones through a volume control which gives independent control of volume to the listener. With this arrangement, proper volume level in the phones can be attained with either high or low settings of the volume control in the set. The volume control used in the headphone adapter can be of any value from 20,000 ohms to 500,000 ohms. With a low value the load on the output tube of the set will change less as the volume is adjusted than with a high value.

In the two units which the author built up, small transformers of the line-to-grid type were used. The low impedance (line) winding was connected across the voice coil of the speaker, and the high impedance (grid) winding was connected to the volume control. A small output transformer connected in the same way (to provide a step-up) probably would be just as satisfactory. Connect the secondary across the speaker and the primary to the volume control.

Both units were built on chassis which measured 3" x 4" x 1½". These can easily be made up of scrap aluminum. The first unit, which is the simpler of the two, and which will suffice for many purposes, consists simply of the transformer, the volume control, and the phone jack mounted on the chassis. These components are connected as shown in schematic diagram (A). The lead wire, of a flexible type and of convenient length, is fed into the chassis through a rubber grommet and is secured so that it cannot be pulled out. The ends of the wire which connect to the set are fitted with alligator clips so that quick connection to, or removal from, the set can be made. Generally, the easiest method of connection is to fasten these clips to the voice coil terminals on the loudspeaker of the set.

The second unit is wired according to schematic diagram (B). This unit is equipped with a single-pole, double-throw slide switch, S_1, which allows the use of the speaker and phones together, or of phones alone. This is particularly desirable when complete silence in the room is desired.

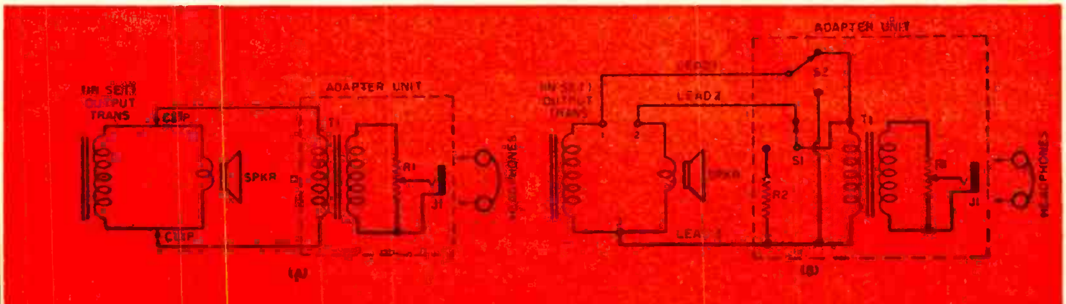
Also incorporated in the second unit is a "squelch" switch. This uses a small single-pole, double-throw, spring-return push-button switch, S_2. When this switch is depressed, sound is "killed" in both speaker and phones. The purpose of this switch in the author's unit was to enable loud applause and/or sound effects to be eliminated, as they were particularly annoying to a hard-of-hearing person who was to use the unit. However, it is also useful in squelching particularly annoying TV commercials. Release of the switch restores the sound to normal.

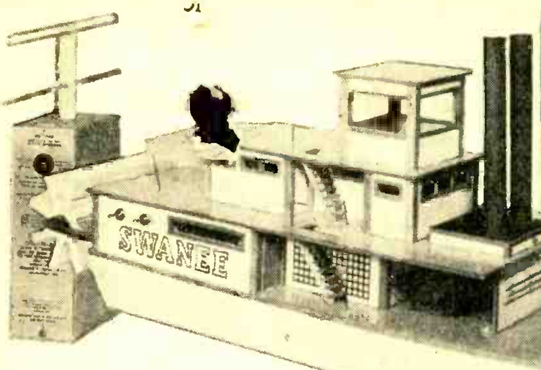
The resistor, R_2, is made from a length of nichrome wire such as is used in heater elements. This wire comes in a coiled form and can be obtained at any five and ten cent store. The coil should be stretched slightly, so that adjacent turns do not touch one another and then a length of it should be measured with an ohmmeter. The value of this resistor should be about the same as the impedance of the voice coil in the speaker, usually between 4 and 8 ohms. The value is not critical; if an ohmmeter is not available, simply measure a piece about 2 inches long.

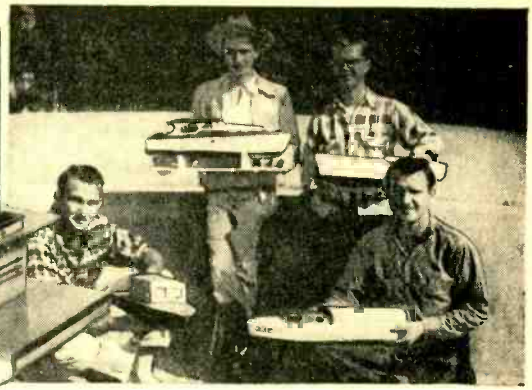
The connection of this unit to a TV or radio set necessitates opening one of the leads which connect the output transformer to the voice coil of the speaker. It also necessitates a three-wire cable for connection. A three-terminal connector strip can be mounted in a convenient place at the back of the TV or radio set, and connected as shown in the schematic. If the unit is disconnected at any time, a jumper wire should be connected between terminals 1 and 2, to reconnect the speaker voice coil to the output transformer. END

R_1—Volume control, [illegible]0,000 ohms to 500,000 ohms (see text)
R_2—4 ohm to 8 ohms (see text)
J_1—Single-circuit phone jack
S_1, S_2—S.p.d.t. slide switches
T_1—Small output transformer (Stancor A-3332 or equivalent)
Headphones—High impedance type headphones

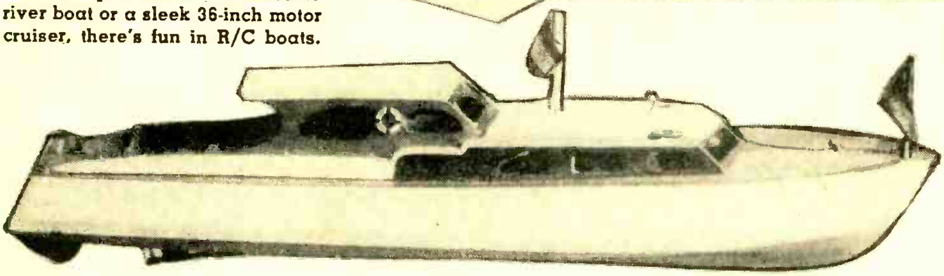
When T_1 is connected in either of the circuits shown, the low-impedance winding (normally the secondary if an output transformer is used) should be connected to the receiver output and the high-impedance winding should be connected to R_1.







Whether you build a semi-scale river boat or a sleek 36-inch motor cruiser, there's fun in R/C boats.



WHAT do the words "radio-controlled model boats" mean to you? A steam-puffing tug as big as the kitchen table? A plunging PT boat, flags waving, turrets revolving? Well, you're only partly right. The R/C hobbyist is building every conceivable type of boat by the tens, if not hundreds, of thousands.

There's been a stampede to the hobby shops. One manufacturer had to suspend advertising of his deluxe boat because he had fallen so far behind the demand. According to a recent survey, 45 percent of the people who read the model airplane magazines now also build boats. Tune a communications receiver to 27.255 mc. and you'll probably pick up some fascinating pulsing.

Reasons aplenty exist for this frenzied marine activity. To begin with, it's one of the inevitable but unexpected results of the establishment by the FCC of the Citizens Band frequencies of 27.255 and 465 mc. Then again, radio-controlling a boat is easier and more convenient than flying a plane by R/C. Boats don't fly away.

You can sail a boat on a couple of inches of water, in swimming pools and ponds. You can take the things on vacation and have fun while the kiddies splash about.

Equipment-wise, weight isn't the critical factor for boats that it is in aircraft. Receivers don't have to be too sensitive, for the range required is not great. Equipment that gives trouble in the air is adequate on the water. Big batteries can be used to insure long life and reliability.

For the benefit of those who have not yet used the Citizens Band, the popular frequency of 27.255 mc. is examination-free, but not license-free. All you have to do, however, is to fill out and return to the FCC in Washington, D.C., the Form 505 that comes with the transmitter, if you buy a commercial one, or which you can obtain from the FCC if you build your equipment. Other readers, no doubt, are hams, who prefer to build their own equipment and who can, and usually do, operate on other frequencies to avoid the Sunday jam session on the Citizens Band at the park.

POPULAR ELECTRONICS has published construction articles on transmitters, receivers, and control systems that can be used for model boats. Almost anything has been described somewhere so that a little research will strike pay dirt. Advertised parts kits cover everything electronic that has been published in the model field. Prefabricated boat construction sets to suit

The Boom in R/C Boats

By WILLIAM WINTER
Editor, "Model Airplane News"

every taste and pocketbook are on the hobby dealers' shelves.

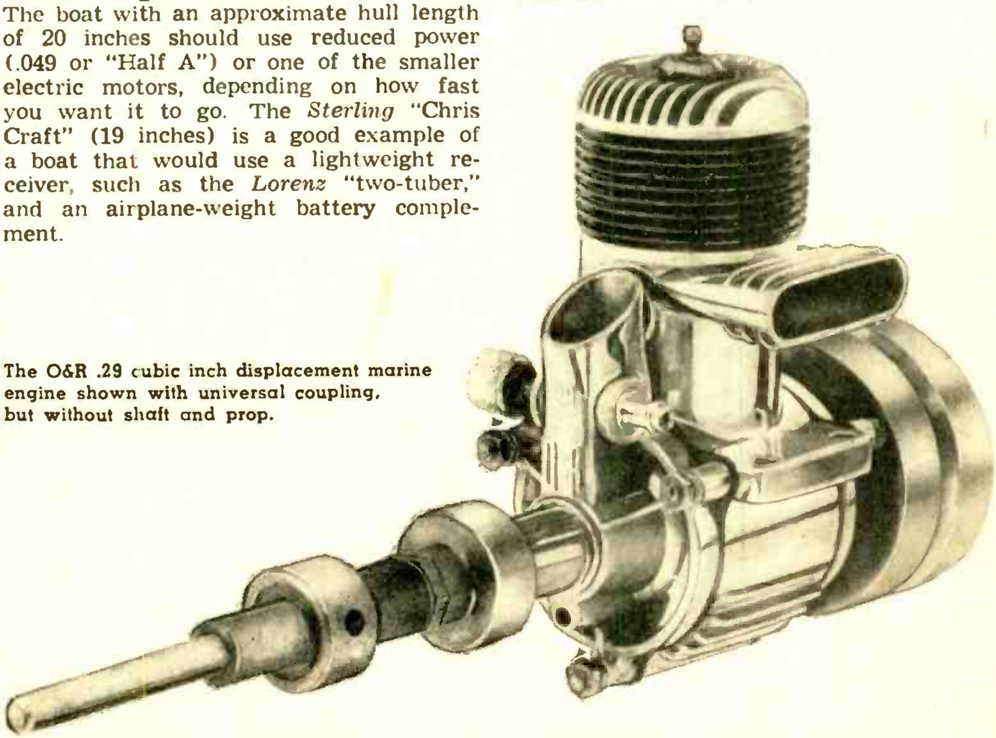
The typical boat is controlled with the same type of equipment and by the same methods as an airplane, although the marine field seems to offer greater flexibility in the combinations of controls, power plants, and actuators. The choice of equipment is directly affected by the size and type of boat. Usually the boat comes first and everything else is tailored to fit.

While anyone can make a boat, it is desirable that the new builder have some perspective on his project before he commits himself to construction. A speed boat that wallows like a barge is the too-frequent result of a willy-nilly approach. Boat size, power, and equipment should always be considered in combination.

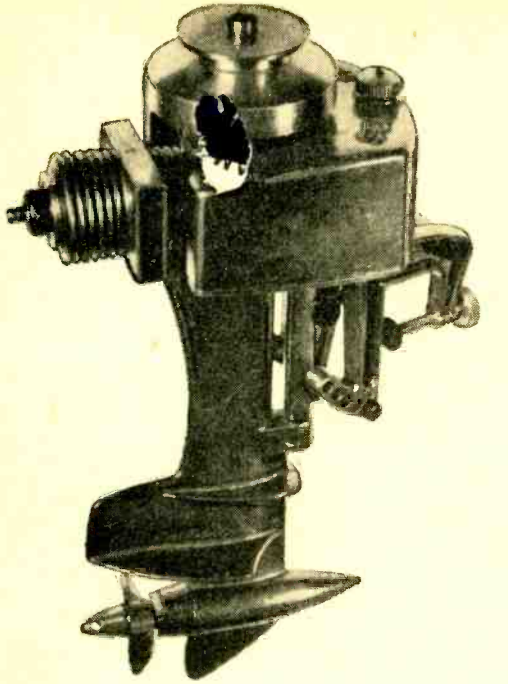
Although it is possible to equip the smaller boat kits (15 to 16 inches in length) with radio, it is better to choose a hull that measures 20 inches or more. Open cockpit (amidships) affairs can be tough because the open area makes it difficult to hide heavy batteries, etc., without affecting the boat's riding qualities. The boat with an approximate hull length of 20 inches should use reduced power (.049 or "Half A") or one of the smaller electric motors, depending on how fast you want it to go. The *Sterling* "Chris Craft" (19 inches) is a good example of a boat that would use a lightweight receiver, such as the *Lorenz* "two-tuber," and an airplane-weight battery complement.

Boats of 24 to 30 inches length will operate on .075, .09, .15, and .19 power, depending on the size, weight, and desired speed. The *Pittman* electric motor, or two electric motors in a twin-screw arrangement, can also be used.

Veteran boat modelers warn against overpowering a boat. Once the craft gets barreling along, you may have to be fast on the control button, just as with an airplane. This is especially true if the boat is being operated in cramped or crowded quarters, where it has to be turned frequently to avoid banks, bulkheads, piles, other boats, or just some joker in a row boat. *Berkeley's* 32 inch "Chris Craft" has only a *Cameron* .09 for power. However, the boat is very light because of its formed plastic hull; a big engine would take it across a pond in nothing flat. Select the powerplant size with the site in mind.



The O&R .29 cubic inch displacement marine engine shown with universal coupling, but without shaft and prop.



Typical .049 cubic inch gas-powered outboard engine for model boats. It clamps onto the boat and steers just like its grownup counterpart. Made by Allyn.

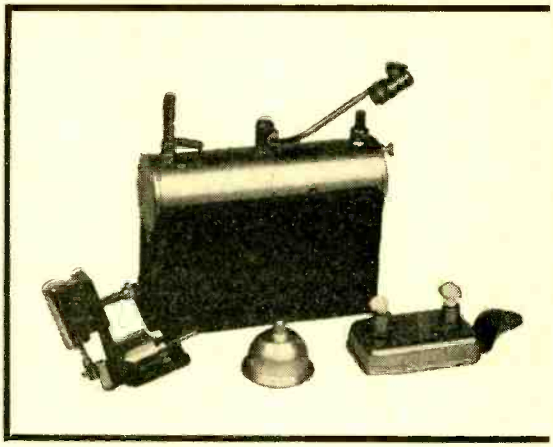
Because so many boat kits exist, the choice can be confusing. It is possible, however, to mention some widely used models. *Sterling Models,* 153-34 N. Hancock St., Philadelphia 22, Pa., currently lists about a dozen, of which five are particularly well suited for R/C. These are the "Chris Craft Cruiser" (28 inches), "Chris Craft Catalina" (31¼ inches), "Harco 40 Deluxe" (27½ inches), the "Chris Craft Monterey" (outboard cabin, 21 inches), and the "Chris Craft Motor Yacht" (40 inches).

Dumas Products Inc., Airport Rd., Phoenix, Ariz., lists approximately 20 boats, practically all of which are big enough for practical R/C work. The biggest is the "Chris Craft Sport Fisherman" (35 inches), closely followed by the "Chris Craft Challenger" (33½ inches), and the "Chris Craft Commander" (33 inches). The "Commander" and "Challenger" weigh approximately 2½ pounds, less radio gear and batteries if electric drive is used. Gross "tonnage" would be 4½ to 5 pounds.

Berkeley Model Supplies, West Hempstead, N. Y., has a number of boats, with the 32-inch long "Chris Craft Cruiser" heading the list. Also available are the "Sea Bird," a 28-inch racing boat, and an outboard "Chris Craft Express Cruiser," 18 inches long.

Another worthy boat is the "Wavemaster," by *Telecommander* (*American Telasco.,* Huntington Station, N. Y.), a 34-inch job that also can take a beating. It is made of hard wood and weighs 7 pounds empty. *Constructo,* 1186 Broadway, New York, N. Y., has a completely assembled 36-inch "Harco Cabin Cruiser," for about twice the price of a comparable kit.

Original designs, preferably based upon existing real boats, should not be overlooked. Why not, for instance, a steam-powered tug, tramp steamer, or some humble but realistic harbor craft? From time to time such designs are published by various magazines. You can pick up three views from a boating magazine or from boat manufacturers' literature. These views can be enlarged by photostating or with the aid of drafting tools. A carved balsa-wood hull mock-up can be sawed into the required number of sections. The end of each hull slice provides a perfect bulkhead pattern. To save money and blisters, make the hull to a smaller scale and then photostat up the resulting bulkhead patterns.



Model boat steam engine with boiler.

For durability use mahogany plywood for siding—1/16 inch thickness is plenty. Covering the balsa-wood bow, if not entire hull, with *Fiberglas* makes it almost indestructible. *Fiberglas* patching kits can be obtained at boat yards, some hardware stores, and hobby shops.

Power Plants

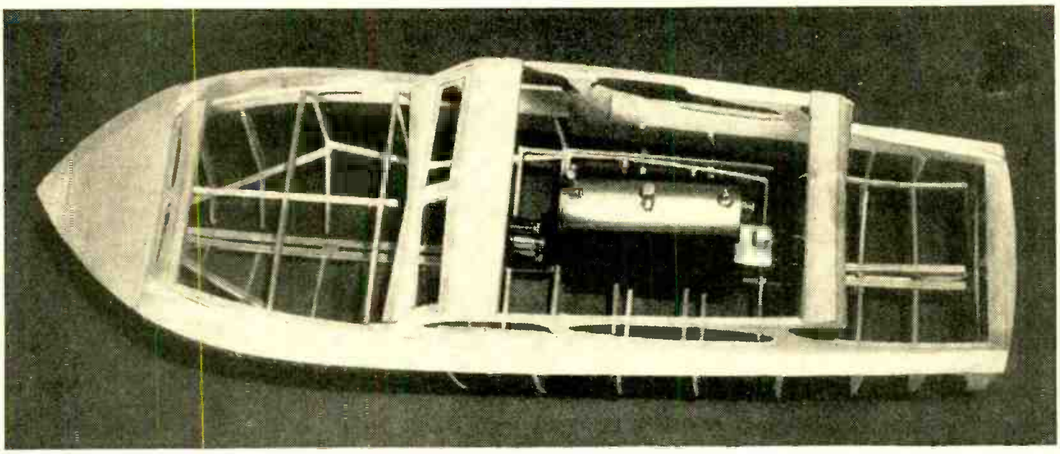
Until recently, there were very few true marine model power plants. Nine out of ten boats ran on converted model airplane motors, which tend to overheat under load, especially when mounted inside the cabin. Marine conversion of these power plants usually was left to the builder who had to pick up, piecemeal, his flywheel, stuffing box, coupling, shaft, propeller, etc. Today, marine engines exist for any model boat and electric drive has proved eminently satisfactory. Though hardware is found easily, it is still true that no one knows much about the precise propeller that is best for a boat, considering the power plants you may choose. This means that boats usually need to be "shaken down" with various "props" tried to give the desired running speed and turning characteristics.

In the bigger engines, the *Cheminol Corp.* has for some years turned out the "O & R Marine" .29, a high performance engine with matching hardware, beautifully designed from coupling to propeller. This rugged engine has a front and rear bearing and has the flywheel mounted to the rear, making it most accessible for starting.

Cameron Precision Engineering Co. makes a jewel of an .09 inboard engine that has no competition. It was designed for continuous running, great strength, good cooling, high torque, and is protected against over "revving." Out of the water, most boat engines will scream their lives away if excessively abused, as they exceed 20,000 rpm's under no load without difficulty. The *Cameron* is designed against this. Although water cooling is provided, this engine is adequately finned for better air cooling than some air-cooled engines.

Two firms, *Allyn Sales Co. Inc.* and *Atwood Motors,* make scale outboard engines of .049 displacement that are remarkable for their design, workmanship, and performance. *Atwood* also has a water-jacketed .049 for inboard use, and an air-cooled version of the same engine. *Allyn* recently introduced a couple of the inboard .049's.

Steam power plants, while not extensively used, nevertheless are readily available. For those who value realism they are tops. A typical engine has a single-cylinder oscillating design, using a "pot" boiler and a spirit wick lamp. *Allyson Co.*, Box 115, Brevoort Station, Brooklyn 16, N. Y., has such an engine, as well as more advanced types. *Boucher-Lewis,* 36 E. 12th St., New York, has long been noted for their realistic line of marine steam power plants of all types, patterned after full-scale types. These are deluxe items.



Steam engine and boiler installed in boat. This is the Allyson engine.

Battery drain, the old bugaboo of electric drives, is no longer a worry, now that high-torque, low drain, electric motors are in good supply. Probably the best known is the *Pittman* "Panther" and "Super Panther." The "Super Panther" will turn a 2-inch marine propeller at 1,700 rpm under load, at a drain of only 1.7 amperes on six volts. When used with the *Willard* WT 6 wet cell storage batteries, a couple of hours running time is assured. Two of these batteries can be connected in parallel for long life when installed in the bigger boats and like car batteries, they can be recharged. The German *Distler* electric motor, distributed by *Polk's Model Craft Hobbies,* New York City, has the phenomenally low drain of only 12 to 15 milliamperes on 4½ volts. The magnetic field is inside the armature!

Other usable electric motors include the "Tiny Atom" by *Wilson's* of Cleveland, Ohio, for 3, 4½, and 6 volts. *Wilson's* has a

The largest R/C boat in American hobby shops is the "ChrisCraft Corvette" shown here. It will carry 75 pounds.

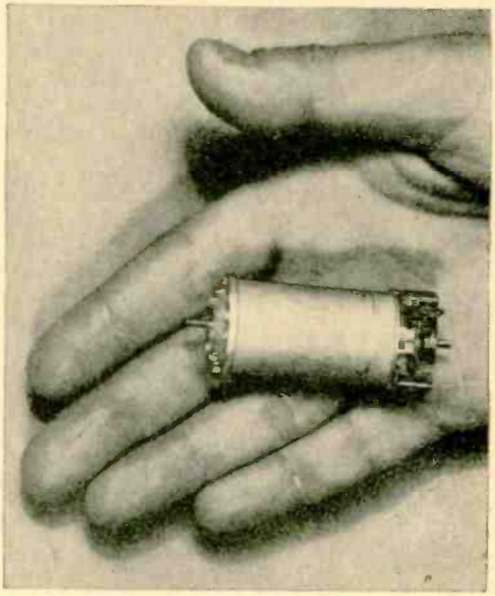
famous gear train which can be used as a speed reduction unit, or as a proportionate-type servo as specified on some *Sterling* plans. Popular, especially on the West Coast where *Pittman* motors seem hard to get, is the Japanese "K & O," with a built-in gear reduction.

Converted 12-volt, "O"-gauge train engines may be operated off two WT 6 batteries connected in series.

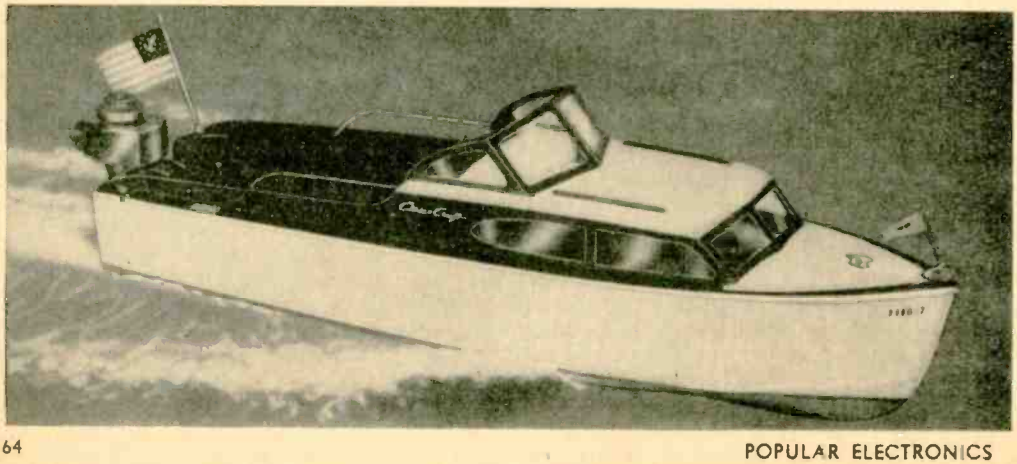
If it is smoke and noise you want, use the gas engine. Outboard types almost certainly have to be gas, although hobby shops stock two scale-type, battery-powered outboards, which could be used on small boats with a lightweight radio installation and simple escapement. Electric drive has real advantages. It is clean and it works by turning a switch. No fueling, attaching of booster leads, or cord pulling of flywheels. Gas exhaust and spilled fuel require fuel proofing and constant cleaning. The electric boat is always clean. Even the wet cells are spill proof.

(To be continued)

The midget-sized German Distler electric motor has a drain of only 12 to 15 milliamperes at 4½ volts. Ideal for R/C boats.



Typical outboard-type model boat controllable by radio. Its length is twenty-one inches, which is close to the minimum for practical operations with reliable radio.



Dual Voltage Power Supply

By WALLACE R. MITTEN

IN CIRCUITS requiring two "B" voltages, such as oscilloscopes, the experimenter is usually required to build two power supplies or else use a special transformer. A way around this difficulty is suggested by the circuit shown below. It is actually a half-wave rectifier that has been added to a conventional full-wave rectifier power supply. It will furnish an additional voltage as high as 1000 v. This potential will operate a 3-inch scope tube with good brightness, and can be had for only the cost of the additional rectifier and filter.

The parts used in the full-wave rectifier section will, of course, depend on the actual circuit already available. Values given for CH_1, C_1, and C_2 are of course, minimum approximations of typical values found in such circuits. If you are building the entire circuit from scratch, you may use C values as high as 40 μfd., depending on the load requirements.

C_3 should be a fairly high voltage unit. Using the values listed for C_3 and T_1, the original circuit produced an additional 880 volts d.c. Using a 750 v.c.t. transformer with the same C_3 value, 1000 volts d.c. may be obtained if the load is light. Since both ends of C_3 have large a.c. potentials, the second filter (R_1 and C_4) is very important. The value of .1 μfd listed for C_4 is, again, a minimum approximation. Actually, values for C_4 may run as high as 1 μfd., and capacitors with this value and the required working voltage of 1000 v. are correspondingly more expensive. The actual C value to use depends on the use to which the power supply will be put. For example, when used with a scope, if the brightness of the sweep trace varies, increasing the value of C_4 will provide more filtering, less a.c. ripple, and consequently a steadier sweep line.

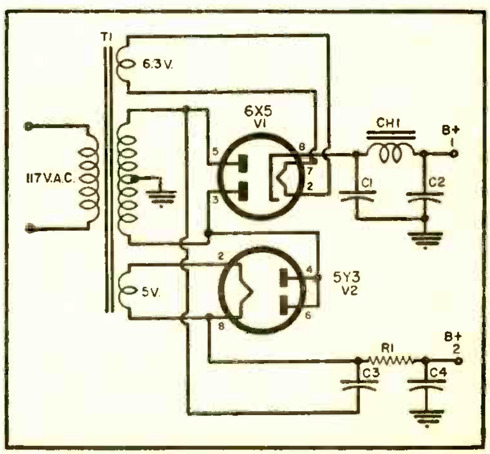
Increasing the value of R_1 will also decrease a.c. ripple and provide improved filtering, but will also lower the output d.c. voltage.

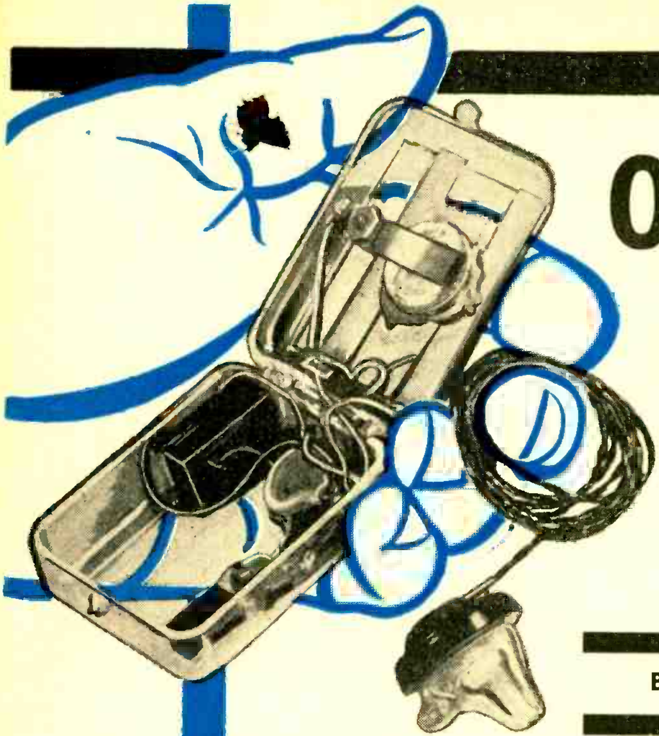
The operation of the circuit is fairly simple: the added circuit (V_2, R_1, C_3, and C_4 is a half-wave rectifier which receives the full a.c. voltage that is developed across the large secondary winding of the power transformer. On one half-cycle of a.c., C_3 is charged to the peak value of the a.c. On the next half-cycle, C_3 discharges this peak value into the load.

The voltage between the filaments of the 5Y3 and ground is the voltage across C_3 plus half the voltage in the transformer secondary. Since the latter is unrectified, the resultant waveform contains a high a.c. component. Hence the need for the extra filtering consisting of R_1 and C_4. END

Parts list and schematic diagram for power supply that furnishes two "B" voltages.

R_1—50,000 ohms, 1 w. wirewound res. (See text)
C_1, C_2—10/10 μfd., 450 v. elec. capacitor (Mallory FP231. See text)
C_3—.01 μfd., 2000 v. vibrator buffer capacitor (Mallory 461)
C_4—.1 μfd., 1000 v. capacitor (Mallory 310; see text)
CH_1—8 hy., 85 ma. filter choke (Stancor C1709)
T_1—Power trans., 340-0-340 v.c.t. @ 70 ma.; 5 v. @ 2 amps.; 6.3 v. @ 2.5 amps. (Stancor PC 8408)
V_1—6X5 tube
V_2—5Y3 tube





Oscillating on a Dime

By LOUIS E. GARNER, Jr.

A novel demonstration of the minute amount of power required to operate transistors.

THE minute amount of power required by transistor-operated equipment when compared to vacuum-tube equipment never ceases to amaze the engineer or technician whose major experience is with vacuum tube circuits. The author, who has designed and built a considerable number of transistor operated devices, still is impressed by the almost insignificant power requirements of transistors.

One example of an inexpensive-to-operate piece of transistor equipment is shown in this article. It is a small audio oscillator, suitable for code practice use, as a miniature audio signal source, or for similar applications. *The cost of the power supply for this oscillator is a thin dime . . . with a dime change!*

Circuit Description

This oscillator is not a difficult item to assemble and wire. It requires neither expensive and scarce components nor a carefully selected experimental transistor. The average technician should have no difficulty in assembling a similar unit in (at the most) a few hours time, using parts that should be available at almost any large electronics wholesale supply house.

Referring to the schematic diagram shown in Fig. 1, a *Raytheon* Type CK722 junction transistor (*p-n-p*) is connected as a modified "tickler feedback" grounded-emitter audio oscillator. Feedback is obtained by means of a *UTC* Sub-Ouncer transformer, T_1, with the primary winding connected to the collector-emitter circuit and the secondary winding connected to the base-emitter circuit.

In operation, the "dime" power supply may be considered as a battery supplying direct current which flows over two paths. Part of the current flows through R_1 and the base-emitter of the transistor, establishing the base "bias" current. The other part of the current flows through the primary winding of T_1 and the collector-emitter of the transistor.

Any variation in current in the primary winding of the transformer is coupled, though magnetic lines of force, to the secondary winding, where a corresponding a.c. voltage is generated and applied to the base-emitter circuit of the transisitor. This signal is amplified by the transisitor and reapplied to the primary winding, thus setting up the basic condition for oscillation.

Oscillations will continue as long as power is supplied by the "dime" source. In order to start and stop oscillation, a hand-key or switch may be placed in either power lead, or in the emitter lead of the transistor. This simple step converts the basic oscillator for code practice use.

Construction Hints

A small plastic pill box serves as both chassis and cabinet for the "dime oscillator." The *Sub-Ouncer* transformer and subminiature tube socket (for the transistor) are mounted simply by cementing them in place, using either *Duco Cement* or general purpose radio service cement.

All other parts, except for the power supply, are soldered in position and allowed to hang freely. Since short leads are used and each component (two capacitors, one resistor) has at least one lead connected to the tube socket, the parts hold their positions quite well—even when the completed assembly is carried in the pocket.

The secondary leads of the transformer (the two black leads) should be "touch-soldered" in place during the original wiring as it may later be necessary to change these connections to obtain oscillation.

The Power Supply: Make up the "power supply" by using a dime, separated from a piece of cadmium plated metal by blotting or tissue paper wet with saliva. The cadmium plated strip is the negative terminal and the dime is the positive terminal of the "battery" thus formed.

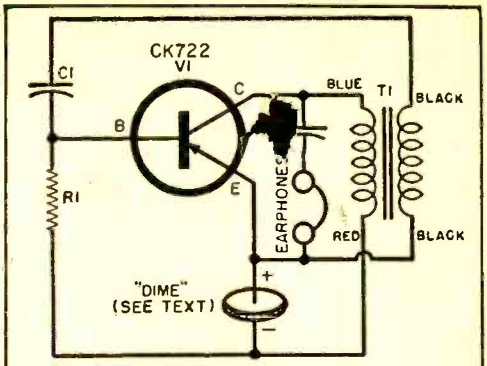
The completed power supply may be mounted in a variety of ways, but provision should be made for easy removal of the coin so that the wet tissue may be replaced when necessary.

Care must be used to insure good electrical contact to both the metal strip *and* the dime, and that the coin and metal strip do not touch each other. The author has found, experimentally, that best results are obtained when a fine facial tissue, such as *Kleenex,* is used. Several layers should be employed—or, as an alternative, use a piece of clean blotter. Cut the tissue or blotter so that it is larger than the dime to insure proper separation between the coin and the metal strip.

Since the coin should not be soldered to, drilled, or defaced in any way, it is best to arrange a spring contact assembly both for holding the coin in position and for making electrical contact. One good technique is illustrated in Fig. 2.

The flat metal strip is cadmium plated steel, copper, or brass. The spring clip should be spring brass, phosphor bronze, or similar material having a certain amount

(*Continued on page* 109)



R_1—47,000 ohm, ½ w. carbon res.
C_1, C_2—.01 μfd. disc ceramic capacitors
T_1—UTC Sub-ouncer trans. type SO-3
CK722—Raytheon (p-n-p) junction transistor
Earphone—Brush hearing aid type crystal earphone
"Dime"—Power supply, consisting of a dime, tissue or blotter paper wet with saliva, and a cadmium plated metal strip (see text)
Misc.—Sub-miniature tube socket, small plastic case, wire, solder, and misc. hardware

Fig. 1. Wiring diagram and parts list of transistor audio oscillator. Although a double unit earphone set is shown in the wiring schematic (this is the universal symbol), a crystal-type hearing aid earphone may be used. This is the type pictured on the facing page.

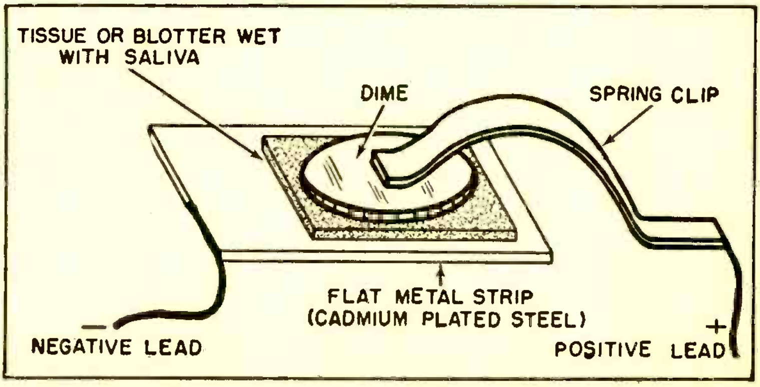
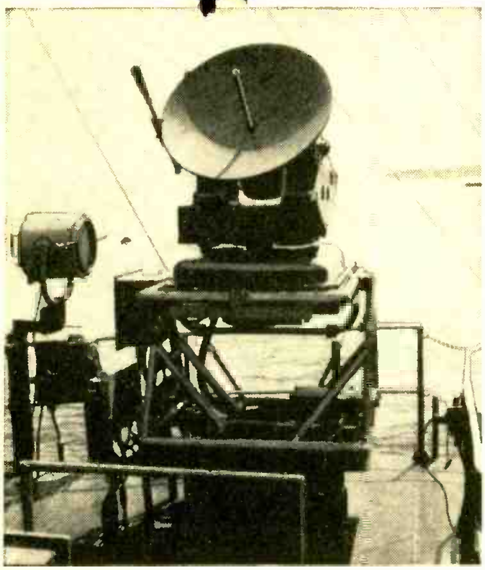


Fig. 2. This is a general view of the construction of the dime oscillator "battery." The plate and the spring clip must be rigidly mounted on an insulator—similar to the plastic case in the photograph.

Radio Sextant Aids



Subjected to operational tests aboard a naval vessel, this unit provided continuous, automatic solar fixes in any weather.

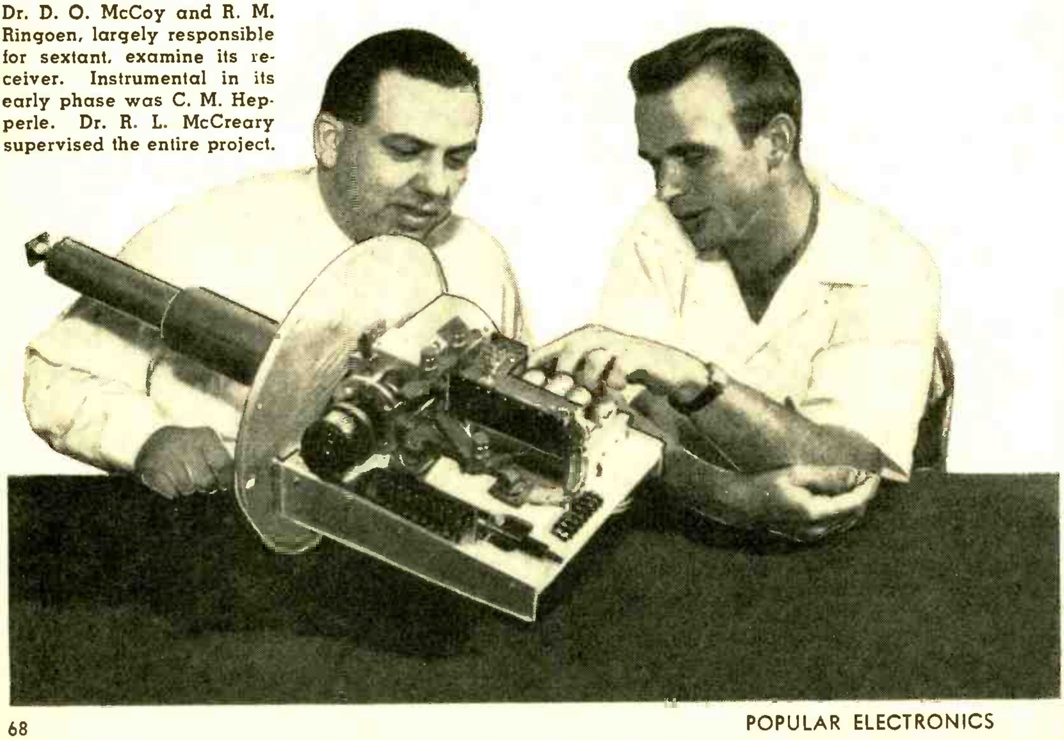
THE age-old dream of mariners, who steer by sun and stars, for a sextant which can see through overcast skies, is nearing realization. Recently, *Collins* announced the development of the first radio sextant, an electronic counterpart of the hand-held optical sextant.

The optical sextant depends on a clear sky, but the radio sextant determines—regardless of weather—the sun's position automatically and continuously. This feat is made possible by the fact the sun emits microwave energy. A radiometric receiver controls the operation of a servo system which moves a small dish antenna to track the sun as long as it is above the horizon. The instrument continuously presents the sun's altitude and azimuth as the craft moves toward its destination.

Developed by the *Collins Radio Company* of Cedar Rapids, Iowa, for the *Navy Bureau of Ships*, the radio sextant has already undergone operational tests on a naval vessel. Although mounted in a large structure, the new instrument utilizes small components, and is capable of miniaturization.

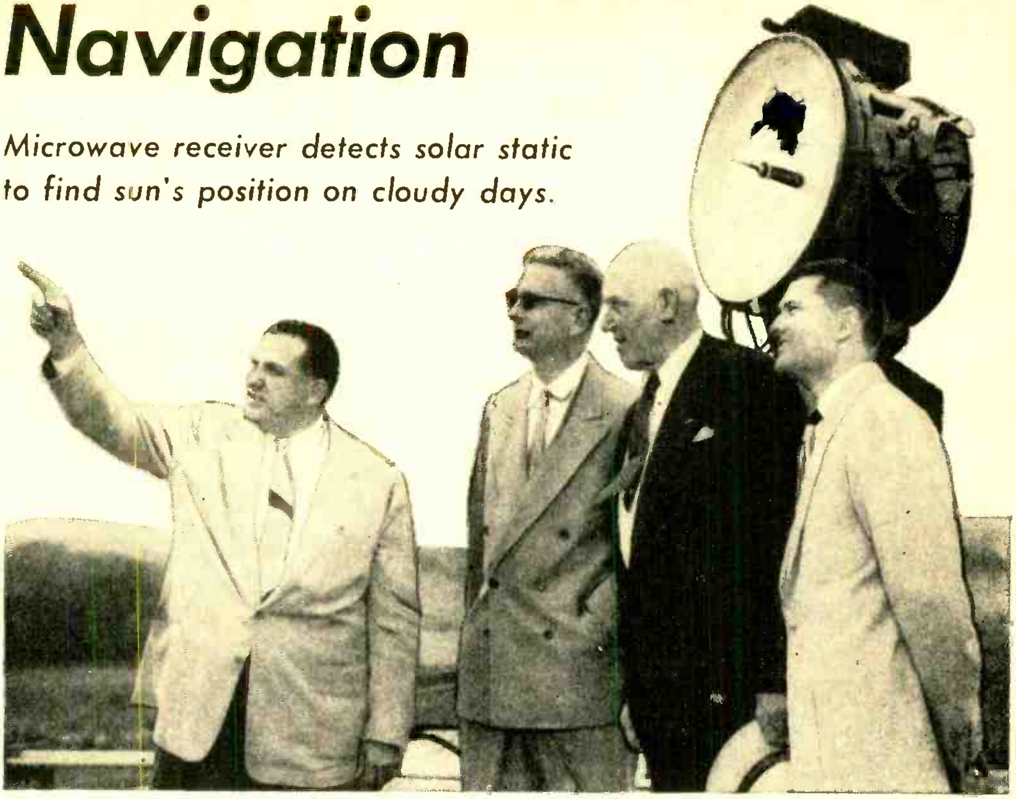
The antenna scans in a circle around the sun's rim. If the antenna is pointed di-

Dr. D. O. McCoy and R. M. Ringoen, largely responsible for sextant, examine its receiver. Instrumental in its early phase was C. M. Hepperle. Dr. R. L. McCreary supervised the entire project.



Navigation

Microwave receiver detects solar static to find sun's position on cloudy days.



Discussing sextant's operation are (from left) Dr. McCoy, Collins president Arthur A. Collins, distinguished navigator Captain P. V. H. Weems, and Collins radio astronomer G. R. Marner.

rectly at the sun, the received signal will show no modulation at the scanning frequency. If the antenna is displaced slightly, however, the solar signal will be modulated. Phase sensitive detectors derive error voltages which are used to make the antenna track the sun.

In order to make the radio sextant usable when the sun is near the horizon, the amount of refraction caused by the atmosphere must be known. Since no previous measurements were available, the sextant is being used to find this refraction. Daily measurements over several months indicate that the refraction can be predicted quite accurately. The results of this aspect of the new device's work will be of interest to other studies of the atmosphere and radio propagation.

Signals From Moon And Radio "Stars" May Be Used

The question is often asked: "What will the navigator do at night?" To date, the answer would be that he will carry on in the same manner as before, except he will know his position more accurately, particularly if the sky is overcast. Actually, the stars are seldom used at night by ships' navigators because the horizon must be visible for a marine optical sextant, and a bubble sextant is usually unsatisfactory for shipboard use. Other stars besides the sun undoubtedly radiate in much the same manner as does the sun, but they are so far away that they have never been detected. Radio stars, the mysterious localized sources of extra-terrestrial radio waves, are extremely weak in the microwave region, and high resolving power is difficult to achieve with the longer wavelengths at which they radiate more strongly.

The moon is probably the most promising source for extending the operating period of the sextant, but its low temperature results in an extremely weak signal. Nevertheless, it is a relatively constant signal as the moon changes phase, presumably because the radiation comes not only from the lunar surface, but also from layers of material beneath its surface. Recent measurements made at *Collins* do indicate the feasibility of a moon-tracking radio sextant. END

Tuning the Short-Wave Bands

By HANK BENNETT

The Editors of POPULAR ELECTRONICS have replaced "The World at a Twirl" with two short-wave listening columns. The material below specifically deals with the stations operating in the 49, 41, 31, 25, 19, and 16 meter bands. A ham SWL column is on page 91.

MANY TIMES when Short-wave Listeners get together, the conversation eventually gets around to some particular DX'er who has amassed a healthy log of 150 countries heard. *"How* does he do it?" one asks. "He really must have a super receiver" is another comment often heard. And in every get-together, there is always one "Doubting Thomas," who is convinced that the DX'er being discussed is a complete faker. "Doubting Thomas" claims that the DX'er consults some little-heard and less-known station in various listings and just puts that station in his log, whether he actually has heard it or not. That type of thing, fortunately, is more of a pipe dream in the mind of our "D.T." than the real thing. Our purpose, then, is to discuss just *how* our DX'er friend is able to hear so many countries.

A person does not necessarily need a high-priced receiver to hear the far-away or weak stations. But by the same token, a cheap receiver will not be nearly as powerful or selective as some of its more valuable counterparts. The more expensive sets have more tubes, crystal filtering and phasing, and additional i.f. stages, which are extremely helpful in bringing in the hard-to-get stations and separating them from the nearly always present interference, or QRM as the DX'er knows it.

Let us assume, however, that you have a low- or medium-priced receiver. The next worthwhile piece of equipment to add to your shack would be a preselector, providing you can afford one. Coupled to your receiver, a preselector can really be an aid in getting the squabble separated from the signal and, in addition, usually raises the signal being received by as much as two or three signal strength units.

The antenna-ground system, though, is undoubtedly the most important feature of anyone's shack. A good, solid, tight ground will help immensely in lowering line noises and static from nearby electrical disturbances. A typical good ground is a cold water pipe, or a pipe driven into the ground, being long enough to be buried into damp earth, but the antenna is still, by far, the main thing. Nearly any kind of antenna will work on the modern communications receivers and since most of these receivers have an antenna compensator, the antenna can be "tuned" fairly effectively to the frequency being tuned. However, if you specialize on the 49-meter short-wave band, for instance, an antenna made to the proper length comparable to the 49-meter band will do a far better job than a plain long wire or a wire of some random length.

Condensing what we've said so far: a fairly decent receiver, perhaps a preselector, a good solid ground, and the proper antenna—these plus patience and a steady tuning hand—and you'll be amazed at the new countries you will be able to hear.

Another thing that will prove to be very useful is a handbook, such as the *World Radio Handbook*. This contains information to help the listener in identifying foreign-speaking stations by their slogan, or perhaps by their interval signals.

In addition to the countries having many short-wave outlets, some countries have only one or two transmitters, perhaps a lone amateur operator. Therefore, tune the ham bands, especially the 20-meter band. A good many new countries can be heard, thanks to the hams. One small country, in West Africa, Rio de Oro, has only one transmitter—an airport station which usually is heard only on code (c.w.). Learn the code, or get together with a few friends and have regular code-practice sessions. If you can copy c.w., you stand a good chance of logging a few more countries.

So, despite the "Doubting Thomas," it *is* possible to hear 150 countries, as well as a few more, and a deluxe set-up is not necessary to do it.

Now for the latest tips. All times shown are in U.S. Eastern Standard Time. This month's tips are taken from the latest issue of the Newark News Radio Club Bulletin.

Australia—VLC17, Shepparton, is noted on the West Coast with music and an English program afternoons at 1600-1630; music at 1735, news at 1745 and sign-off at 1758. Frequency is 17800. On 15320, VLC15 can be noted with English at 1200-1230. On 11810, VLA11 has a DX program from 2300-2315, although this channel is not always heard. VLA9, 9580, has United Nations news to Asia and the Armed Forces at 0810.

Belgium—ORU3, Brussels, is heard daily at 0500 with music and English news. ORU4 on 6085 has regular transmission to North America in evenings; is heard at 2015 in English.

Canada—CHU, Ottawa, Ontario, on 7335 and 3333 has time signals and now has added voice announcements every minute. This is the Dominion Observatory. CFRX, 6070, Toronto, noted almost all day carrying programs of its CBC outlet, CFRB. Signs off at 0207 with "God Save the Queen." CKNA, 5970, Sackville, N.B., has news and music to Australia and New Zealand around 0345. On 9540, VE9AI, Edmonton, is well heard evenings with their relatively low power.

China—The China Press Agency in Peking, is being heard at 1900 sign-on, all in Chinese, parallel to 13800, 12114, and 12203.

Ecuador—HCJB, Quito, 17890 is noted 1030-1035 with music and Spanish announcements. Thursday at 1600 has "Mailbag" in English. On 11915, HCJB is heard afternoons with strong signal. Evenings at 2345 they have an English religious discussion. HCJB on 9745 is heard 2315-2345 with music and talks in English. It is also noted in the 49-meter band at the same time, on 6050. A seldom-heard station is HC4BJ on 6270. Sometimes around 0015 with music.

Egypt—Cairo has a new transmission to Latin America at 1830-2030 on 9.475 mc., in Portuguese, Arabic, and Spanish. The Cairo transmission for South Asia at 0630-0930 (English at 0800) is now heard on 15.315 mc.

England—London and the BBC can be tuned in English at any of the following times: on 17750 at 1235 with "Radio Newsreel"; 17700, GVP, at 1000 with "Voice of America" programs; on 15360 at 1100-1145 with music and talks; in North American service over GSP, 15310, at 1145-1200; at 1500-1530 relaying VOA on GWU, 15210; organ music on GVY, 11955; at 1630-1700 over GRH, 9825; and in the General Overseas Service via GWS, 6035, at 2330; as well as many other channels and times.

Finland—OIX5, Pori, 17800 (parallel with OIX4, 15190) has English news to North America at 0600-0615 weekdays, but no English on Sunday.

French Equatorial Africa—Brazzaville, on 9625, is noted on this new channel. Heard in French around 1615. Sign-off at 2035 and often heard around 1815. At times is bothered with QRM from CKLO.

French Guiana—Radio Cayenne, now on 6.220, continues to operate 1730-1830 with programs in French.

Guatemala—TGNA, Guatemala City, 9668, is noted at 2230-2300 with a religious program; at 2330-2345 with religious music and organ melodies. They ask for reports at 2346 closing. TGWB on 6180 has a Spanish-speaking program at 0030-0105.

Israel—Tel Aviv, 9007 kc., now using 50 kw. transmitter, has a good signal on their 1615-1700 English program.

Mexico—XEWW, Mexico City, has been testing on 15162 at 1400-1700, replacing their normal 9500 channel.

Monaco—"Radio Monte Carlo," now on 7345, can be heard with fair strength from about 1500 until 1730 sign-off, with programs in French.

Pakistan—Best reception of Karachi in Eastern U.S.A. is on 15137 at 0745-0830 with English program for Indonesia.

Ryukyu Islands—Okinawa, 7160, is a "Voice of America" relay station and can be tuned at 0725 in language; at 0730 has English announcement.

Spain—Madrid on 9362 is being widely

(*Continued on page* 115)

Assuming charge of the new short-wave broadcast columns for POPULAR ELECTRONICS is the well-known ham and SWL, Hank Bennett, W2PNA. Interested in SWL-ing since 1938, Hank is also short-wave co-editor of the Newark News Radio Club. His ham license was obtained in 1946 after service overseas with the 7th Army. Hank uses a HQ-129X receiver with a surplus BC-348Q and Sky Champion as alternates. Good use is also made of an Ampro tape recorder. He works for the Franklin Institute, Philadelphia, Pa. Short-wave broadcast reports may be addressed to Hank Bennett, % POPULAR ELECTRONICS, 366 Madison Ave., New York 17, New York.

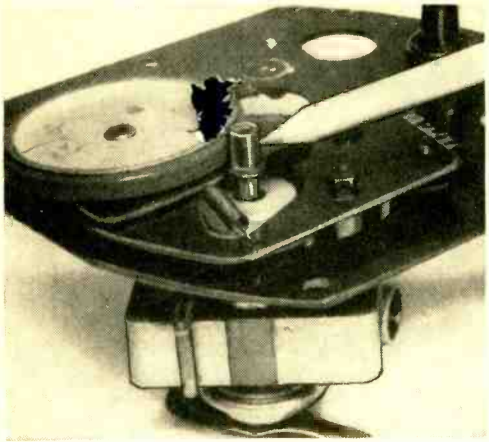


Fig. 1. Pencil points to drive shaft on 78 rpm phono motor before changes were made.

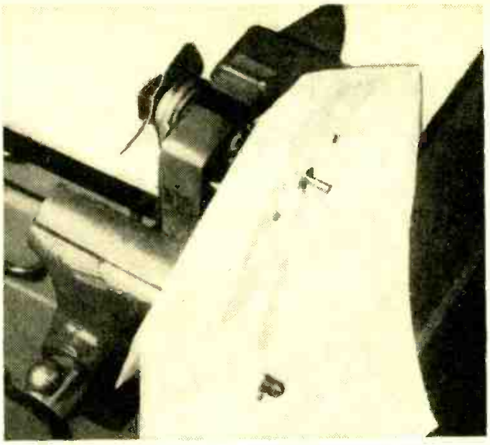


Fig. 2. In vise, sheet hung over mounting plate protects motor bearings from filings.

Converting Your 78 Phono to LP

THE gradual but inevitable swing away from 78 rpm records has put many serviceable 78 rpm phono motors on the shelf. A 78 rpm motor in good working condition can easily be converted into a 45 rpm motor or into a 33⅓ rpm motor, as described in this article.

Fig. 1 shows a standard, widely used (*Alliance*) 78 rpm phono motor. The pencil points to the motor drive-shaft (15/64" diameter in this case) which drives the turntable at 78 rpm. To reduce the turntable speed to 45 rpm or to 33⅓ rpm, it is necessary to reduce the diameter of this drive-shaft by the required amount. A machine-shop is not necessary to do this either; the only tools used by the writer were a small flat file, a vise, and a long-nose pliers (or tweezers).

If the rubber "tire," or drive, on your idler-wheel is rough, hard, or badly worn, replace it with a new one before you work on the motor shaft. If the rubber drive is replaced after you have reduced the motor's speed, the speed may be thrown off again. New rubber drives can be purchased at any radio supply house. It's a good idea to remove the idler-wheel and take it with you when you buy new rubber drives. To remove the idler-wheel, simply pull off the hairpin on the bottom of the shaft using long-nose pliers, or tweezers, then remove the small washer and pull out the wheel and its shaft.

Fig. 2 shows the motor mounted in a vise for the motor shaft filing job. The idler-wheel was removed because it was in the way, and a sheet of ordinary paper was draped over the top, so the fine metal filings would drop harmlessly to the floor. Don't clamp the motor in the vise too tightly or you may bend and damage its assembly of metal laminations. Note that the motor shaft protrudes through the paper.

Filing the Motor Shaft

Fig. 3 shows how the motor shaft is filed. Use a flat, fine-toothed file. With the motor running, file the shaft against the direction of its turn. Use long, light, file strokes, being sure that you put the file flat on the shaft each time. Don't bear down too hard on the file or the motor will slow to a stop. After you have reduced the diameter of the shaft considerably, put the idler-wheel and turntable back and time the rpm's of the turntable, using the second-hand of a watch or clock. This will indicate how much of the shaft has been removed and how much filing will have to be done yet. If 45 rpm is your goal, test the turntable speed occasionally as you approach 45 rpm so you won't take too much off the shaft.

Fig. 4 shows the motor shaft filed down to 45 rpm (or about .138" dia. in this case).

Fig. 5 shows the plastic centering discs or "spindle adapters" for 45 rpm records. These sell for a few cents each at record shops. Only one is needed.

Fig. 6 shows the same motor shaft filed

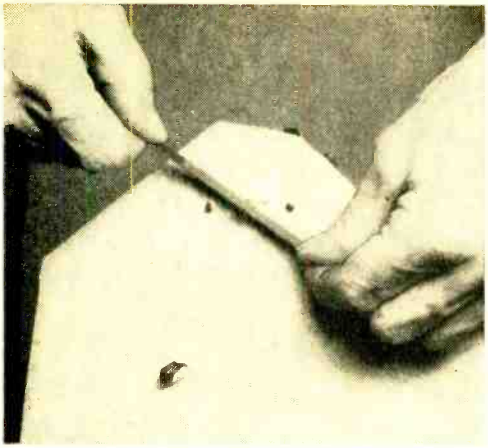


Fig. 3. File against the turn of the revolving shaft, using long, light strokes.

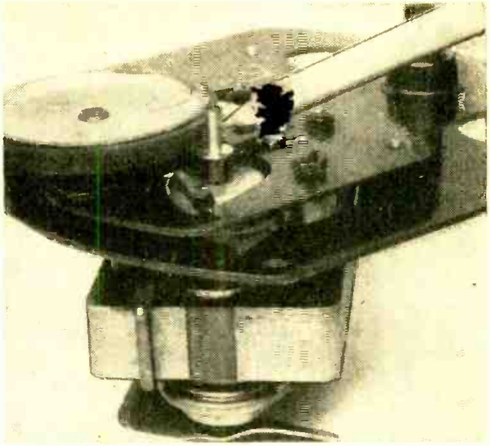


Fig. 4. Same motor shaft after filing has reduced its diameter to provide 45 rpm.

By ARTHUR TRAUFFER

down to 33⅓ rpm (or about .100" dia. in this case).

When filing the motor shaft, do not rely on the shaft diameters given in this article, as there are variations in different makes and models of phono motors. Some have larger or smaller diameter turntables, etc. Shaft diameters are mentioned simply to give a rough idea of how far to file.

Try for a uniform cross-section of the motor shaft when doing the filing. In the final stages of the filing, smooth off the file marks with emery cloth while the shaft is revolving.

It is best to test for turntable speed with the motor out of the metal vise. The writer has noticed that the motor runs a few rpm's slower when it is clamped in a metal vise. It seems that the metal of the vise has an effect on the field currents in the metal laminations of the motor. Turntable speed may be checked by either of two simple methods. One is to paint a white dot near the outer rim of the turntable and count the number of times per minute that it passes the same point. Another way is to use a stroboscope disc. This item is available for a few cents at parts jobbers and indicates all turntable speeds.

After the motor shaft has been reduced in diameter, it may be necessary to shorten the idler-wheel spring a little to give the idler-wheel a good grip on the motor shaft and turntable rim. This was the only adjustment found necessary. END

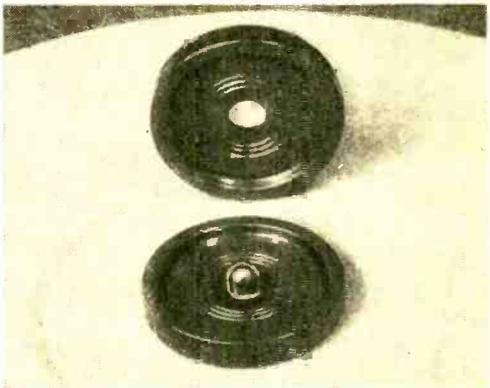
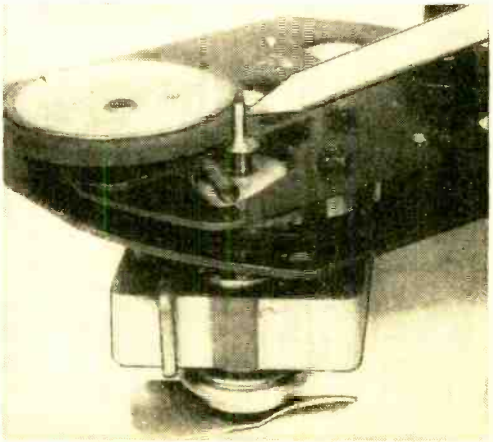


Fig. 5. Plastic centering disc, or "spindle adapter," is needed to play 45 rpm records.

Fig. 6. Further filing can reduce same motor shaft to correct diameter for 33⅓ rpm.



Magnetic Mouse Has Super Memory

Dr. Claude E. Shannon, Bell Telephone Laboratories mathematician, places his mouse in maze through which it finds its way.

This novel device was designed to provide fundamental knowledge which will help improve telephone service.

AN ELECTRICAL MOUSE with a man-made "super-memory" has been at work, repeatedly threading its way through a series of complicated mazes at *Bell Telephone Laboratories*. The handiwork of Dr. Claude E. Shannon, a *Bell Labs* mathematician, the mouse uses for its "brain" switching relays similar to those found in dial telephone systems. The reason it exists, in fact, is to provide fundamental knowledge which will help improve telephone service.

The mouse, in reality a two-inch bar magnet with three wheels and copper whiskers, quickly solves more than a million different mazes, learning each new one rapidly, then instantly forgetting it in order to be ready to learn the next one. Its goal, which Dr. Shannon refers to as "a piece of cheese," is really an electrical terminal with a bell which rings when the mouse nudges it with its copper whiskers.

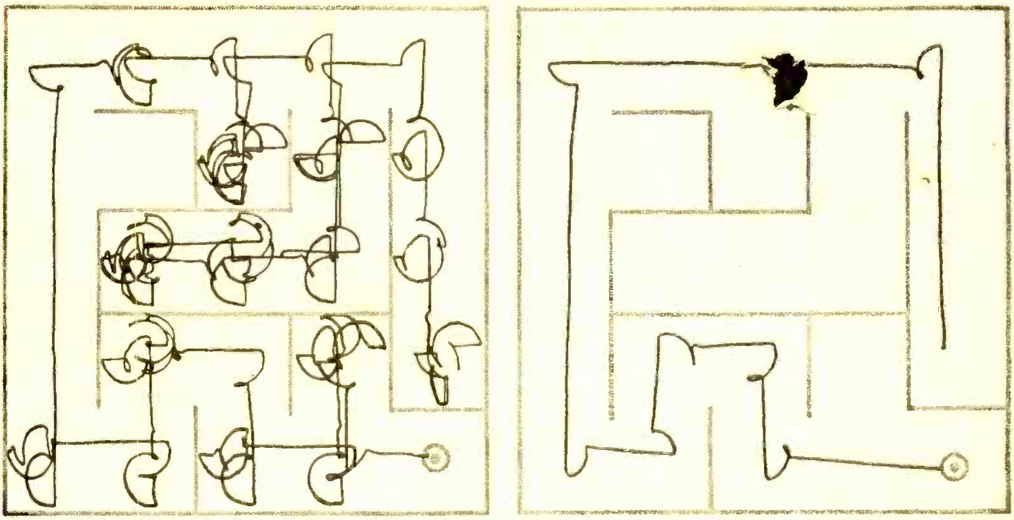
Dr. Shannon has built his maze about half the size of a desk top. It has aluminum fences which can be rearranged at will in 40 different slots to create the hardest possible problems for the mouse. Dr. Shannon places the mouse at some arbitrary point in the maze and the cheese at a different arbitrary point. After a brief pause to get its bearings, the mouse goes scuttling up and down corridors, bumping into walls, backing up and turning and exploring until—a minute or two later—it finds the cheese and rings the bell.

Then comes its most interesting performance. Having learned the correct path to the cheese, the mouse can now be set down at any point that it visited during its explorations and, without making a single false move, it will proceed directly to the goal in 12 to 15 seconds. If it is placed in a part of the maze not previously visited, it will explore about until it reaches a known part and then move directly to the cheese.

After this, if the maze is altered, the mouse will have to learn the new paths by further exploration, but it will readily remember those parts of the path which remain unchanged.

Uses Ninety Relays

This is the way the mouse works: When it is set down on the metal floor of the maze, it trips an electric switch which signals its position to a mechanism under the floor. A motor-driven electromagnet



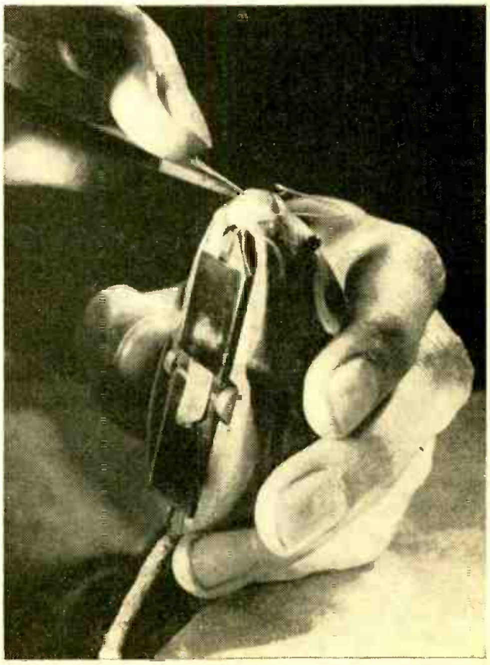
Time exposures made with small light attached to mouse's back reveal patterns made during its trips through the maze. Left, exploratory trip took two minutes, was full of mistakes. Right, mouse has learned the most direct route and reaches its goal in less than 15 seconds.

moves swiftly to the spot directly beneath the mouse and from then on holds it in a magnetic grasp. The magnet turns through a 90-degree angle, carrying the mouse with it, then guiding it forward. If the mouse hits a barrier and detects, by means of its copper whiskers, that it's in a dead end, the magnet will back away, shift the mouse to another direction, and start it forward to try again to find an open path. It keeps trying until it finds the way to the goal. Then it "remembers" the successful path and can solve the maze directly without error.

To regulate the sequence of movement, Dr. Shannon has built what is called a "programming" circuit, consisting of 40 electrical relays. Another part of the mouse's "brain," which serves as its memory, contains 50 relays. Two small motors complete the equipment.

By working with such problem-solving equipment, Dr. Shannon, who several years ago announced a plan whereby a computer could be made to play chess, hopes to learn more about what man can do with machines. Many of the techniques by which machines are able to "remember" are applied in the *Bell System* in dial switching, automatic accounting, and other equipment.

"The real significance of this mouse and maze," Dr. Shannon says, "lies in the four rather unusual operations it is able to perform. It has the ability to solve a problem by trial and error means, remember a solution and apply it when necessary at a later date, add new information to the solution already remembered, and forget one solution and learn a new one when the problem is changed." END



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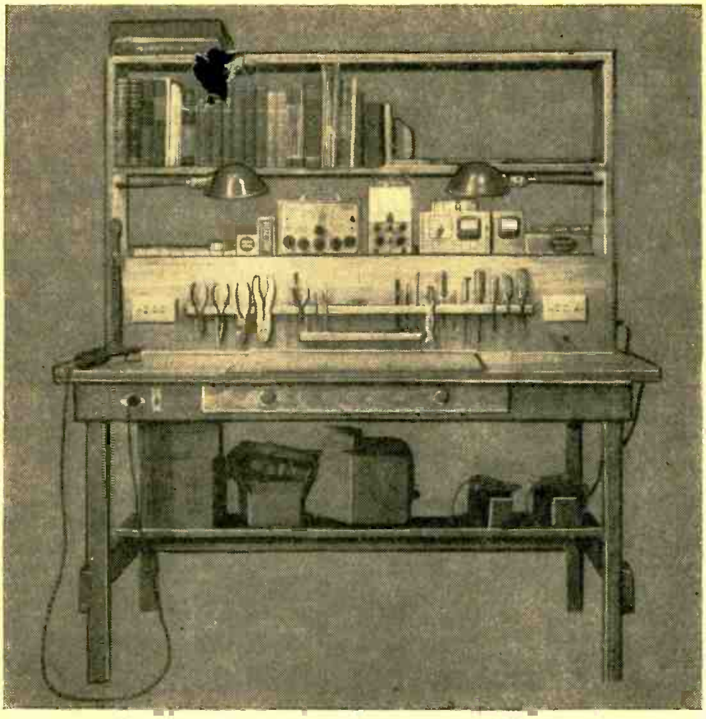


Every technician has at one time or another wanted his own workbench. The example described in this article may be readily duplicated with basic wood-working tools.

Philip Bridges

Experimenter's Workbench

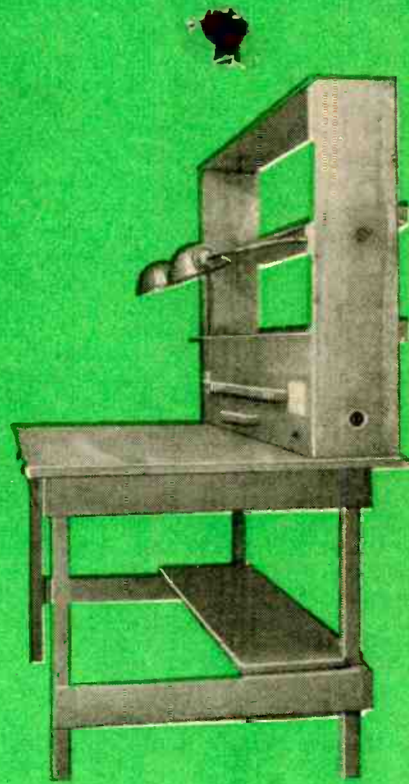
THE practical, handy workbench described in this article was built without power tools, at a cost of less than twenty-five dollars, including all the wiring, lamps, and finish, using stock sizes of lumber. It has proved to be extremely useful for the part-time service technician and home experimenter.

The legs are 2 x 2's, cut to 28 inches for sitting height. This dimension can be changed, as can all the dimensions, to suit the individual, and for stool or standing height. The pieces of the bench are sanded smooth after cutting and fitting, but before final assembly, for greater handling ease. Assembly throughout is by screws, 1¼ inch steel flathead, number 8, with countersunk holes prepared in advance for them. Wherever possible, sawing, including dadoes and rabbets, is done with a saw and miter box to keep the work square.

The two bracing frames for the table unit are made from 1 x 4 stock, fir or cypress. The four short 26½-inch pieces are screwed to the legs, one at the top of each pair, one with the top edge 10 inches above the floor. The long 50-inch pieces complete the top frame, placed with their ends overlapping the short pieces. A third 50-inch piece forms the back of the bottom frame. A 1 x 12 piece of white pine shelving, two corners notched to fit around the back legs, is added for storage space and additional bracing. A 1 x 4 center cross bar screwed into the top frame between the long pieces and parallel to the ends will add necessary rigidity.

This completes the base, unless a drawer is desired. For the latter, the front frame piece is notched 2½ inches deep and 26 inches wide. A 1 x 2 brace set horizontally is screwed behind the full length of the front piece just below the opening, its ends being screwed to two small blocks of the same material nailed to the tops of the legs behind the front piece. The cross bars instead of one are used, with their ends notched to fit over the horizontal brace, one at each side of the drawer opening, so that the drawer slides between them. Two narrow strips of scrap wood screwed onto these near the bottom edges serve as drawer runners.

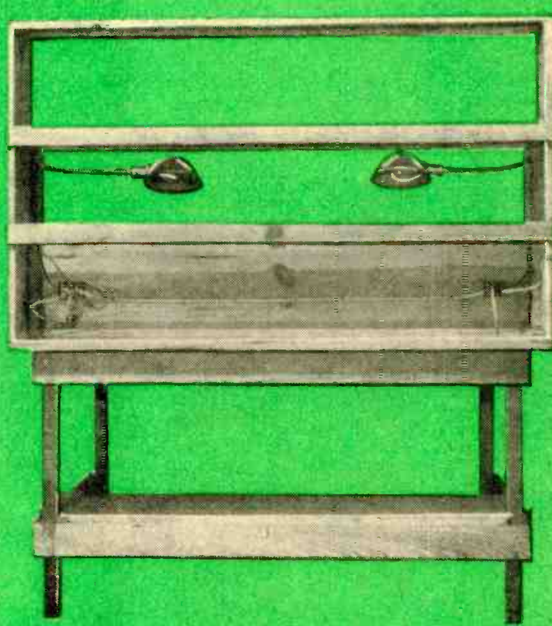
The drawer is made from 1 x 3 clear white pine, with a ⅛ inch-hardboard bottom. The front piece is made long enough to overlap the opening, and is rabbeted on the bottom and ends to fit into the hole, leaving ¼ inch thick lips to butt against the front. The end rabbets are made wide



Construction of the workbench is a simple operation of coordinating the text, bill of materials (below), and these three photographs. Wiring of the outlets and lighting fixtures is also detailed in the text.

Bill of Materials

1 pc.	*1 x 12 x 6 ft. shelving*
1 pc.	*2 x 2 x 10 ft. fir*
3 pcs.	*1 x 4 x 10 ft. fir*
1 pc.	*1 x 3 x 10 ft. white pine*
1 pc.	*1 x 2 x 6 ft. pine*
1 pc.	*1/8 x 2 ft. x 4 ft. hardboard*
1 pc.	*3/4 x 32 x 8 ft. plypanel*
1 pc.	*1 x 10 x 6 ft. shelving*
2 pcs	*1 x 8 x 10 ft. shelving*
1 pc.	*1 x 2 x 10 ft. pine*
1 pc.	*1 x 1 1/4 x 8 ft. pine*
2	*Student lamps*
1	*"Tap-a-Line"*
1	*Cord receptacle*
1	*Fuse mounting*
1	*Box of fuses*
1	*Below-surface plug*
1	*A.c. receptacle*
1	*Three-position switch*
1	*Switch-outlet combination*
1	*Flush triple outlet*
25 ft.	*16 gauge ivory lamp cord*
Misc.	*Wood scraps, screws, nails, glue, etc.*



enough to take the thickness of the sides too. The side pieces, two feet long, are sawed and planed to a width slightly less than that of the [illegible] opening, just under 2½ inches.

Dadoes are cut near the back ends to take ⅜ inch-rabbets cut on the ends of the back piece. The front and sides are grooved to take the hardboard, with the top of the groove being two inches below the top edges of the front and sides. A method of making the groove is to clamp a board to the drawer pieces as a guide for the saw, making two parallel cuts and knocking out the strip between. The back piece of the drawer is made two inches wide and rabbeted to fit the sides. The drawer is assembled with glue and nails, and the bottom held in place with small screws or nails driven into the back piece.

A finishing touch is a pencil trough made from another piece of 1 x 3. Several saw cuts are made the length of the piece, to graduated depths, then the wood is chiseled out between the cuts and smoothed with sandpaper. Screws, run into the trough through the drawer bottom, hold it in place. Two pull-knobs complete the drawer. (Recess the heads of the knob screws to clear the trough.)

The top of the workbench is made from a selected piece of *Plypanel*, which comes ¾ inches thick, 32 inches wide, and 8 feet long, with one good side. Several panels should be looked at to find a really good one, free from knots where they might show. A piece 56 inches long is cut for the top, and sanded smooth. This is screwed to the leg assembly from underneath. Recesses are made for the screw heads by boring halfway into the frame boards with a large auger bit, and boring down at a slant into the recess with a screw-sized drill. The recesses are placed so that the screws can project into the top no more than a half inch. The front overhang, 1½ inches, is made less than the back overhang, so that the drawer is more accessible.

Putting Up the Shelves

On top of the bench a shelf unit 54 inches long is mounted by screwing it to cleats screwed to the bench top. The shelf unit is made from 1 x 8 shelving, with two shelves and a top dadoed into the side pieces. Each shelf is backed by a 1 x 2 strip to keep objects from being shoved through too far. The tool panel is a 1 x 10 board, and the first shelf is placed just above it. The test instrument shelf is 9 inches high, and the bookshelf is 11 inches high, to take large books and catalogues. A bookend is made from leftover scraps. These shelf heights put the instrument dials at eye level for easy reading.

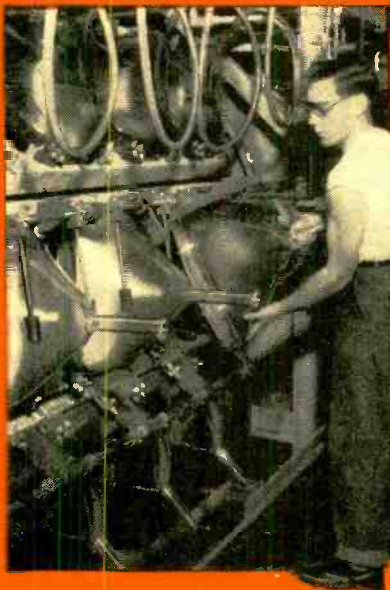
The tool panel is set flush with the front of the shelves and is nailed to scrap wood cleats. The tool racks are made from 1 x 1¼ pine strips (these may have to be ripped to size) mounted by screws from the back. Suitably sized holes and notches are cut to take the tools desired. A short lower rack supports the ends of alignment tools which would otherwise fall through too far, and holds small tools such as knives and wire strippers. The file has a rack to itself on the far left.

Lighting Fixtures

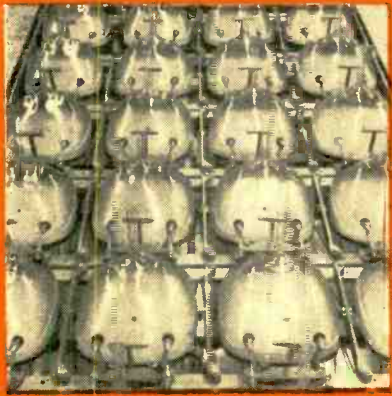
Two gooseneck lamps are mounted on 1 x 1¼ strips screwed and nailed between the lower shelves. The bases of the lamps are removed (be sure to get the kind which are held on by nuts) and the goosenecks fastened to the strips by the nuts. To make the wood thin enough to take the shafts, a large hole is bored part way through from the back, leaving about 5/16 of an inch for mounting. The same trick is used to mount the fuse holder in the front panel.

A "Tap-a-Line" receptacle which will take up to eight plugs is screwed to the bottom of the test instrument shelf at the back. The cord that comes with this is removed and a female line receptacle put on the end of it for the supply cord. Number 16 lamp cord is soldered to the channels in place of the original cord, and is used to connect the "Tap-a-Line," the front panel receptacles, and the fuse to the recessed male plug mounted in one side of the shelf unit. The panel receptacles are complete units, with switches and outlets attached to the front plates, so no boxes are necessary. Rectangular holes are cut in the panel to fit them. A switch and a single female a.c. receptacle are mounted in the front piece of the base next to the drawer for the soldering iron. (On the left since the author is left handed; these would ordinarily go on the right.)

The wires from the soldering iron receptacle and the lights are brought through holes in the table top and shelves to the panel receptacles for connection to their screw terminals, and all connections are made with solderless crimped terminals for neatness and ease of connection. The switch is wired to control the whole system, and a five ampere-fuse is used in the fuse holder. The soldering iron switch is a three-position, center-off switch so that an idling resistor can be added to the circuit if desired. All the wires are stapled to the wood. The components are readily obtainable, most of them from any radio supply house. The lamps come from *Sears'* retail store, and the #16 wire and the front panel receptacles come from *Ward's*. END



The first step in actual processing of a picture tube is screening, in which the phosphor picture screen is applied to the inside of the bulb's face. Note screens inside tubes at left. Hoses (top) pour one mixture into bulb, other comes later.



On the screening conveyor, picture tubes move slowly along as the phosphor-silicate mixture settles inside of their face areas. At far end of belt, tubes will be tipped, and water will be run off.

Careful inspections follow the picture tubes all the way during processing. Here an operator inspects phosphor screens on tubes after they have been removed from the screening conveyor belt (above).

Picture Tubes

The "heart" of your television set is the incredibly complex C-R tube. Here is how it is made.

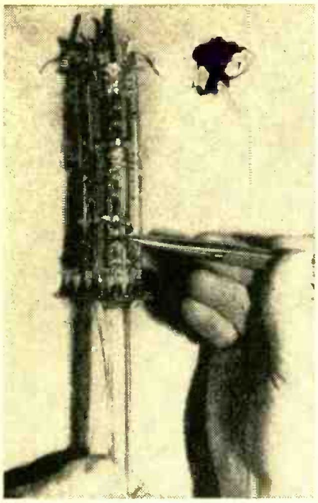
DO YOU take your television receiver so much for granted that you never wonder about the complex circuitry and the vast amount of engineering "know-how" that is represented in your living room?

One of the most fascinating components in your television receiver is the picture tube itself. While this is almost the only "internal" component that everyone gets to see, very few televiewers know how it is constructed or what is involved in the manufacture of such a tube.

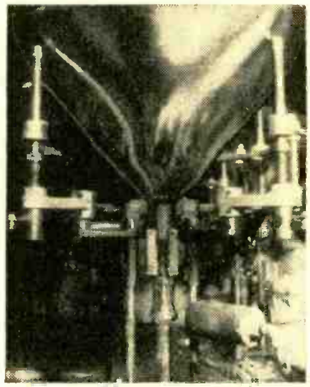
The photographs on this and the two succeeding pages show how such tubes are "built" at the *General Electric Company* plant in Buffalo. This factory now turns out thousands of picture tubes each day—including the 21-inch size.

The mass production of picture tubes is no simple proposition, but the operation isn't as much a difficult effort as it is a delicate one. Every step of the operation must be carefully controlled.

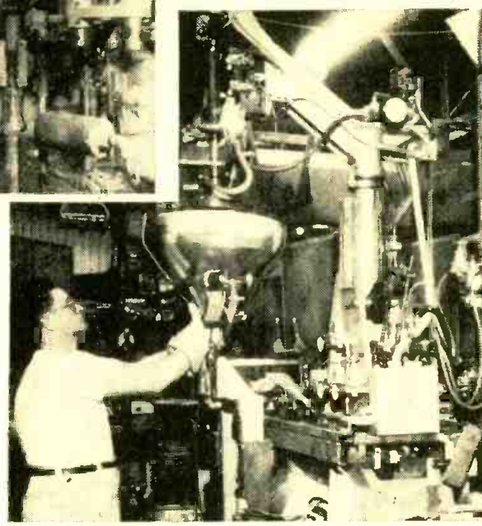
Every part that goes into a tube must be checked and inspected all the way through



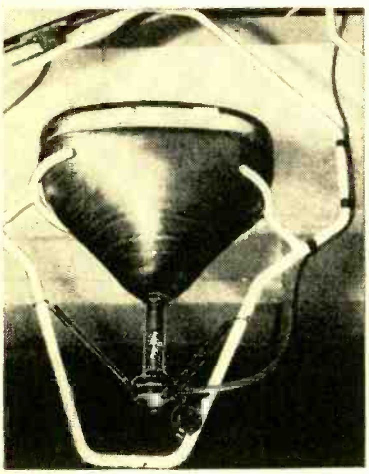
Electron gun, which later will be sealed into neck of a picture tube, receives final inspection after assembly. At bottom are leads and glass tubulation of stem assembly. Above, in order, are grid No. 1, grid No. 2, and metal sections of anode structure. At top is focus electrode, the "getter," etc.



After all of its processing, the picture tube bulb is now ready for installation of its electron gun. Step is performed on this rotary gun-sealing machine by welding process.

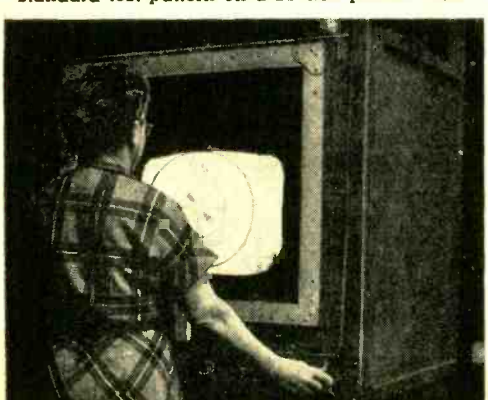


Almost completed, the picture tube is swung from automatic "tip off" machine after being pumped out to a vacuum and sealed at end of its neck. Later the base is added and the tube completed.

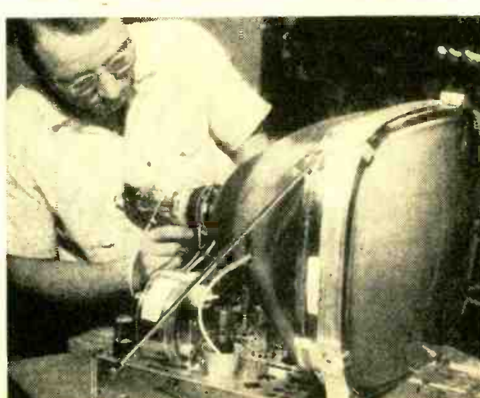


Processing "en route" takes place as completed tube is "aged" on a conveyor taking it to final test section. "Aging" is process whereby electrical characteristics are stabilized in tube.

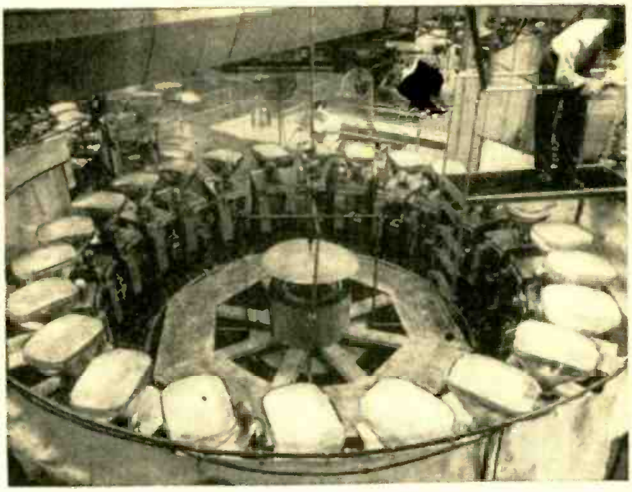
Final inspection of the picture tube consists of checking it for electrical stability, short circuits, brightness, and gas. Operator adjusts standard test pattern on a 21-inch picture tube.



In place in a home receiver chassis, the picture tube is checked before the completed unit is installed in a cabinet. Unit around neck of tube deflects electron beam to sweep the screen.



"Merry-go-round" rotary aluminizer automatically coats interior of tube bulbs with film of aluminum four one-millionths of inch thick. In finished tube, this metallic layer on the back of the phosphor screen will reflect increased illumination for brighter pictures and better contrast. Machine handles 24 tubes.



production. The finished tube must meet exacting standards before it is shipped to a set manufacturer or released for replacement applications.

Basically, a picture tube is a conical glass bulb with a phosphor screen on the inside of the bulb face. Mounted in the neck of the bulb is an electron "gun" whose electron beam is directed at the screen to activate it and reproduce the transmitted image.

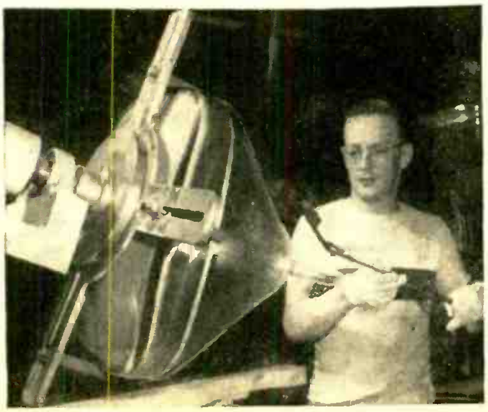
The metal electron gun parts, including units about the size of a thimble, magnets not much larger than a pencil eraser, and tungsten wire finer than a human hair, are weighed, measured with fine-precision gauges, or inspected on a shadowgraph which projects their silhouettes, magnified 20 times, on a translucent screen.

These various components eventually emerge as a television picture tube after going through the processes which are pictured in the photographs accompanying this article.

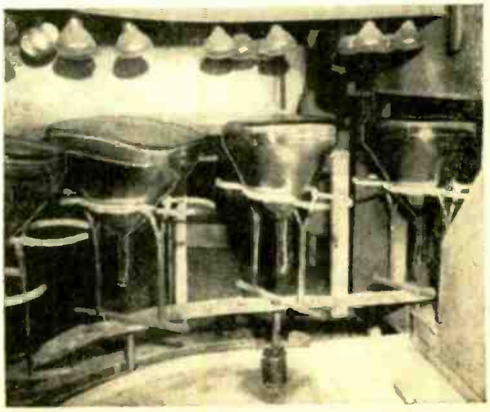
During 1955, *General Electric* statisticians estimate that over 11,750,000 picture tubes will be manufactured, 5,600,000 of which will be earmarked for replacements in existing television receivers. The percentage of color TV picture tubes will still be relatively small, with the prediction, as of now, at about a quarter of a million tubes for the multi-hued television sets.

The next time you step up to your TV set to turn on your favorite program, take a long, hard look at the "cyclops" staring out at you. It is an eye-opener if you will only take the time to examine this electronic eye to your world of entertainment, education, and sheer fun. It can truly be classed as an "electronic miracle" of the first order. END

A "double-jointed" paintbrush, which bends after insertion through the bulb's slender neck, coats entire cone of non-aluminized bulb with an electrically-conductive paint as the bulb is rotated.



Into the bakeout oven's 350 degree C. heat go the picture tube bulbs after screening and aluminizing or inside painting. Here heat removes the moisture and gas from these prepared tube bulbs.



EXPERIMENTS with THYRATRONS

By
HARVEY POLLACK

Five experiments to show principles of circuits using these "relay" tubes. Subsequent articles will describe a thyratron photo relay and a stroboscope.

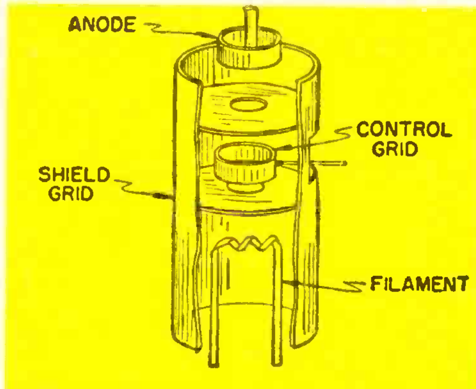


Fig. 1. Internal construction of thyratron.

BECAUSE they differ from ordinary triode and pentode vacuum tubes in certain important respects, thyratrons offer the electronics hobbyist the opportunity to perform a whole new group of exciting and informative experiments. The advent of tubes like the 2051, 2050, and 2D21 has brought thyratrons within range of even the most meager budget and, as the required operating voltages are low, very inexpensive power sources may be used.

The official nomenclature applied by tube manufacturers to the thyratron group is "grid-controlled, gas-filled rectifiers." A thyratron looks like an ordinary vacuum tube, but this resemblance is entirely superficial. The presence of an inert gas such as argon in the standard small types and the arrangement of its electrodes (see Fig. 1) result in important differences in performance:

(1) When the control grid of a thyratron is very negative with respect to its cathode, no plate current flows at all. As the grid voltage is advanced in a positive direction, no change occurs in this quiescent condition until a certain, critical voltage is reached, then up soars the plate current to the maximum value permitted by the resistance in series with the plate circuit. When this abrupt change from zero to maximum plate current occurs, the thyratron is said to have "fired". This characteristic of a thyratron makes it very useful as a "relay" tube in circuits where it may be used to establish either an "on" or an "off" condition with no intermediate points.

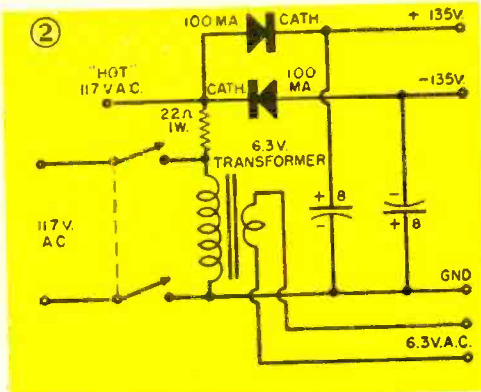
(2) After the thyratron has fired, the grid which was able to initiate the discharge in the first place no longer can exercise the slightest control on the plate current, even if it is restored to its original negative voltage or beyond. The only maneuver that will cause deionization and consequently a cessation of plate current is momentary or permanent removal of anode voltage. If, while the thyratron is conducting, the grid potential is made as negative as it was before conduction began, even a very brief removal of anode voltage will stop the flow of plate current. Removal need not last longer than about 10 microseconds to make this happen.

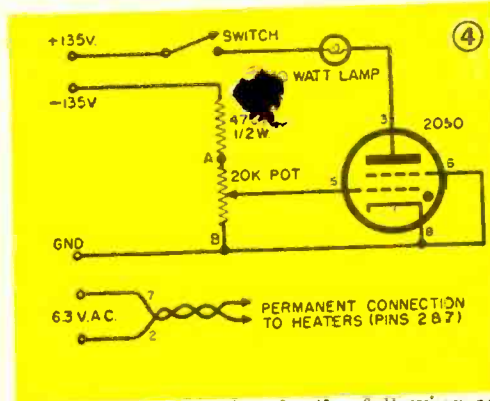
These two differences account, in the main, for the adaptability of thyratrons to radio control, relay operations, photo-electric controls, timing circuits, etc. The experiments to be described in this article make use of these unique features and provide a solid background for other, more advanced applications.

Equipment Required

To perform these thyratron experiments, it is necessary to have a power supply, a thyratron tube, a few additional parts, and some means for changing the connections of the parts conveniently, so that they can be used in different circuits. The power supply should be capable of supplying 6.3 volts a.c. or d.c. at 0.6 amperes and two d.c. outputs, one positive and the other negative, of 100 to 150 volts each. Figure 2 shows the schematic diagram of a suitable power supply.

Some of the parts which are used in more than one of the experiments can be





mounted permanently on a chassis, to which the other parts required for each circuit can be added. A suitable chassis is shown in Figure 3. It has two octal tube sockets, with pins 2 and 7 (which usually are the heater pins) permanently connected to the clips marked "6.3 v."; an Edison screw-type lamp socket; a 20,000-ohm potentiometer; a single-pole, single-throw toggle switch; and a number of Fahnestock clips for making temporary connections. This board was designed by the author as one which can be used to set up almost any type of simple electronic circuit; only one of the tube sockets is required for the thyratron experiments described in this article.

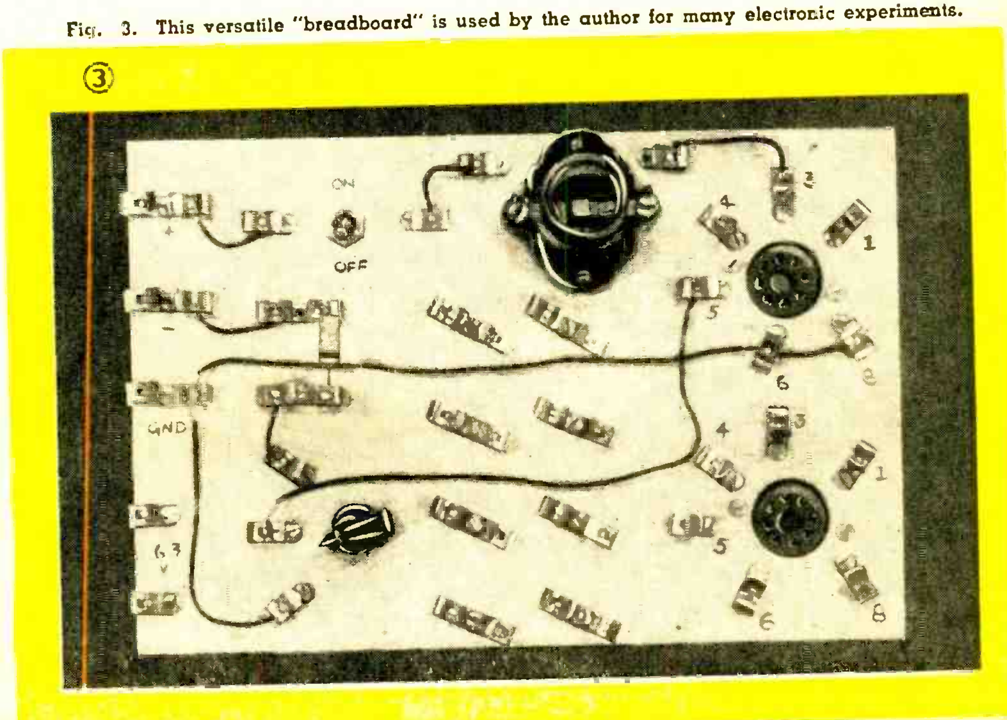
In addition to the parts permanently mounted on the chassis, the following are required for these experiments:

1—2050 tube
1—117 v. lamp, 10 w. or smaller
2—82 ohm, ½ w. res.
1—15,000 ohm, ½ w. res.
1—27,000 ohm, ½ w. res.
2—47,000 ohm, ½ w. res.
1—470,000 ohm, ½ w. res.
1—4.7 megohm, ½ w. res.
1—0.1 μfd., 400 v. capacitor
1—1.0 μfd., 400 v. capacitor

Experiment 1: Trigger Action of a Thyratron

Connect the circuit of Figure 4 on the test board, insert a 10-watt lamp (no larger!) into the cleat socket on the board, and a 2050 thyratron in the octal socket

Fig. 3. This versatile "breadboard" is used by the author for many electronic experiments.



wired into the circuit. Run the wiper of the potentiometer down all the way to the end marked A, then apply power. Allow the thyratron to heat up for about one minute. The [illegible]-watt lamp will not light.

Now slowly rotate the knob of the control potentiometer toward end B. As this is done, it slowly reduces the negative bias on the grid of the thyratron and, when the critical voltage is reached, the thyratron will fire, as evidenced by the blue glow in the tube, and the load lamp will flash on. Even if the potentiometer is now backed off toward A again, the load lamp will remain lit, showing that the grid has lost control. If the switch is turned off for a brief moment while the potentiometer is near point A, turning it on again will restore control to the grid, and the lamp will not now come on. Thus, removal of anode voltage from the thyratron enables the control grid to regain its influence over the electron stream inside the thyratron.

To establish the value of the critical potential necessary to fire the thyratron when its anode voltage is 135 volts, measure the potential between the grid (pin #5) and the cathode (pin #8) of the thyratron at the setting of the potentiometer which *just* flashes the load lamp on. This is a useful figure to know for future applications of the 2050. A vacuum-tube voltmeter is to be preferred over a multitester for this kind of measurement.

Experiment 2: Cutting Off a Thyratron by Closing a Switch

One of the things emphasized in Experiment 1 was the need for removing the anode voltage of a thyratron to stop it from firing once ionization has occurred. This means opening the plate circuit, a process which is often inadvisable or even impossible if the current flow is very heavy; breaking a heavily loaded circuit causes switch arcing which soon pits the contacts and destroys the switch. This experiment shows how a thyratron may be cut off by means of a tiny switch, regardless of the size of the tube's load current.

Wire the circuit of Figure 5 on the test board. Note that point A may be connected at will to the ground lead by means of a short piece of insulated wire by tapping the end on the Fahnestock clip to which the 1 μfd. capacitor is connected. When wiring is complete, apply power with the switch open and set the potentiometer at point B. This places a large negative bias on the grid and prevents the thyratron from firing.

Now close the switch and then immediately open it. The 2050 will fire and light the load lamp even after the switch has been returned to the open position. With the tapping wire connected to the ground lead, touch it to the clip connected to A. The thyratron will extinguish and remain quiescent. This performance should be repeated several times while the experimenter observes that the tube may be extinguished readily, without arcing at the tapping wire, as often as he wishes.

Here's the way this circuit operates: When the switch is closed, the grid is jumped to ground, removing bias and enabling the thyratron to fire. When it is opened, the thyratron continues to conduct even though negative bias is restored, because the grid has lost control of the electron stream. During conduction, the total voltage drop across the load lamp and the 27K resistor charges the 1 μfd. capacitor to about 120 volts, the negative side of the capacitor appearing at the left—the side which joins the plate lead. With the tapping wire "open," the capacitor simply retains this charge without producing any circuit changes. The moment the tapping "switch" is closed, however, the plus end of the capacitor is connected to the cathode of the tube. Thus, the capacitor applies about 120 volts to the plate-cathode circuit in a direction opposite to that of the power supply; this effectively cancels the plate voltage momentarily, de-ionizes the thyratron, and stops conduction. As negative bias was restored when the switch was re-opened in the early steps, the tube remains non-conducting until the process is repeated.

Experiment 3: "Quantity" Grid Control

Let's see how a thyratron behaves with a.c. rather than d.c. on its anode. We saw that this tube continues to conduct once the discharge has been initiated, regardless of what we do to the grid, and that cessation of conduction can be obtained by removing anode voltage when d.c. is used. Try the circuit of Figure 6. Experiment with different settings of the control potentiometer and see what happens to the thyratron current as indicated by the brightness of the load lamp. Note that the range of control is far from satisfactory and would certainly not be useful, for example, in a theater-light dimming system. Now try the really elegant method of controlling the load current of a thyratron by the phase-shift method.

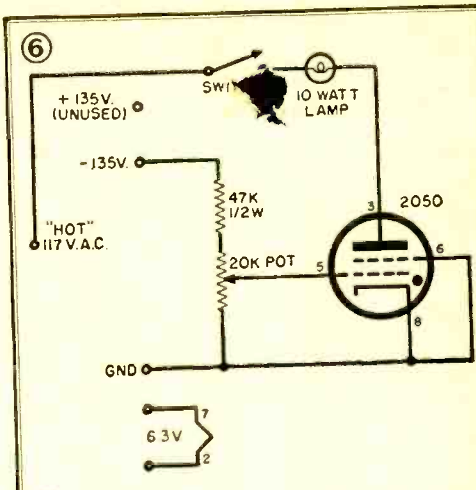
Experiment 4: Phase-Shift Grid Control

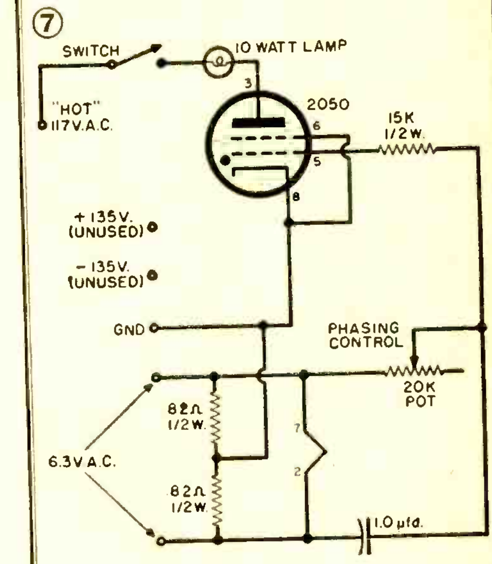
Both the anode and the control grid of the thyratron have a.c. applied in this hook-up (Fig. 7). The resistor (20K potentiometer) and the 1.0 μfd. capacitor are arranged to permit changing the phase of the a.c. grid voltage with respect to the plate. When the two voltages are in *phase*, the thyratron fires for the entire anode positive half-cycle and provides the largest load current it possibly can. As the phase of the grid voltage is advanced or retarded, the tube conducts for a smaller and smaller amount of *time* during each positive half cycle. As the total brilliance of the load lamp depends upon both the magnitude of the current and the time during which it flows, the lamp becomes dimmer as the difference in phase increases, finally extinguishing altogether. This grid control scheme offers the smoothest kind of action; with it, enormous amounts of anode current—as one finds in the large industrial thyratrons—may be controlled by tiny potentiometers in the phase-shifting network.

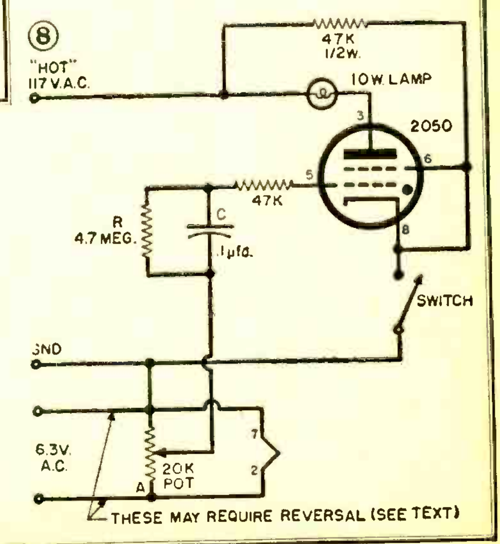
Experiment 5: Time Delay Thyratron Circuit

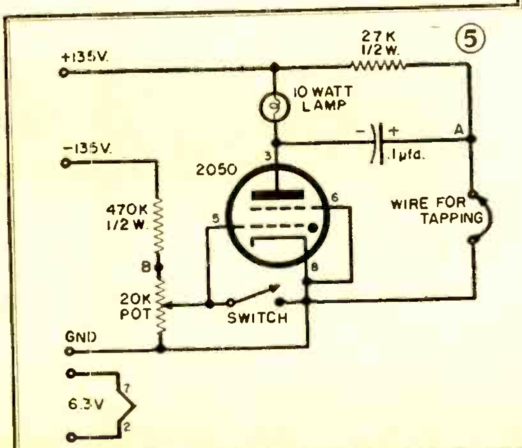
This is a remarkable little circuit, simple yet offering a wide range of time delays from a tiny fraction of a second up to about two minutes with so few parts that practically nothing can go wrong with it. (See Figure 8.) When the circuit has been wired, run the wiper of the potentiometer to the ground end, leave the switch open, and apply power. The load lamp should not light. Now close the switch; the load lamp should light within a fraction of a second.

With the lamp glowing, slowly rotate the potentiometer away from the ground side toward point A. As this is done, a point should be found where the lamp goes out. If this does not occur, remove power and reverse the two heater connections going to the 6.3 a.c. terminals on the power supply to correct the phasing. When this has been done, small changes in the setting of the potentiometer will produce large changes in the time delay between throwing of the switch and the activation of the









load lamp. This circuit may be converted into a real utility timer for photographic or other industrial uses by doing three things: (1) change the 20K pot to a 5K pot; (2) use a potentiometer of 5 megohms for the 4.7 megohm resistor; and (3) substitute a 2500 or 5000 ohm plate circuit relay for the load lamp, using the relay to control the enlarger lamp or other device. In this modified form, the 5 megohm potentiometer is set at maximum resistance and the 5K potentiometer is adjusted to give the maximum time delay intended to be used (30 seconds, 1 minute, etc.). Then, adjustment of the 5 megohm potentiometer provides smooth variations of delay from zero to the previously determined maximum. The charging capacitor, *C*, may also be changed to increase or decrease the delay.

When the switch is open, grid rectification occurs, causing a current flow through the 4.7 megohm resistor and consequent charging of the capacitor with the grid side becoming negative. Upon closing the switch, the thyratron cannot fire because the grid is below the critical potential.

The grid-cathode potential at any instant is composed of an alternating voltage (from the heater winding), the magnitude of which is a function of the position of the slider on the pot, and the voltage across the capacitor. The heater winding of the transformer is so connected that when the "hot a.c." line is positive with respect to ground, point A is negative. Consequently, motion of the wiper toward A increases the negative component of alternating grid voltage when "hot a.c." is positive. Since the tube will fire only when "hot a.c." is positive, the adjustment of the slider on the potentiometer permits a considerable reduction in the component of grid voltage that has to be supplied by *C* in order to prevent ionization of the tube. This permits long time delays without the need for large value capacitors and high values of discharge resistance. END

Shipboard Radio "Broadcasts" Programs to Crew

RECENTLY completed, a shipboard radio studio will "broadcast" popular music, news and sports to the men of the U.S.S. *Kula Gulf* (CVE-108) by way of the ship's internal speaker system. The new "station" is planned as a morale booster during long periods at sea when the use of personal radios is forbidden. The shipboard studio features dual multi-speed turntables and a complete control console to provide continuous professional mixing and fading. The system was built entirely by the ship's interior communications technicians. It will do "anything a professional studio can, and then some" according to station advisor, Ensign Richard Earle.

Shown in the photo is J. L. Christie, Jr., AN, USN (center), chosen as the ship's best potential disc jockey, as he receives pointers from Pat Fitzgerald (right) and Al McLellan, disc jockeys on Norfolk station WNOR.

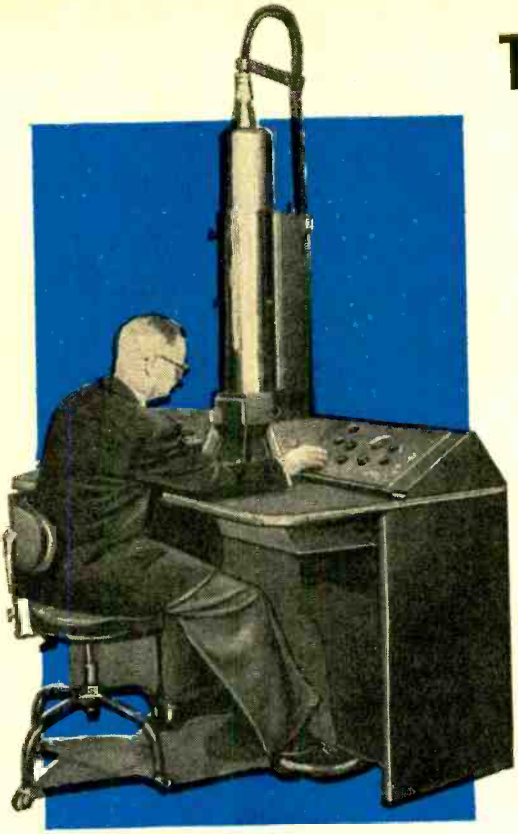
Free Classes in Radio

NOVICES and technicians in the Chicago area can now attend free classes in code and radio theory held every Monday and Thursday from 7 to 9 p.m. at *Allied Radio Corporation,* 100 N. Western Ave. The course is sponsored by *Allied* and *The Hallicrafters Corporation* in conjunction with the *Quarter Century Wireless Association,* a ham group. Instructors are authorized by the FCC to give examinations for the Novice and Technician Licenses. Classes, which are arranged according to the different technical levels of the students, will run through May 26th, and resume this fall.

Predict Transoceanic TV

EXCHANGE of television programs between Europe and America is seen as a future development growing out of a proposed transatlantic telephone cable. The cable, 2000 nautical miles long, will link Newfoundland and Scotland. Details were disclosed at a recent meeting of the *American Institute of Electrical Engineers* in New York City.

According to authorities, 1956 should see the completion of the first transatlantic telephone connection via submerged cable. The use of transistors is expected to increase the cable's communications possibilities beyond present-day limitations.



The Electron Microscope

Magnifying power made possible by electronic action provides science with a powerful weapon.

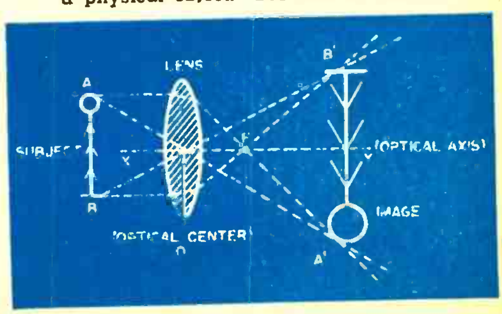
"IT WAS a vast circular plateau, high, and over two miles in diameter. It was covered with mountains, hills, valleys, and deep gulleys, and on it were ferocious and strange beasts. The entire plateau was almost pure silver. . . ."

An imaginative description of a plateau on a remote planet as it might appear in a science-fiction story? No! It is a description of how an ordinary dime might appear if it could be magnified by the powerful eye of *RCA's* new electron microscope. The hills, valleys, mountains, and gulleys represent the markings and surface scratches on the dime. The "strange beasts" are microscopic bacteria, germs, and virus. For under the electron microscope, familiar objects take on strange and new appearances. A human hair, if it could be magnified by the new microscope, would dwarf the giant Redwoods of California. With a direct magnification of 30,000X and photographic enlargements to 200,000X, *RCA's* newest commercial electron microscope has approximately twice the magnification of earlier commercial instruments.

The electron microscope, although in use for many years, is comparatively young as scientific instruments go, and represents one of science's most powerful weapons in its attack on the frontier of the unknown. It has already helped to forge many links in man's ever increasing chain of knowledge. Although the first electron microscope was built in 1932, research and theoretical investigations which led to its development date back many years. As far back as 1873, it was shown, theoretically, that there was a maximum limit to the resolution that could be obtained with an optical microscope. However, it was not until the 1920's that the need for a microscope of increased resolving power became urgent. By this time, it was well established that a microscope using light rays, or other types of electromagnetic radiation, could not provide the resolution and magnification needed. Louis de Broglie, E. Schrödinger, H. Busch, C. J. Davisson, C. J. Calbick, E. Brüche, H. Johannson, and other scientists developed theories and practical techniques in the 20's and early 30's which resulted in the development of practical electronic lenses.

After the construction of an electron microscope in 1932 by German scientists M. Knoll and E. Ruska, work progressed at

Fig. 1. Diagram showing operation of a simple optical lens. Converging rays of light are used to form enlarged image of a physical object. See text for details.



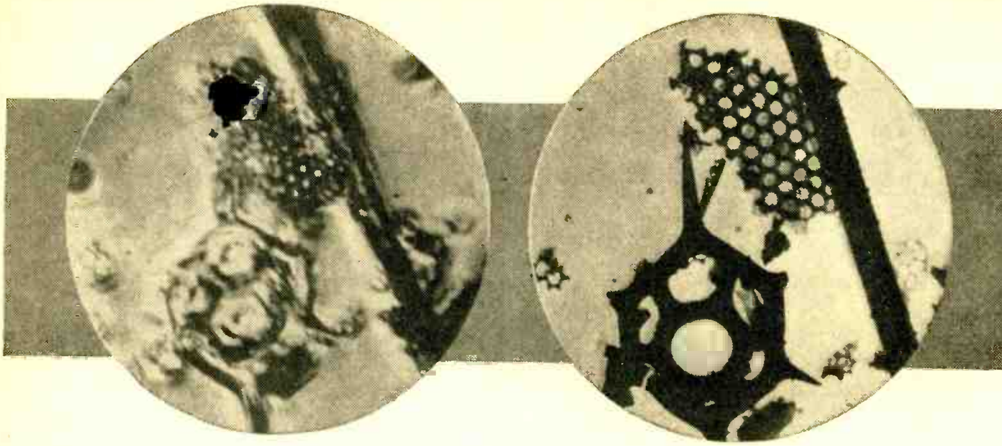
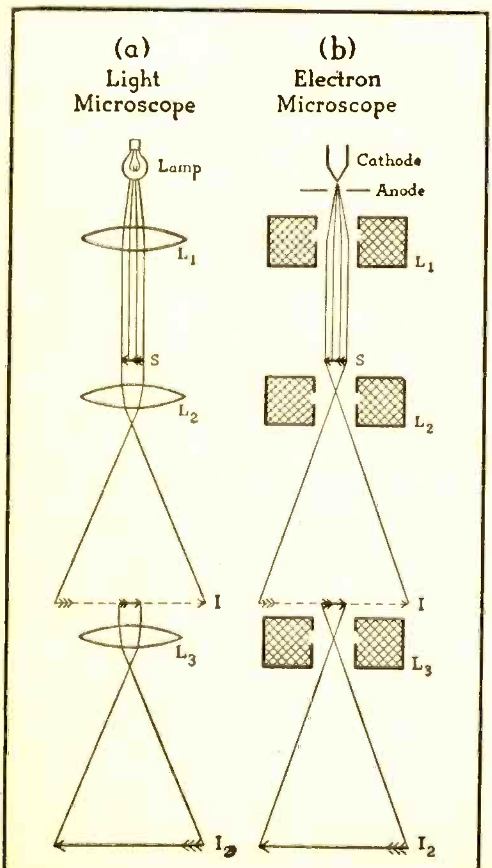


Fig. 2. Power of RCA electron microscope is illustrated by these two micrographs. A fossil particle was magnified 3000 times by a conventional light microscope, and then by the electron microscope. The electron micrograph (right) is sharp, clear, and detailed. RCA's newest unit provides magnification up to 200,000 diameters—50 percent greater than previously possible.

Fig. 3. Diagram below shows comparison between a compound optical microscope and an electron type. In the latter, an electron stream replaces conventional light source.



a rapid pace all over the world. In 1934, Ruska described the construction of a new electron microscope which was built specifically for the purpose of obtaining high resolution. Ruska's work was followed shortly thereafter by the work of L. Barton of Brussels, and Martin, Whelpton, and Parnum in England. Although considerable work was done from 1932 on, both in improving the design of the basic electron microscope and in developing and refining the techniques of using it, many of the early instruments did not provide a resolution any greater than that obtained with existing optical microscopes.

However, scientists E. Driest and E. O. Müller, in 1935, working with Ruska's electron microscope, and incorporating a number of changes which Ruska had suggested, finally achieved a resolution greater than that obtained with light microscopes. Work progressed rapidly. In 1938, B. von Borries and Ruska described an improved electron microscope designed for practical laboratory work. Another practical electron microscope was being designed independently of the work of Borries and Ruska by A. Prebus and J. Hillier, two scientists in Toronto. They described their instrument in 1939. Also in 1939, Martin designed an electron microscope for *RCA* and, in 1940, *RCA* announced the development of a commercial electron microscope designed by Hillier and Vance.

How It Works

In order to understand better the operation of the electron microscope, let us first review the operation of a simple optical lens. As the reader may recall from his high school

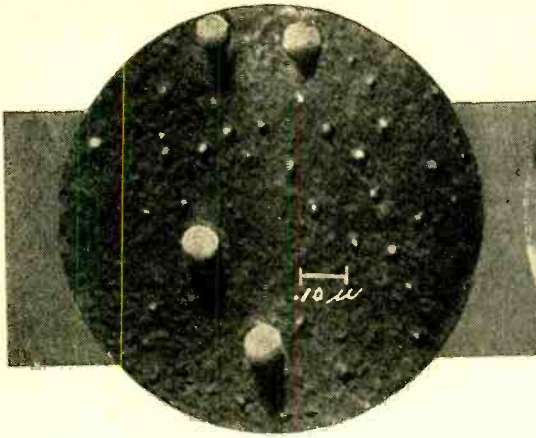


Fig. 4. Influenza virus magnified 78,570 times. Significant advances in medicine are made possible by unprecedented magnifications provided by electron microscope.

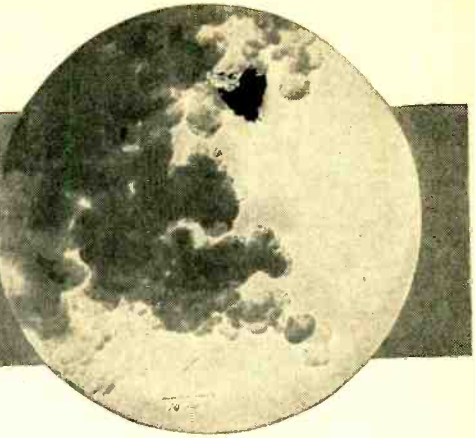


Fig. 5. Looking like a storm cloud is this group of carbon particles magnified 200,000 times under an electron microscope. Studies like this provide valuable data to industry.

physics, a simple converging lens may be used to form an enlarged image of a physical object. This action is illustrated in Fig. 1. With an object placed at AB, an enlarged image is formed at A′B′. Every ray of light entering the lens parallel to the optical axis (*XY*) is bent so that it passes through the focus point at *F*. Rays of light which pass through the optical center (*O*) of the lens are not bent and pass straight through. At the points where the rays of light passing through the optical center of the lens and those which enter the lens parallel to its optical axis meet, an enlarged image of the original object is formed.

A good deal of magnification may be obtained with a simple lens of this type, depending on the design of the lens and the relative distances between the lens, the object, and the image. Where greater magnification is desired, a second lens is used. The first lens forms an enlarged image, giving a certain magnification. The second lens is located so that it *magnifies the first image,* giving a second, greatly enlarged, image. The total magnification obtained, then, is the product of the magnifications obtained with the individual lenses. For example, if the first lens gave a magnification of 10 diameters and the second lens gave a similar magnification, the total magnification would be 100X. Theoretically, this procedure could be carried on indefinitely, with greater and greater magnification obtained each time another lens is added. However, a practical limit is soon reached due to the light losses in each lens and the loss of resolution.

There are two factors which are important when dealing with microscopes, *magnification* and *resolution*. The magnification is, of course, the ratio of the sizes of the image and the original object. The resolution is essentially the ability of the microscope to distinguish between two small points close together. The two do not necessarily go together. It is possible to have a microscope of high magnification but with poor resolution, and small details, although greatly magnified, may tend to blur together. See Fig. 2.

Due to the nature of light and lenses, there is a practical limit to the amount of resolution that can be obtained with optical microscopes. The observation of extremely small objects is limited by the wavelength of the light used, with the best microscopes distinguishing objects whose size is about half that of the wavelength of the light used. The practical limit is reached when light of extremely short wavelength, such as deep blue or ultraviolet, is employed.

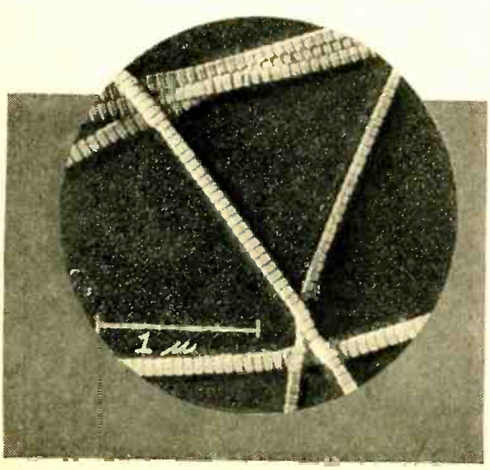
The smallest particle that can be seen, even with the finest optical microscopes, must have linear dimensions of at least 1/125,000 of an inch, and the greatest useful magnification is, therefore, only about 2000X. Under special circumstances, optical magnifications up to 5000X may be used. Unfortunately, scientists find it necessary to observe viruses and other tiny objects which may have dimensions of only 1/1,000,000 of an inch. Trying to see these extremely small objects with light is almost like trying to observe a mouse by throwing a basket full of tennis balls at it and noting which ones are bounced back. It was this impasse that led to the development of the electron microscope . . . for electrons are much smaller, physically, than the wavelength of even ultraviolet light, and thus may be used to observe extremely small objects. Theoretically, an electron microscope may be used to observe molecules and, perhaps, individual atoms!

A combination of lenses to obtain increased magnification is known as a *compound microscope*. The first lens in the system is generally called the *objective* lens and the last one may be called either the *projecting* lens if the image is thrown on a screen or photographic plate, or an *eyepiece* lens if the image is viewed directly with the eye. A direct comparison of a compound optical microscope and an electron microscope is given in Figs. 3A and 3B, respectively.

In the light microscope, shown in Fig. 3A, a lamp acts as a source of light. The light rays are concentrated and formed in parallel beams by the *condensing* lens L_1. These light beams strike the subject object S, outlining it. In addition, greater or lesser amounts of light may pass through the subject, depending on its relative transparency. The majority of light microscopes depend on light passing through the object to be viewed. An enlarged image of the subject is formed by the *objective* lens L_2 and appears at I. This image, or, actually, a portion of the entire image, is enlarged by the *eyepiece* or *projecting* lens L_3, with the second image appearing at I_2. The final image is a "light shadow" of the subject.

Point-by-point, the electron microscope works in a very similar fashion. Instead of the lamp which served as a light source, a combination of a cathode and an anode serves as an electron source (such a combination is frequently called an electron "gun"), for in the electron microscope light rays are replaced by streams of electrons. Electrons are "boiled" out of the heated cathode and are accelerated forward by the positively charged anode. They are then concentrated and focused into a sharp beam by the *condensing* magnetic lens L_1. The action of a magnetic lens is to bend and to focus the stream of electrons in much the same way that a glass lens bends and focuses a light beam. A magnetic lens is made up of a soft iron shell enclosing a coil of copper wire. A narrow ring-shaped gap is made on the inside of the iron shield and this gap, together with the amount of current flowing through the coil, determines the characteristics of the magnetic field produced and hence the "optical" characteristics of the lens.

Fig. 6. Human collagen is magnified 34,285 times by RCA electron microscope to provide scientists with close-up study of essential ingredient of bone's organic substance.



The focused electron beam strikes the subject object S. As in the case of the light microscope, the electrons must pass through the object and thus the subject must be relatively transparent to the stream of electrons. The *objective* lens L_2 forms an enlarged image of the subject at I. A portion of this image is magnified by the *projecting* lens L_3 which forms the final image at I_2. The final image is an "electron shadow" of the subject.

In an optical microscope, the light is visible, of course, and it is only necessary to allow the light to strike a plain white reflecting surface for the image to be seen. In the electron microscope, on the other hand, the electrons are not visible, so the electrons are allowed to strike a fluorescent screen to form the final image. The screen used is similar in composition to the fluorescent screen used on the face of a cathode-ray tube in a television receiver. In either the optical or the electron microscope, sensitive photographic film or plates may be substituted for the viewing screens. The picture obtained may then be enlarged photographically to give even greater magnification. This is quite feasible in the case of the electron microscope, since resolution is good. Considerable photographic enlargement is possible. In the light microscope, however, the poor resolution obtained limits the amount of photographic enlargement that may be used before the image becomes too blurred to be useful.

In the future, we may expect to see even more extensive use of the electron microscope than we have in the past. It may well be that the electron microscope will play an important role in defeating the remaining disease enemies of mankind. END

AMA-TOURING with Roger Legge

LISTENING to amateur radio stations in all parts of the world is fun, and it isn't difficult if you know where and when to tune. Amateurs in countries on all the continents can be heard contacting other amateur stations.

All that is needed to hear them is some sort of short-wave receiver, either a simple, home-built set or a more elaborate communications receiver, also an antenna, preferably an outside one set as high and as clear of obstructions as possible.

Next comes the problem of where and when to listen. Certain frequency bands are allowed for amateur station operations, as follows:

1.80 to 2.00 mc. (160 meter band)
3.50 to 4.00 mc. (75 or 80 meter band)
7.00 to 7.30 mc. (40 meter band)
14.00 to 14.35 mc. (20 meter band)
21.00 to 21.45 mc. (15 meter band)
28.00 to 29.70 mc. (10 meter band)

The 14 mc. band is the best one for hearing foreign stations. On this band, most of the foreign phone stations operate in the 14.10 to 14.20 and 14.30 to 14.33 mc. sections, on either side of the U. S. phone band, which is 14.20 to 14.30 mc. Most of the c.w. (code) stations, both U. S. and foreign, operate at the low end of the band, 14.00 to 14.10 mc.

During May, foreign stations should be audible in the 14 mc. band throughout the day and evening. Stations from the West Indies, Central America, and South America may be heard throughout this period, but normally should be best at 0700 to 0900 and 1600 to 2000 EST in the Eastern and Central states, also about the same hours PST in the Western U. S.

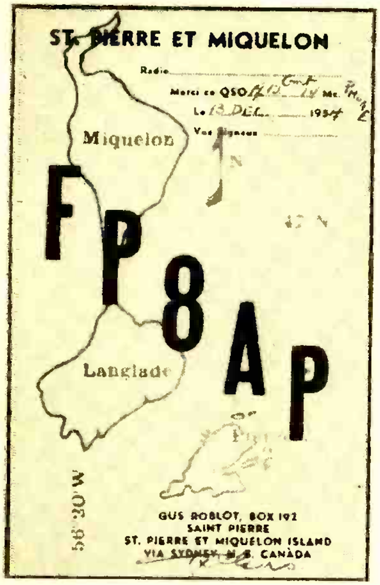
European amateurs may be heard from as early as 0600 until late afternoon in the Eastern and Central areas, but should be best at 0600 to 0800 and 1300 to 1700 EST. Listeners on the West Coast will find the Europeans much more difficult to hear, but should try around 0700 to 0900 and 1300 to 1500. Stations from Africa are more likely to be heard during the afternoon period, approximately the same hours as the Europeans.

Stations from across the Pacific are more difficult to hear in the East than stations from Latin America and across the Atlantic. However, signals from Australia and New Zealand should be heard at times around 0600 to 0900 during May, and from the Far East occasionally at the same hours. West Coast listeners will find better reception from the Pacific area during the period from 1400 to 2200 PST.

POPULAR ELECTRONICS is pleased to appoint Roger Legge as Contributing Editor in charge of our ham band SWL column. Rog has been actively tuning the ham bands, as well as the short-wave broadcast bands, for nearly 22 years. During this period he has heard and received confirmation cards from radio amateur phone stations in 170 countries. Before World War II, Rog was ham band DX editor of the International DX'ers Alliance. He has also contributed many articles and reception reports to various radio and electronic publications. Presently working for the Government, Rog is residing outside of Washington, D. C. Reports for this column may be sent to Rog by addressing them to his attention; % POPULAR ELECTRONICS, 366 Madison Ave., New York 17, New York.

Reception of distant stations on bands other than the 14 mc. is best during the winter months at night on the 1.8, 3.5, and 7 mc. bands. Further details about reception on these bands will be included in future issues, when the prospects for good reception of foreign amateur stations on these bands are better.

The amateurs in each country can be identified by the prefix of their call letters. A prefix is assigned to each country by international agreement and normally consists of one or two letters followed by a number. The most frequently heard countries and the prefixes are as follows: *Europe;* England (G), France (F), Germany (DL), Italy (I), Portugal (CT1), Switzerland (HB9). *Africa;* Morocco (CN8), South Africa (ZS). *South America;* Colombia (HK), Brazil (PY), Argentina (LU), Venezuela (YV). *Asia and Oceania;* Australia (VK), New Zealand (ZL), Japan (JA).



Reception of amateur stations varies greatly from day to day and at different hours. Best results can be obtained by checking the band conditions and concentrated listening when reception is good. It is advisable to keep a log of reception, including call letters of stations heard, time, frequency, signal strength, and interference, and also the call letters of the other stations being called or contacted by the station heard.

Hearing stations is only part of this interesting hobby of short-wave listening. Most amateurs have attractive cards printed for sending to other amateur stations to confirm contact with them. Many amateurs will send a card to confirm an SWL report, particularly if return postage is included. Collecting verifications from amateurs who have been received is another interesting feature. Details about how to send for these cards will be presented next month.

Now, here are some of the stations in unusual places that can be heard on the 14 mc. band:

San Andres Island—This is a small island in the Caribbean, north of Panama and belonging to Colombia. Last summer a shipload of Colombian amateurs journeyed to San Andres and several weeks of considerable radio activity followed. Now HKØAI is the only amateur station operating there. He is heard around 1800 EST on about 14.18 mc.

St. Pierre—This small island off Newfoundland belongs to France. During the summer months American and Canadian amateurs operate there with an FP8 call letter, but FP8AP is the only amateur to be heard all year round. He was most recently on 14.19 mc. at 1500.

Cocos Island—TI9MHB on 14.13 mc. was a station operated by W6MHB, who was with a treasure hunting expedition there on Cocos Island in the Pacific, West of Costa Rica. For those who heard this station, reception reports may be sent to John R. Beck, P. O. Box 75, Oakland, California.

Ships—Amateurs on ships at sea are heard occasionally. One heard recently was EL1FI, on 14.18 mc. at 1500, operating from a Liberian ship in the Atlantic.

These are a few of the numerous amateurs operating on the 14 mc. band. Next month, more details on these and verifications. END

Editor's Note: The policy in this, as well as future issues of POPULAR ELECTRONICS will be to divide short-wave listening activities into two separate and distinct sections. Rog Legge, as we have seen above, will write on SWL-ing in the radio amateur ham bands. Hank Bennett (page 70) will confine his activities to reporting on the short-wave broadcast stations. Both editors will be anxious to receive reports and these may be addressed to them through our office at 366 Madison Ave., New York 17, New York.

Plans are also being drawn to incorporate more material in POPULAR ELECTRONICS on the subjects of antennas, receivers, and the radio amateur novice license. Reader suggestions will be appreciated.

Both short-wave editors will publish photographs of SWL stations. We urge our readers to submit theirs at the earliest opportunity.

Detector Finds Small Objects

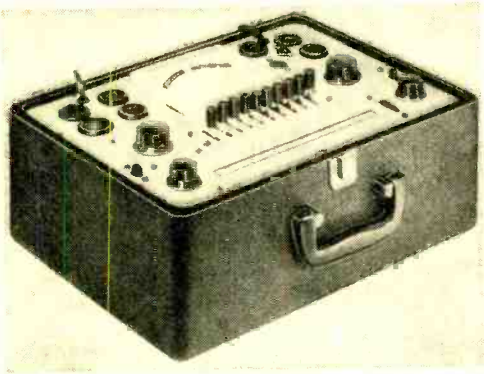
DESIGNED for detecting small objects at appreciable depths is the new "Beachcomber". Although similar in operation to the military type of mine detector, the "Beachcomber" covers many applications and is recommended for use by professional and amateur treasure-hunters and hobbyists, as well as by public utility companies, marine salvage crews, and search parties.

Its circuitry enables the "Beachcomber" to penetrate earth, water, rock, ice, cement, adobe brick, asphalt, etc. Its high sensitivity enables the user to locate lost objects, as well as hidden pipes and conduits.

Weighing nine pounds, the new unit is tuned by a single knob. It uses standard, low-voltage batteries. Methods of indication are a headphone and a meter, both of which respond strongly when the exploring probe passes over a metallic object.

The "Beachcomber" is being offered by *The Radiac Company of New York* for $138.50 f.o.b. N.Y.

New Low-Cost Kit Builds Tube Tester



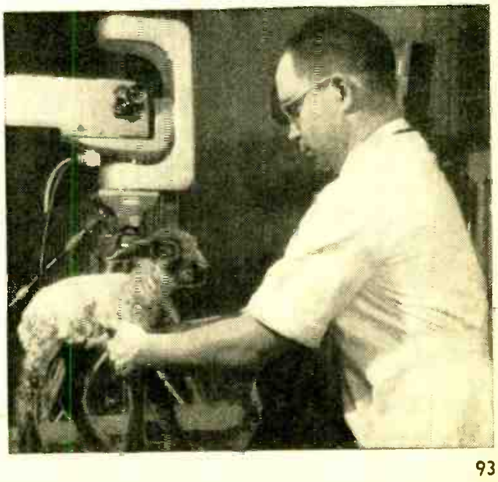
THE new *Knight* tube tester kit is easy to build and measures tube performance by the cathode-emission method. It also checks for shorted elements, open elements, and heater continuity. It will test 4-, 5-, 6-, and 7-pin large, regular, and miniature types, as well as octals, loctals, 9-pin miniatures, and pilot lamps.

A 4½-inch meter, line-voltage compensator, and clearly marked, smooth rolling chart are provided. To prevent obsolescence, universal socket-pin selectors are included. These permit testing tubes with new base arrangements without the need for wiring changes. The roll chart can be removed for easy addition of testing data on new tubes. A blank socket is provided for future use. A single unit, 10-lever function switch simplifies operation.

The *Knight* tube tester, complete with counter-type case, panel wires and solder, is priced at $29.75 net f.o.b. Chicago. A model in a portable carrying case is priced at $34.75. An adapter to permit checking TV picture tubes is priced at $3.75. For complete specifications, write to *Allied Radio Corporation,* 100 N. Western Avenue, Chicago 80, Illinois.

Color TV Screens Surgery

PROBABLY the youngest performer ever screened for TV is the newborn lamb shown in this photo. His birth, and that of his twin, was color-televised during a demonstration of the use of video to present close-ups of actual surgery to more than 600 veterinarians. Normally, considerably less viewers can observe an operation close enough to earn anything from it. Three different lenses and varied positions of the TV camera provided the audience with much the same details and view perceived by the operating surgeon. The closed circuit TV system was engineered by *General Electric* for the recent Veterinarian Conference at Cornell University, N. Y.



New *Heathkit* VFO KIT

MODEL VF-1

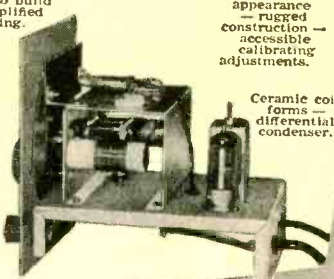
$19.50

Ship. Wt. 7 lbs.

- Smooth acting illuminated and precalibrated dial.
- 6AU6 electron coupled Clapp oscillator and OA2 voltage regulator.
- 7 Band coverage, 160 through 10 meters—10 Volt RF output.
- Copper plated chassis—aluminum cabinet—easy to build—direct keying.

Here is the new Heathkit VFO you have been waiting for. The perfect companion to the Heathkit Model AT-1 Transmitter. It has sufficient output to drive any multi-stage transmitter of modern design. A terrific combination of outstanding features at a low kit price. Good mechanical and electrical design insures operating stability. Coils are wound on heavy duty ceramic forms, using Litz or double cellulose wire coated with polystyrene cement. Variable capacitor is of differential type construction, especially designed for maximum bandspread and features ceramic insulation and double bearings.

This kit is furnished with a carefully precalibrated dial which provides well over two feet of calibrated dial scale. Smooth acting vernier reduction drive insures easy tuning and zero beating. Power requirements 6.3 volts AC at .45 amperes and 250 volts DC at 15 mills. Just plug it into the power receptacle provided on the rear of the AT-1 Transmitter Kit. The VFO coaxial output cable terminates in plastic plug to fit standard ½" crystal holder. Construction is simple and wiring is easy.



Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1

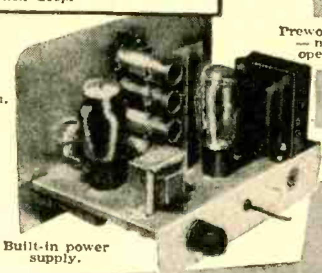
$29.50

Ship. Wt. 16 lbs.

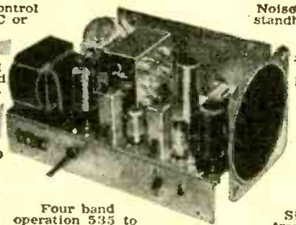
SPECIFICATIONS:

Range 80, 40, 20, 15, 11, 10 meters.
6AG7 ....Oscillator-multiplier.
6L6 ....Amplifier-doubler
5U4G ....Rectifier.
105-125 Volt A.C. 50-60 cycles 100 watts. Size: 8⅛ inch high x 13⅛ inch wide x 7 inch deep.

Here is a major Heathkit addition to the Ham radio field, the AT-1 Transmitter Kit, incorporaring many desirable design features at the lowest possible dollar-per-watts price. Panel mounted crystal socket, stand-by switch, key click filter, A. C. line filtering, good shielding, etc. VFO or crystal excitation—up to 35 watts input. Built-in power supply provides 425 volts at 100 MA. Amazingly low kit price includes all circuit components, tubes, cabinet, punched chassis, and detailed construction manual.



Heathkit COMMUNICATIONS RECEIVER KIT



SPECIFICATIONS:

Range..........535 Kc to 35 Mc
12BE6 ....Mixer-oscillator
12BA6 ....I. F. Amplifier
12AV6 Detector—AVC—audio
12BA6 ....B. F. O. oscillator
12A6........Beam power output
5Y3GT ....Rectifier
105-125 volts A.C. 50-60 cycles, 45 watts.

MODEL AR-2

$25.50

Ship. Wt. 12 lbs.

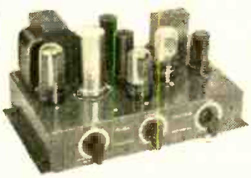
CABINET:

Proxylin impregnated fabric covered plywood cabinet. Shipg. weight 5 lbs. Number 91-10, $4.50.

A new Heathkit AR-2 communications receiver. The ideal companion piece for the AT-1 Transmitter. Electrical bandspread scale for tuning and logging convenience. High gain miniature tubes and IF transformers for high sensitivity and good signal to noise ratio. Construct your own Communications Receiver at a very substantial saving. Supplied with all tubes, punched and formed sheet metal parts, speaker, circuit components, and detailed step-by-step construction manual.

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

Heathkit ECONOMY SIX-WATT AMPLIFIER KIT



MODEL A-7B

$15.50 Shpg. Wt. 10 lbs.

Here is an outstanding amplifier value. This economically priced amplifier is capable of performance usually associated only with far more expensive units. Can be nicely used as the heart of an inexpensive high quality home music system. Features inputs for tuner and phono (Model A-7C accommodates a microphone by using an additional preamplifier stage). Separate bass and treble boost and cut tone controls for just the degree of tonal balance you want. The entire kit can be built in a few pleasant hours for years of enjoyment.

Technical features, frequency response ± 1½ db 20–20,000 cycles. Full 6 watts output. Push-pull beam power output stage. Output transformer impedances 4, 8, and 15 ohms. Tube lineup, 12L5GT, 12SL7, 2—12A6, 5Y3GT, and 12SJ7 (A-7C only).

All parts including tubes are supplied along with a prefabricated and painted chassis. Detailed step-by-step Construction Manual eliminates necessity for specialized knowledge.

MODEL A-7C incorporates a preamplifier stage with special compensated network to provide necessary gain for operation with variable reluctance cartridge or microphone. **$17.50**

NEW *Heathkit* BROADCAST BAND RECEIVER KIT

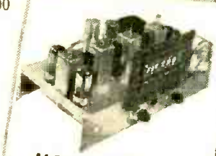
Here is the ideal radio kit for the student, beginner, or hobbyist. If you have ever had the urge to build your own radio receiver, this kit deserves your attention. Circuit is transformer operated, eliminating shock hazard usually associated with "economy" AC-DC circuits. New high gain miniature tubes and IF transformers—powerful ferrite core built-in rod type antenna—chassis mounted 5½" PM speaker—optional operation either as receiver or tuner and phono input. Covers broadcast band 550—1600 Kc. Uses 12BE6, 12BA6, 12AV6, 12A6, and 5Y3 tubes.

MODEL BR-2

$17.50 Shpg. Wt. 10 lbs. *less Cabinet*

CABINET: Proxylin impregnated fabric covered plywood cabinet available. Includes aluminum panel, flocked re-inforced speaker grill and protective rubber feet. 91-9. Shpg. Wt. 5 lbs. **$4.50**

Heathkit FM TUNER KIT



MODEL FM-2

$22.50 Shpg. Wt. 8 lbs.

Here is an FM tuner kit designed for simplified construction to operate either through the "phono" section of your radio or with a separate amplifier. AC transformer operated—8 tube circuit—slide rule type tuning dial—88-108 megacycle coverage—three double tuned IF stages—factory adjusted front end. Experience the thrill of building your own FM tuner and at the same time enjoy all of the advantages of true FM reception.

HEATH COMPANY • BENTON HARBOR, MICH.

MAIL YOUR ORDER TODAY TO THE HEATH COMPANY A SUBSIDIARY OF DAYSTROM, INC. BENTON HARBOR 10, MICHIGAN

ORDER BLANK

From ____________________

____

____

(PLEASE PRINT)

SHIP VIA
- ☐ Parcel Post
- ☐ Express
- ☐ Freight
- ☐ Best Way

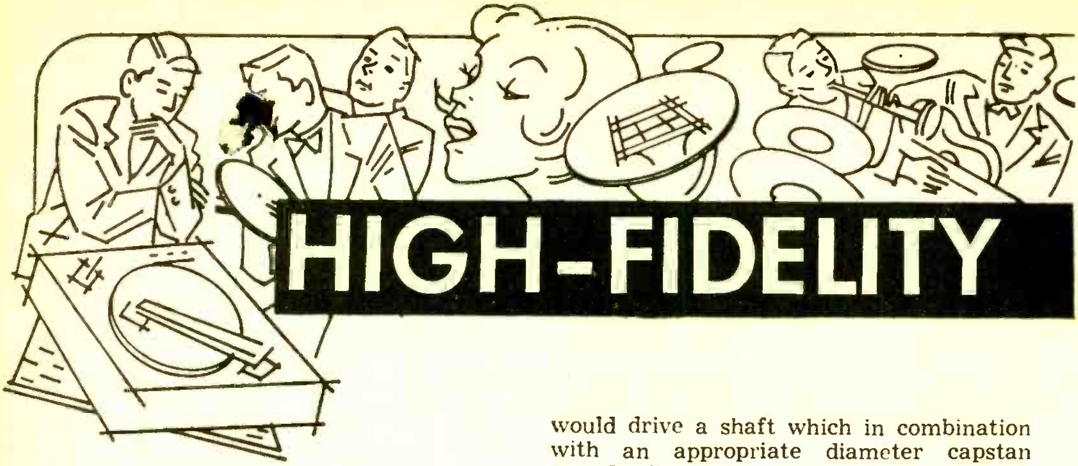
QUANTITY	ITEM	MODEL NO.	PRICE

Enclosed find ( ) check ( ) money order for
Please ship C.O.D. ( ) postage enclosed for pounds.

On Express orders do not include transportation charges—they will be collected by the express agency at time of delivery.

ON PARCEL POST ORDERS insure postage for weight shown.

ORDERS FROM CANADA and APO's must include full remittance.



HIGH-FIDELITY

Tape Recorders

THIS MONTH will inaugurate a series of articles concerning tape recorders and the art of tape recording. Let's assume that like most hi-fi fans these days, you have been thinking about taking the plunge and getting into tape recording. A little preliminary investigation has revealed this to be quite an undertaking.

Number one reason in the puzzle parade is what machine to buy. What machine will do the things you have in mind at the price you are prepared to pay? Sounds like a perfectly logical and fairly innocent question doesn't it? Unhappily the answers to these questions are usually hidden in the raft of recorders and mountains of misinformation being dispensed these days. At last count there were 149 (count 'em) tape recorders on the market, encompassing the whole range of good, bad, and indifferent!

Let's take a look at an "idealized" tape recorder to use as a standard of comparison. This unit would be able to handle all reel sizes up to 10½", yet retain portability and weigh less than 50 pounds (this figure is for the tape *transport* mechanism only). The unit would have positive braking action to stop tape within 3 inches after brake was applied from either rewind or fast forward speeds. It would have rewind and fast forward motors capable of spooling a 2400-foot, 10½" reel in one minute or less. A tape *break* (do not confuse with *brake*) switch would give protection from tape spillage in the event of the tape's snapping or power failure. The head structure would allow up to 6 heads to be utilized as follows: either half or full track erase, record, playback for *monaural* sound; erase, record, and playback for *binaural* sound. A two-speed hysteresis synchronous motor would drive a shaft which in combination with an appropriate diameter capstan would give tape speeds of 7½ and 15 inches-per-second. The wow and flutter content of the drive at these speeds should be 0.1 percent or less at 15 inches and 0.2 percent or less at 7½ inches-per-second. Tape threading should be of the "drop-in" slot type and positive contact should be maintained with the heads without resort to pressure pads.

The amplifier section should also be portable and weigh less than 30 pounds. With appropriate circuitry a tape speed of 15 inches-per-second would give a frequency response of 20 to 20,000 cycles-per-second plus or minus 2 db. At 7½ inches-per-second speed, response would be limited to 15,000 cycles-per-second plus or minus 3 db. At both speeds harmonic and intermodulation distortion would be less the 0.1 percent at the full voltage output of the preamplifier. The preamplifier would have provision for line input from a tuner, a balanced and unbalanced output switch selected for connection to a power amplifier. Three low impedance (50-250 ohms) microphone inputs would be provided with gain controls for each and a master control would regulate the output of the three channels when used in mike mixing. A four-inch illuminated VU meter with zero set and cut-off switch would indicate recording, bias, and playback levels. Record and playback functions would be push-button controlled with a safety interlock system to prevent accidental erasure. Colored pilot lamps would indicate which function the machine was set for and a small thermocouple and meter would indicate head temperature. Space would be provided within the amplifier case for the mounting of a duplicate amplifier for binaural recording.

Does such a fabulous unit exist? Well, yes and no. No, not at this precise moment, although some come very close to

(*Continued on page* 114)

Superior's new Model TV-11

TUBE TESTER

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ 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 tu...

★ N... ...igned Line Voltage C... ...pensates for variation of any ... Voltage between 105 Volts and 130 Volts.

★ 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.

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.

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

$47.50 NET

Superior's new Model TV-40

C.R.T. TUBE TESTER

★ **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!

★ **Tests *all* magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

- 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.
- Tests for open elements.

EASY TO USE:

Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (Ion Trap Need Not Be on Tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Model TV-40 C.R.T. Tube Tester comes absolutely complete — nothing else to buy. Housed in round cornered, molded bakelite case. Only

$15.85 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

We invite you to try before you buy any of the models described on this and the following page. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate. (See other side for time-payment schedule details.)

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

SEE OTHER SIDE

CUT OUT AND MAIL TODAY! ▶

FIRST CLASS
Permit No. 61430
New York, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the U. S.

VIA AIR MAIL

POSTAGE WILL BE PAID BY —

MOSS ELECTRONIC DIST. CO., INC.
3849 TENTH AVENUE
NEW YORK 34, N. Y.

Superior's new Model 670-A

SUPER-METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

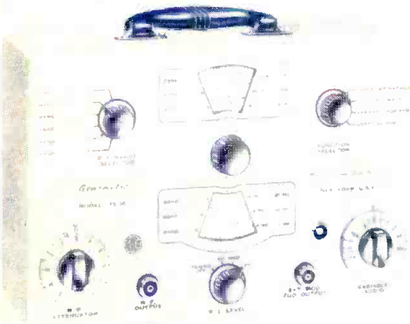
D.C. VOLTS: 0 to 7.5/15/75/150/750//1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad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

ADDED FEATURE:

Built-in ISOLATION TRANSFORMER reduces possibility 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.

$28.40 NET



The 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

7 Signal Generators in One!

- ✓ R. F. Signal Generator for A.M.
- ✓ R. F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

R. F. SIGNAL GENERATOR: The Model TV-50 Genometer 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 Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: The Model TV-50 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: The Model TV-50 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) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. 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 Model TV-50 includes all the most frequently needed marker points. 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.)

THE MODEL TV-50 comes absolutely complete with shielded leads and operating instructions. Only . . .

$47.50 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-120, 3849 Tenth Avenue, 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 payments when due, the full unpaid balance shall become immediately due and payable.

☐ Model TV-11 . . . Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

☐ Model 670-A . . . Total Price $28.40
$7.40 within 10 days. Balance $3.50 monthly for 6 months

☐ Model TV-40 . . . Total Price $15.85
$3.85 within 10 days. Balance $4.00 monthly for 3 months.

☐ Model TV-50 . . . Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

Name ______________________

Adddess ______________________

City ______________ Zone ______ State ______________

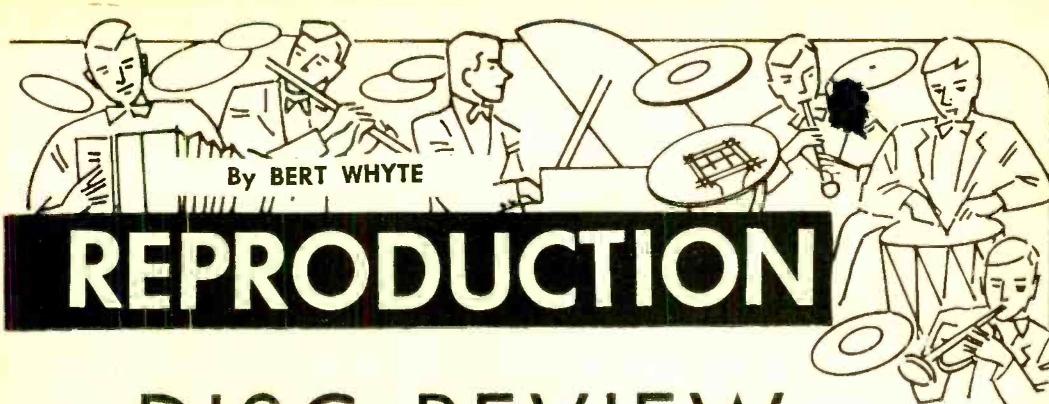
We invite you to try before you buy any of the models described on this and the preceding page. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate.

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

SEE OTHER SIDE

CUT OUT AND MAIL TODAY!



DISC REVIEW

By BERT WHYTE

AS PROMISED last month, we will investigate the recorded literature of the "tone poem," a work for a symphony orchestra, but one which is not cast in the traditional four movement symphony form. It is more a "free-form" or "fantasia" type of work, which might be expected since tone poems are largely programmatic. Definitions aside, the important thing is that a great many composers have written them and they have enjoyed great popularity with the musical public.

Probably no composer has been more closely allied with the tone poem than Richard Strauss. He wrote eleven tone poems in all, several of which have become enormously popular staples of the symphonic repertoire. Perhaps the best known of the Strauss tone poems is *Till Eulenspiegel's Merry Pranks*. This is a delightful and captivating work whose musical essence is in the rondo form (a principal subject recurring with variations) and whose "program" content concerns the legendary rascal of *Mittel* Europe, Till Eulenspiegel.

The music purports to show the life and pranks of this rogue and Strauss accomplishes this most effectively with his brilliant orchestration. Here you will find some of the most amazing writing for woodwinds in symphonic literature. Flute, clarinet, piccolo, bassoon, and other, more rarely used, woodwinds are given the task of portraying Till and representing some of his pranks. Combine this with some stunning strings, brass, and percussion, and you have a completely irresistible work. It was works like *Till* and others of the same *genre* that earned Strauss the reputation as a master of orchestration.

As you might expect, a work as popular as *Till Eulenspiegel* has been the subject of much recording. There are thirteen versions in the LP catalogue. In spite of this large number, only three recordings can honestly be described as having modern high fidelity sound. These are the Horenstein-Bamberg Symphony on *VOX* PL9060, the Krauss-Vienna Philharmonic on *London* LL233, and the Steinberg-Pittsburgh Symphony on *Capitol* P8291.

The best sounding of these is the Steinberg version. The *Capitol* engineers have captured the all-important woodwinds with a brilliance and sonority that outstrips their competition. String tone is smooth and clean and the brasses are crisp and articulate. Percussion, especialy the snares, is very sharp and accurate. Distortion is virtually non-existent and throughout the work, the sound is wide range with good dynamic expression. Acoustic perspective was well handled with enough reverberation to sustain liveness without obscuring inner detail.

The *VOX* recording runs a close second, but has neither the lustre and definition of the Pittsburgh strings nor the smoothness. Brass and percussion are about equal, but the woodwinds are less mellifluous than the *Capitol* recording. However, the *VOX* recording has the advantage of acoustics even more persuasively "live" than the *Capitol* —a "big sound" that finds favor with many people. The recording is blessed with wide dynamic and frequency response and is exceptionally well balanced.

The *London* recording is the oldest of these three by several years, but nevertheless it stacks up very well. The sound is quite obviously not as wide range as the newer version, but it is still more than acceptable. In the matter of dynamics, it does not bow to either of the others. Bass

(*Continued on page* 111)

WHAT'S THE PE ANSWER?

Although POPULAR ELECTRONICS began publication only a few months ago, we have received hundreds of letters requesting technical information, including many on subjects not directly related to anything we have published. We try to give individual answers to all letters relating to articles we have published, but we cannot give individual attention to all of the other letters. However, some of our readers' individual problems probably would interest other readers. Therefore, beginning with this issue, a few selected letters on such problems in electronics will be answered in this department. —*The Editors*

Numbers or Color Bands?

For identifying the values of condensers and resistors why not use numbers instead of color bands, such as, in 520 for example, the number 5 instead of the green band, the number 2 instead of the red band, and the zero instead of the brown band (indicating one zero)? I believe it would help those who cannot read the colors.

E. BORKE
Detroit, Mich.

Actually, all resistors and capacitors used to be marked with numbers instead of color bands, but the color band system has some advantages: the marking is legible with the component in any position, it is easier to apply a recognizable color band than a legible number, and the color lasts longer than printed numbers.

Citizens Band Radiophone

What I want is a diagram for building a radiophone transmitter and receiver that will work on the Citizens Band like for radio control, only instead it will be phone operated.

ARTHUR VILAIN
Clarksburg, W. Va.

Sorry, but the radio control frequency, 27.255 mc., is for radio control only, and homebuilt radio equipment is not authorized for other Citizens Band frequencies. May we suggest that you consider the amateur bands; requirements for a novice license are not difficult to meet and the equipment can be built at home.

TV Receiver Trouble

I have a Motorola TV set, the sound is perfect but I get no picture. The only thing I see is that the 6BQ6 tube heats excessively. Three different servicemen have given me three different reasons. Could you explain this trouble?

(name withheld)
Chicago, Ill.

We could give several possible explanations, but we would prefer not to do any television troubleshooting "by remote control" in POPULAR ELECTRONICS. Television receivers are complicated enough so that any particular trouble symptom can be due to several different faults or combinations of faults. No one could be sure that he has thought of all of the possibilities in a given case. An incomplete list of suggestions would be helpful only to a competent technician who was able to proceed on his own in case none of the suggestions offered happened to work.

Television troubleshooting can be learned, but it cannot be done successfully except by one who has learned it, through study and experience. POPULAR ELECTRONICS is a magazine for people who have a nonprofessional interest in electronics. We do have readers who are radio or television servicemen or electronic engineers, but we do not intend to compete with the engineers' and technicians' professional magazines.

Distant TV Reception

1—**I would like to know if there is any way to get out-of-town TV stations. There are stations in Champaign, Ill. (Channel 3), Hannibal, Mo. (Channel 7), Quincy, Ill. (Channel 10), Decatur, Ill. (Channel 17 u.h.f.), and Springfield, Ill. (Channel 20 u.h.f.).**

KENNETH SCHAPER
St. Louis, Mo.

2—**As I live about 260 miles from our TV station, Channel 4, picture is not of good quality. Signal strength is about 60 microvolts on a double-stack ten-element Yagi. If I added a wide-band amplifier of the type they use for community TV systems, would it improve the picture? Would a rhombic antenna improve the signal?**

CURTIS CHAGUN
Columbia Falls, Mont.

1—Extremely long distance reception (several hundred miles or even more) occasionally is obtained on the lower TV channels, 2, 3, 4, 5, and 6; apparently it is due to special atmospheric conditions which occur during the late spring and early summer months. No tricky equipment is required, just a high-gain antenna at a good height above the ground, together with a sensitive receiver or a receiver with a booster. The stations you mention all are a hundred miles or so from you. If you have the facilities just described, you should be able to receive the Channel 3 station without much trouble. Channels 7 and 10 are possible, but a cascode booster or a high-gain receiver with cascode r.f. amplifier may be necessary. Reception on the u.h.f. channels over a hundred miles or more is extremely rare. Unless the experience of others in your vicinity indicates that the local conditions are unusually favorable, it probably would not be worthwhile to invest in any special equipment for Channels 17 and 20.

2—Nothing that we know of can guarantee consistently good reception over a distance of 260 miles, except a phenomenally good location, but a rhombic antenna probably would help if you have the space for it. A cascode booster tuned to the desired channel would be better than a wide-band amplifier.

1&2—For the best possible results, installation of antennas and boosters for television reception must be done very carefully by a person who has special technical knowledge. Readers who do not themselves have the necessary knowledge to make special installations are advised to obtain the assistance of competent television servicemen.

Triode Receiver with No Plate Voltage?

I am interested in the question of how far one can depart from theoretical standards in different kinds of radio equipment and still expect any kind of results. My question deals with a grid-leak detector that I wired up the other day using a 6J5 triode tube. At first for the plate voltage I used an old power supply with sufficient resistance to lower the voltage to around 50 v. I disconnected the B voltage, or rather pulled out the rectifier tube, and discovered that the radio continued playing. I naturally attributed this to the charge left in the condensers, but the radio continued for several minutes. I then tested the power supply terminals and found there was no voltage across them. Then I tried substituting a 1.5 volt flashlight battery and found the result was about the same. After that, I eliminated the dry cell and touched the B+ and B— leads together and even this way without any B voltage I still got a weak signal over the phones. I didn't think this was possible. Was there some special factor to account for this, or will a vacuum tube pass a signal without a B battery?

LAWRENCE A. SHARPE
Chapel Hill, N. C.

A vacuum tube will operate without a B battery. Edison first discovered the effect named after him when he measured the current between the filament of a lamp and an additional electrode which had been inserted in the bulb, but without any source of voltage being connected between the two electrodes. When the filament or cathode of a tube is heated, electrons leave it; the electrons have enough velocity to get away from the cathode and some of them have enough velocity to reach the plate, even without being attracted by a positive plate voltage. In a triode with no plate voltage, the grid exerts control over the plate current, just as if plate voltage were present. Of course, the power output of a stage with no plate voltage is limited to a very small value, since it must come from the electron flow from the heater or cathode. With a plate voltage supply, some plate power can be converted into signal output.

One cannot depart at all from theoretical standards and get good results—if the theory is correct and complete. Edison's original discovery and reports similar to Mr. Sharpe's, which are published from time to time, show that the theory a triode must have plate voltage is, at least, incomplete. END

R/C NOTES

DID you notice the radio-control transmitter used to control the flight of the glider on this month's cover? Take another look because it's one of the handiest and easiest-to-build you'll see around. It is a single tuber, has long battery life, and is so light that you can hold it in one hand and launch your model with the other. Interested?

Actually, we're not trying to tease—a complete construction article, including a pictorial diagram, will be run in next month's issue.

* * *

IF YOU'RE from Ohio or the neighboring provinces, fly model airplanes, and are interested in entering a model meet this summer, write to *R. E. Beck,* 556 Westphal Avenue, Columbus 13, Ohio. *The Columbus Modeling Association* is interested in reviving the Ohio State Model Airplane Meet, but before they do, they would like to get some idea of how many modelers would enter. Also, the help of local modelers will be needed to carry off the contest successfully.

* * *

ONE new item that should be of great interest to R/C fans is a 50/50 solder in paste form produced by the *Hercules Chemical Company* of New York City. The stuff comes in a neat plastic tube which enables you to squeeze out just the amount you need for a joint. Applying a lighted match makes a neat solder joint.

This is the first solder of this type that we've been able to make work and produce the kind of joint that you normally get with a soldering iron or gun. Known as "Swift," this should be a "must" in every tool kit for field repairs. It may be obtained from hardware stores for 59 cents.

* * *

A NEW tuned-reed relay receiver, available in either 5 or 6 channels, is being offered by *Bramco Products,* 1717 S. Main Street, Pleasant Ridge, Michigan. The relay itself, is shown here and is available separately at $21.50 for the 5-reed unit, and $31.00 for the 6-reed unit. The complete receiver sells for $96.50 for 5 channels and $116.00 for 6 channels.

The main feature of this receiver is that the reeds have a contact dwell time of from four to seven times longer than any other brand tested. This results in more reliable secondary relay operation. The manufacturer states that the receiver itself is relatively unaffected by temperature changes from 10 to 100 degrees F.

* * *

TWO big, officially sponsored flying contests are coming up in May for East and West Coast R/C flying fans. On May 21st, at Floyd Bennett Field in New York, the 10th Annual Mirror Model Flying Fair will include an R/C event, as in past years. This is always a big show, for spectators as well as contestants. The Navy will again participate with a show since this is also Armed Forces Day. A new twist this year to be tried at the Mirror Show will be a separate registration for R/C fliers right at the R/C area. Also, there will be a special cage-type enclosure for R/C equipment to minimize interference.

Moffett Field, California, will be host for the 1955 Class AAA California Model Airplane Championships to be held on May 21 and 22. An R/C event is scheduled. For additional information write to *Harvey S. Roberts, Sr.,* Contest Director, 5610 East 17th Street, Oakland 21, California.

Two more R/C meets have been brought to our attention at press time. One is at Harvey, Illinois, for the R/C Club of Chicago (May 8); the other is at San Diego, California, on May 29. END

Simple L-C Adapter

(*Continued from page* 44)

> *Example:* Highest meter swing occurs at 10,000 cycles (10 kc.). What is the unknown capacitance? Chart 1 shows the capacitance of 0.1 μfd. to correspond to this frequency.
> *Answer:* 0.1 μfd.

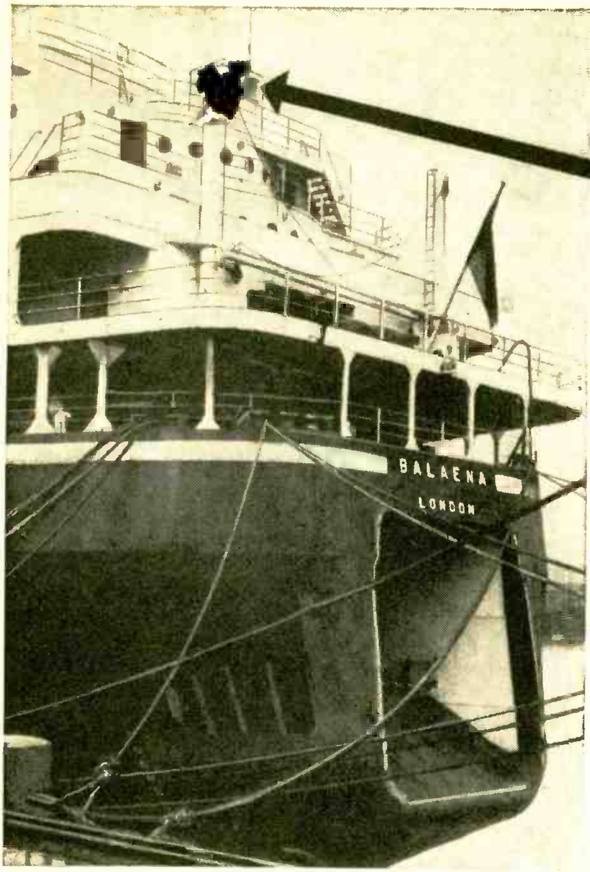
To Check Inductance: (1) Connect the unknown coil to the *Comp* terminals, using the shortest possible leads. (2) Set switch, S_1, to its *Ind* position. (3) Tune the oscillator throughout its frequency range, starting at its lowest frequency. (4) When a sharp upswing of the meter is noticed, carefully retune for the highest meter reading. Adjust potentiometer, R_1, during this final tuning, to sharpen the meter response. (5) Read the frequency from the oscillator dial. (6) Using Chart 2, find the inductance value corresponding to this frequency.

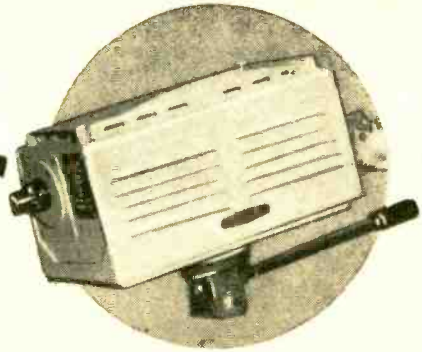
> *Example:* Highest meter swing occurs at 1000 cycles. What is the unknown inductance? Chart 2 shows the inductance of 2.5 henrys to correspond to this frequency.
> *Answer:* 2.5 henrys.

Similar problems involving unknown values of capacitance and inductance may be solved with the above techniques. As mentioned in the first part of this story, this unit will not provide accurate readings with electrolytic capacitors attached to the *Comp* terminals.

Accuracy of the adapter will be good enough for most practical purposes. The adapter does have a small amount of self-capacitance which is unavoidable. This value of self-capacitance may be found by checking the adapter with switch, S_1, in its *Cap* position, but with nothing connected to the *Comp* terminals. Tune the oscillator for the highest upswing of the meter. Read the frequency at this point and find the capacitance, as before, from Chart 1.

For the highest accuracy in use of the adapter, this self-capacitance value must be subtracted from all capacitance values obtained in measurements. It will be between 15 and 50 μμfd., depending upon the way the adapter is wired inside and upon the length of the leads to the voltmeter and to the capacitor under test. It can be held down by keeping the meter leads and the leads to the capacitor under test short and spread as far apart as possible. END





TV camera, 10½ inches long by 5¼ inches wide, relays pictures to screen via 750 feet of cable in closed circuit system.

TV TOUGH ON WHALES

Stern of the whaling ship "Balaena," first to use new television system. Camera is enclosed in small, rectangular "hut" at the top of the ship, in the center of the photo.

IF MOBY DICK were alive today he would probably find TV tougher on him than Captain Ahab. England is putting it to sea on whalers. A small camera and monitoring screen on board the whaling factory ship lets those on the bridge see what is going on at the stern where other vessels of the fleet deliver their whales and replenish their stores and harpoons. Before television, control from the bridge-house was complicated because the deckhouses and two big funnels of the factory ship blocked the view of anyone wanting to see aft. Manufactured by *Pye, Limited* of Cambridge, England, the closed circuit TV system has been installed aboard the whaling ship *Balaena* for use during this year's whaling season. END

Monitoring screen in the bridge-house of the whaler provides supervisory personnel with constant view of critical operations.

TOOLS & GADGETS

CLEANING FLUID

"Q-T" is a new formula designed for noise elimination and preservation of moving contacts. It cleans and retards corrosion at the same time. Said to be sediment-free and harmless to insulation and soldered joints, a three-ounce bottle sells for $0.69. "Q-T" is made by *Superex Electronics Corporation,* 4-6 Radford Place, Yonkers, New York.

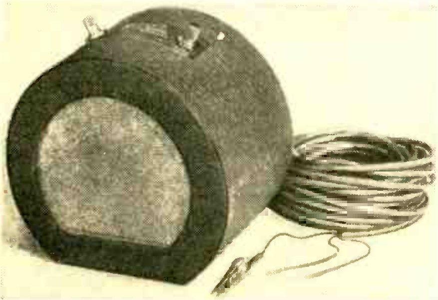
3-IRON SOLDERING KIT

Compact and portable, *Drake's* new "do-it-yourself" soldering kit features three interchangeable irons that fit readily into a single handle assembly. For medium and heavy duty there is a 150-watt iron with a 1⅛" tip; for light duty, the 100-watt iron with ¾" tip is recommended; while the 60-watt iron with ¼" tip is useful for most hobby work. The three irons and their socket handle are clamp-held in an all-steel tool kit. Also included are a safety stand and two tubes of *Drake* solder—one acid and one rosin core. The new kit is available through hardware stores, hobby and service shops. Retail price is $15.95. For

more information, write to *Drake Electrical Works, Inc.,* 3656 Lincoln Avenue, Chicago 13, Illinois.

VERSATILE REMOTE SPEAKER

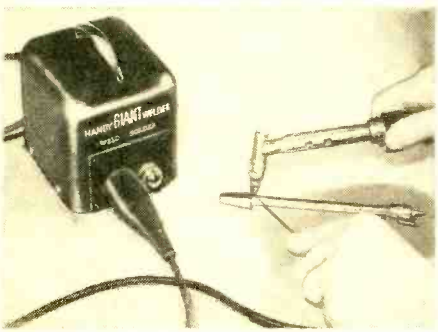
The new "Private Sound" remote speaker is easily attached to any sound-reproducing instrument by means of a 25-foot plastic-encased 3-wire cable and permits the listener to place the sound wherever he wants it. Invalids and those who are hard-of-hearing find this speaker helpful because it permits listening at any desired volume level without disturbing others. Two potentiometers, with full "off" position, permit the user to control independently the volume at the instrument speaker, and also at the remote speaker. By balancing the volume from the two



speakers, the listener can simulate a "stereophonic" effect. The speaker is also suggested as an auxiliary tweeter in a two-way speaker system. For complete information, write to the manufacturer, *First-American Products, Inc.*, 1717 Wyandotte St., Kansas City, Missouri.

NEW WELDING TOOL

Designed for amateurs and professionals is the new "Handy-Giant Welder." Powerful and free from shock hazard, the new tool can be operated from 115 volts, 60 cycle a.c. as well as from batteries. No glasses are needed by the user. Its many uses include welding, brazing, soldering, and etching and cutting holes in metal. The unit is guaranteed and carries the manufacturer's lifetime exchange policy. Made by the *Cauhorn Manufacturing Company*, 9999 Broadstreet, Detroit 4, Michigan, it is priced at $49.50 f.o.b. Detroit. Shipping weight is 12 pounds.

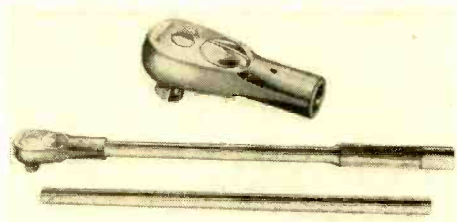


MULTIPLE ELECTRIC OUTLETS

The "Safcorde" outlet box, model W-1, contains six heavy-duty standard receptacles, an on-off switch, and a pilot light to indicate when voltage is on. Both sides of the line are fused to protect against shorts or excessive loads. The unit is priced at $9.95. For additional information, contact the manufacturer, *The Kenru Company*, Box 121, Parsippany, New Jersey.

HEAVY DUTY RATCHET HEAD

A new ¾" square drive heavy-duty ratchet head has been announced by *J. H. Williams & Company*, 400 Vulcan Street, Buffalo, New York. The tool is drop-forged from alloy steel, fully heat-treated, and finished in satin chrome-plate. Its ratchet gear has 24 teeth instead of the usual 16. A shift lever on the head reverses ratchet action instantly. Two types of handle are available, plain or with



knurled handle grip. Adequate leverage is afforded by the handles' length of 20 inches. For further information, write to the manufacturer.

NEW KNIGHT V.O.M. KIT

The new *Knight* 20,000 ohm/volt volt-ohmmeter, available in kit form from *Allied Radio*, features an improved circuit which provides high sensitivity, as well as versatility. Careful placement of parts assures simplicity of construction. Scales are easy to read on the 4½" meter. Selection of both function and range are accomplished with a single switch.

Instrument's nineteen ranges include: 6 d.c. voltage ranges to 5000 volts; 6 a.c. voltage ranges to 5000 volts; 3 resistance ranges to 200 megohms; and 4 d.c. ranges to 10 amperes. Supplied complete with all parts, a pair of 4-foot test leads, and complete instructions, this v.o.m. kit is available at $26.50 f.o.b. Chicago. For full specifications, or to order, write to *Allied Radio Corporation*, 100 N. Western Avenue, Chicago 80, Illinois. END

Oscillating on a Dime

(*Continued from page* 67)

of "springiness." In the model shown in the photograph, two metal strips are used, however, one is sufficient.

If the builder does not have nor cannot easily obtain the subminiature tube socket, the transistor may be wired directly in place using its leads. Should this step prove necessary, take special pains to avoid overheating the unit. It is a good idea to hold the transistor lead which is being soldered with a pair of flat-nosed pliers during the soldering process—the pliers should be between the transistor and the soldered joint.

And if the builder doesn't have a dime available for the "power supply", a quarter may be used instead!

Adjustment and Operation

Once the wiring is completed, the oscillator may be checked for operation by holding the earphone to the ear. If oscillation is not obtained, make sure that the tissue is thoroughly wet.

The power source may be checked for operation by connecting the negative and positive leads to the appropriate terminals of an 0-1 milliammeter. A current of at least 100 microamperes should be obtained, and under some conditions (depending on the acidity of the saliva, the amount of oxidation on the coin, etc.) currents as high as several mialliamperes may be obtained.

If little or no current is obtained, it may indicate that the tissue is not wet enough, that the coin and metal strip are shorting together, or that a thick film of oxidation has been built up on the coin or metal strip (best results are obtained with bright shiny coins). Check each possibility.

Once the power source has been checked and is functioning properly, if oscillation is still not obtained, try reversing the secondary leads of transformer, T_1, (the two black leads). This will insure proper phasing of the feedback signal.

Finally, if the preceding steps have not started oscillation, try varying the size of R_1. If necessary, a 100,000-ohm potentiometer may be used here and adjusted until oscillation takes place. A fixed resistor having the correct value may then be permanently soldered in place. END

Carl & Jerry

(*Continued from page* 57)

In a couple of minutes the boys were upstairs and had Jerry's TV set going. The volume was turned down to quiet the noise and the receiver was set to a blank channel as Jerry swung the antenna about with the rotator.

"You get the best lines when you're aiming south," Carl observed, "but that's about all you can tell. The front receiving lobe is too wide to do any pin-pointing."

"Let's try turning the antenna broadside to the storm," Jerry suggested. "A Yagi antenna has very sharp nulls off the sides. We'll adjust it for minimum noise reception with one side pointed in the general direction of south."

"Hey, now you're in business!" Carl exclaimed. "See; there's just two short periods of time as the antenna swings around when the lines go away down."

"Let's see now," Jerry said. "Our antenna indicator says the antenna is pointing about ten degrees north of due east; so that should mean the side of the antenna we're interested in is pointing about ten degrees to the east of south. That would put the storm center somewhere along a line from here through a point a little to the east of Indianapolis—"

"Listen!" Carl interrupted as he suddenly noticed the little transistor receiver grinding away in his shirt pocket. The crashes of static it had been giving off suddenly merged into a continuous roar that sounded very much like the interference created by an old-fashioned electric razor or a food mixer. "Golly!" he exclaimed; "that sounds exactly like the kind of static Bert was telling me about."

"Can you get any broadcast stations?" Jerry asked.

Carl moved the little dial to the frequency of the local broadcast station, and it came in clearly with only an occasional weak scratching sound heard under the powerful signal. Jerry returned to his TV rotator control and found that now the continuous lines across the face of the tube made it comparatively easy to find a very sharp null; but he also noticed he had to keep nudging the antenna to the north to maintain the null.

"That storm must be moving to the east," he remarked over his shoulder to Carl, only to find that he was no longer standing there. "What are you doing over there at the window?" he demanded as he caught sight of Carl holding the curtains aside and peering out to the south.

"Well, it's thisaway," Carl drawled; "tracking tornados is all well and good, but I just want to be sure the tracks don't get too fresh. If I see anything out there that looks the least bit like a funnel-shaped cloud, I'm going to break the sound barrier getting back into that basement. Just don't get in my way."

"Pooh!" Jerry scoffed. "Bert has your imagination all fired up. We've just been hearing a bad thunderstorm. Even that seems to be subsiding. I notice the grinding noise is quieting down in the TV set, and all I hear are isolated crashes of static again—"

He was interrupted by the announcer breaking in on the musical program coming out of Carl's shirt pocket: "Ladies and gentlemen, we interrupt this program to bring you a special bulletin. A small tornado has just been reported by a pilot flying near Indianapolis. He reports when he first sighted the tornado it was about eight miles due east of that city and was travelling in an east-northeasterly direction. When he was watching the funnel, it was clearing the earth by an estimated five hundred feet, and he could observe no damage in its wake. After a few minutes it disintegrated and was not seen to reform. Keep tuned to this station for further news as it developes. We now return to our program of recorded music."

"Holy cow!" Jerry breathed, "that *was* a tornado we heard."

"Well, anyway, we've learned two things," Jerry remarked as he switched off the TV set and pulled the line cord from the wall as he always did when there was danger of a thunderstorm. "First, a TV set and an antenna rotator can be used to determine the general direction and progress of a thunderstorm or tornado. Secondly, a tornado *does* put out a special kind of static that is easy to recognize once you've heard it." END

"How's about a cup of coffee and an aspirin sandwich?"

Home Broadcaster

(*Continued from page* 33)

caster" are simply tuned to the same frequency as the first receiver. The Broadcaster is then placed at its permanent location. Reception should be tried with all of the receivers, one at a time.

The antenna is unrolled as needed for satisfactory reception with the most distant receiver. As the antenna wire is unrolled some changes in the operating frequency may take place due to the loading change on the oscillator. This is corrected by adjusting the oscillator trimmer capacitor, C_2.

If a squeal or whistle is heard in any of the receivers, the oscillator frequency may be too close to that of a broadcast or other signal. It is then necessary to select a different oscillator frequency. END

Disc Review

(*Continued from page* 101)

is a little tubby-sounding, but strings make up for it with considerable brilliance. Woodwinds are quite articulate with particularly good intonation. Brass is good, but weighty rather than sharp. The acoustics are the equal of the *VOX* recording. In matters of performance, none of the newer versions and indeed, none of the other versions of the work in the catalogue can equal the Clemens Krauss-*London* recording. An acknowledged master of Strauss, Krauss' tempi are just right, his balance judicious, his dynamic shadings carefully chosen and they are neither cramped nor overblown. Couple his mastery of the score with the magnificent playing of the Vienna Philharmonic and you have a performance which I believe will always be among the "top," no matter how many future recordings there might be forthcoming.

Steinberg and Horenstein do a fairly competent job with the score, but fall by the wayside in one department or another. Therefore, it can be summed up this way—if you want the best sounding recording with a reasonably good performance, then the *Capitol* would be a good choice with the *VOX* not far behind. If you want an absolutely superlative performance with reasonably good hi-fi sound, then the *London* is the recording of choice.

Before leaving these recordings, I should mention the works with which *Till Eulenspiegel* is coupled. Happily for record lovers, Strauss wrote a number of tone poems which fit quite neatly on one side of an LP. Both the *Capitol* and the *VOX* records have the somber and powerful *Death and Transfiguration* on the flip side. The *London* recording has the fabulous *Don Juan* on the reverse side and the *VOX* recording also has *Don Juan*. Yes, that's right—the *VOX* recording has all three! Truly a good bargain and if you want to acquire the most Strauss for the least money, this is the answer. The remarks previously made about the sound of *Till* are equally applicable to the material on the reverse sides of these recordings.

Death and Transfiguration is better sounding on the *Capitol* and *VOX* disc than on any of the seven other versions in the catalogue. Performance wise, Steinberg and Horenstein do a fine job, but are up against such formidable opposition as Furtwangler and Mengelberg. *Don Juan* on the *London* is acceptable hi-fi, with once again, Krauss taking the honors for best performance in the eleven available versions in spite of such stalwarts as Toscanini and Fritz Reiner.

Speaking of Reiner brings to mind a new *Don Juan* which he performs with the Chicago Symphony on *Victor* LM1888. While Krauss still gets the nod for best performance, the sound on this new *Victor* is far superior to any of the other recordings. The Chicago Symphony, cloaked in the fabulous acoustics of Orchestra Hall sounds magnificent. String tone is exceptionally clean with some wonderfully sonorous contrabassi; the brass is bright and uninhibited with the famous horn theme soaring out effortlessly. Huge, imposing sound here, ultra-wide in frequency response, and with some absolutely tremendous dynamics. It is unfortunate that *Victor* chose to couple this *Don Juan* with Rolf Lieberman's very modern twelve-tone *Concerto for Jazz Band and Symphony Orchestra*. I, personally, am very impressed with the work and really like it. Maybe you might like it too, but there will be many who won't and would have preferred a more appropriate coupling.

Now we come to one of the most fabulous of all the Strauss tone poems and certainly his most controversial work in this form, *Ein Heldenleben* (A Hero's Life). This work could be considered a sort of summation of Strauss' life, or if not that, certainly a summation of the tone poems that preceded it. Throughout the work there are definite thematic quotes from *Don Juan, Till Eulenspiegel,* and other early works.

This is the most complex and highly orchestrated of all Strauss works and if the word is allowable, the most dissonant. One can only imagine the howls that critics and public alike set up, when the cacophonous thunder of the "battle scene" first smote their ears! Of course, the work has long since outgrown these objections and while there are certainly many parts of the score which still can be termed "modern," it hardly can be placed in the same category as some of the "shockers" we hear today! Modern or not, Strauss must have envisioned high fidelity sound when he wrote it, for few works can equal *Ein Heldenleben* as a vehicle for the demonstration of super hi-fi sound.

There are nine versions of *Ein Heldenleben* in the LP catalogue, and here we are faced with an embarrassment of riches! Not only are there four recordings which are extraordinary hi-fi in sound quality, but all four have the added benefit of good performance!

Clemens Krauss and his splendid Vienna Philharmonic on *London* LL659 must be considered as one of the most knowing interpreters. The sound of his recording is very good indeed, with a fine "big hall" type of sound aiding the clean strings and crackling brasses.

Eugene Ormandy has the incomparable Philadelphia Orchestra to aid his efforts on *Columbia* 3ML4887. His is a very tense reading full of vitality, but a little draggy in matters of tempi. The incredible Philadelphia strings are heard with silken clarity and throughout this disc, the sound is first rate with my only quibble concerning a bass line that was a little on the weak side.

Fritz Reiner has the ultra-sonorous Chicago Symphony and Orchestra Hall acoustics on *Victor* LM1807. His reading probably comes as close to the composer's intentions as any, yet suffers from a certain lack of cohesion. The sound quality on the Reiner disc is formidable. Great huge sounds here, with the whole ultra-wide range in both dynamics and frequency response. Big, brilliant brass and heavy but clean percussion are notable features.

Antal Dorati and the Minneapolis Symphony combine their considerable talents on *Mercury* MG50012. Here we have a reading which is at variance with the composer on several points, but which is certainly the most exciting. This is a taut, supercharged performance, which may be lacking in matters of finesse, but is most assuredly not lacking in vigor and robustness.

In the matter of sound, while the Reiner is very good, indeed, the Dorati is not merely good, but is phenomenal. Every element, from the super clean strings and the full-throated, clangorous brass, to the awesome bass drum and tympani explosions is ultra "live" and incredibly distortion-free. The dynamics of the "battle scene" are literally shattering! It is one of the finest sounding records in existence.

So take your choice. You can't go wrong on any of these, but best performance would be the Krauss and best sound the Dorati. Or if sound is not important at all, you can hear the work conducted by the great Strauss himself on *Decca* 9602!

Next month, back to the symphonies. END

Tape Recorders

(*Continued from page* 98)

these specifications, and yes, this type of unit will appear within the very near future. All the specifications listed are well within the present "state of the art" and indeed in special applications these specs have been greatly exceeded.

I know what's on your mind now—this would be a very expensive unit and strictly out of your league. So let's get down to cases. Let's say that your only reason for owning a tape recorder is to have some fun. You would like to record the voices of the children while they are still young or you think you could have fun at a party with this gadget. If your ambition goes no further than this, your needs are easily satisfied. Almost any home-type recorder up to $150 will serve the purpose.

Since voice will be your main preoccupation, select a unit that will give you tape speeds of 3¾ inches-per-second and 7½ inches-per-second. At the 3¾ speed, the recorder will give you a frequency response from about 75 to 3500 cycles-per-second which is adequate. If you want still better articulation, use the 7½ inch speed which will go on out to about 6500-7000 cycles.

It is time here to interject a warning—the specifications listed are what the record/playback *head and preamplifier* are capable of, and should not be construed as the response which will be obtained through the *amplifier* and *speaker* section of the unit. This same warning can be applied to other tape recorders costing a lot more than $150.00.

To touch once more briefly on the $150.00-or-less unit, make sure the machine is equipped with half-track heads which, of course, can cut your tape expenses in half. In recording voice on machines of this type which are equipped with "magic eye" recording level indicators, do *not* let the "V" of the eye close completely or *overlap*. To do so will surely cause distortion.

Contrary to the opinion of most uninformed amateurs, voice recording is *not* the easiest thing to accomplish with a tape recorder. The human voice in speech or singing is full of peaky transients from expletive and other explosive type sounds. The microphones with which these low-priced machines are equipped are extremely liable to transient overload. Don't have the subject literally breathing into the mike. Record them about ten to twelve inches away from the mike, but *do* have the party face the mike directly. Watch the magic eye carefully and set your gain control so that on peaky sounds like "p's" and "t's", the "V" of the eye just *doesn't quite close.* This will give you a fairly good distortion-free sound. If the unit has a jack for connection to external speaker, and you have same, by all means play back through it rather than the speaker which comes with the unit.

Now if you intend to do any *music recording,* whether it be live or off records, or "off the air," this calls for still different types of techniques and as a matter of fact, calls for a machine of better quality in the above $150.00 class. Next month I will list some of the features that are desirable in machines of this class, how to record music with them, and show you some modifications which can be made to these more expensive units, to produce some pretty good sound! END

Short Wave Bands

(*Continued from page* 71)

heard evenings, with English program to North America at 1800-1840. On Sundays has "Post Exchange" at 1807. Can be tuned in Spanish later in the evening.

Switzerland—HER3, Berne, 6165, is noted 2050-2130 with accordion music and program for invalids. English program noted at 2300. On 9535, HER4 has English news and music at 1715; another English program runs 2030-2115.

Syria—Damascus, 9555, is received with fairly good strength at 1630-1730 with English program directed to Europe.

Thailand—A fairly easy one to hear, Bangkok on 11690, noted 0545 with English news, weather, and music; English news again at 0615; native music at 0628; news in Malay at 0630; identifies at 0801; native music and talk at 0830; English identity at 0900; then into Thai. English news and music is noted around 2330.

That is all for this time. Good listening! 73, —Hank, W2PNA

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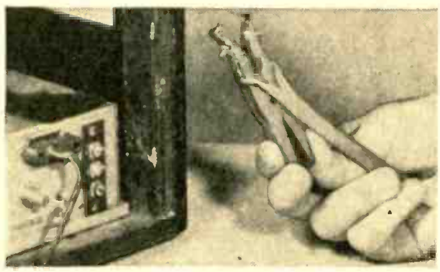
TIPS and TECHNIQUES

CLOTHESPIN ANTENNA CLIPS

PLASTIC clips of the type shown are available at TV stores. Similar ones can be made from spring-type wooden clothespins. Drill suitable holes into the ends of the clothespins. Then attach small metal strips to the ends and connect the cable to the metal strips.

There is enough spring in the clip to slip over the standard two TV antenna input screws, thus making it easy to connect and disconnect the antenna, or transfer the antenna to another set.



* * *

USED TUBE CARTONS ARE HANDY

EXPERIENCED technicians seldom throw away old tube cartons—they're much too handy for storing used, but good, tubes. Take a tip from them. Keep old tube cartons in a special box. Then, when disassembling an experimental circuit or salvaging parts from an old receiver, the used tubes can be placed in cartons and stacked neatly on a shelf. If a carton, with the right type designation can't be found, you can make a new label. Small labels are available at most dime stores. One further tip: be sure to check used tubes before

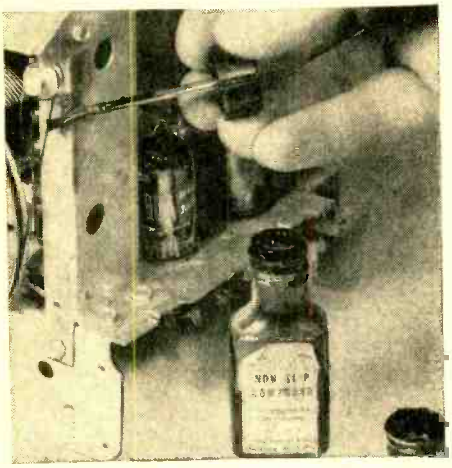
storing them, and keep them separate from "new stock."

* * *

DIAL CORD SLIPPAGE

SLIPPING radio dial cords can be repaired by the application of "Non Slip Compound," available at radio supply stores. Plain rosin applied to the cord will also help.

Make sure there is no defect and that the cord is not very loose before applying



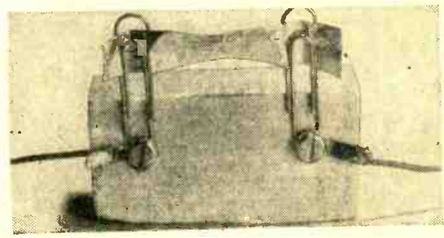
the compound. There are often small springs which may be adjusted or replaced which place tension on the cord.

When applying the compound keep moving the cord against the brush lightly saturated, to insure even distribution.

* * *

EMERGENCY FUSE AND MOUNT

FEW things are more nerve-racking than having your last fuse blow while working on an experimental circuit. You don't want to take a chance on blowing the line fuse, but you are anxious to continue with your work. And, to top it off, this trouble generally develops late at night or on a



week-end, when it's virtually impossible to obtain a replacement fuse.

A solution is to make an emergency fuse holder. All that is needed is a small scrap of wood, two soldering lugs, and two paper clips, with two screws for mounting. The paper clips and soldering lugs are fastened to the wood about an inch or two apart. A strip of tin or aluminum foil serves as a fuse. Connections should be made to the soldering lugs, but, in a pinch, these can be eliminated and wires may be soldered directly to the paper clips.

The "rating" of the foil fuse will depend on its thickness (whether "regular" or "heavy duty" foil is used) and on its width, as well as on the type of material used (whether tin or aluminum). Experiment with different sized strips to determine the best widths for the particular material used and for the "rating" needed.

* * *

EASILY MADE ADAPTERS

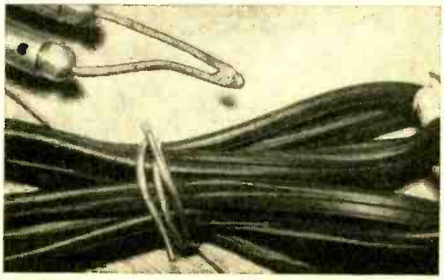
SINCE so many different kinds of connectors are used on electronic equipment, it is worthwhile for the experimenter to make up a number of special "adapters." These may be fitted on the ends of cables to permit a minimum number of connector cables to be used in a maximum number of applications.

A properly made adapter should be compact, sturdy, and well shielded. Cans salvaged from fluorescent lamp starters make almost ideal containers for adapters. All metal, they provide a good shield. And, although quite small and compact, they are still large enough to handle most common connectors.

* * *

SOLDER ALWAYS HANDY

TO insure always having solder handy, wrap a length around the cord of the soldering gun. This not only makes the solder readily available, but also keeps the



cord neatly coiled. Wrapped in this manner, solder is also useful for folding up slack in extension cords.

* * *

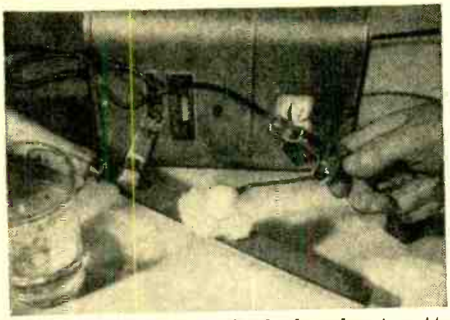
PROTECTION FOR NEON BULBS

ELECTRONIC and recording devices using neon bulbs (such as recording indictators, modulation level indicators, monitors and pilots) are subject to the problem of how to protect the fragile neon bulbs. The "life" of any type of neon bulb can be lengthened considerably by applying a *thin* coat of clear varnish over the bulb or pilot light. This protective coating adds enough strength so that the most fragile neon bulb can withstand rough handling without cracking.

* * *

CLEAN FILES ELECTRICALLY

FILES can be cleaned thoroughly using an electric current, available from a battery charger or similar d.c. source. Connect the negative side of the d.c. source to the file. Connect the positive side to a stiff copper wire. Wrap a wad of absorbent cotton around the free end of the wire and dip it into a salt solution. Apply to the file, being careful not to touch the file with any portion of the copper wire except the end wrapped in cotton. This would short-circuit the d.c. source. When contacted by the cotton, the file will be subject to a rapid release of hydrogen gas which lifts cuttings and other foreign matter from between the file's teeth. Following this, rinse, dry, and oil the file immediately.



* * *

SAFEGUARDS LOOP ANTENNA

TURNS of wire on loop antennas of small radios become loosened and may become entangled with other parts or the case after a period of time.

When working on the radio chassis for any reason, light applications of radio service cement on the antenna, particularly the end turns, will eliminate future trouble.

END

AFTER CLASS

WHETHER it is simple or complex, basic or advanced, amateur or commercial—every electronic device depends upon the correct combination of resistors and capacitors to help it function according to plan. In this article, some of these combinations are to be investigated with a view to learning something about their behavior in electronic circuits.

Resistors and capacitors are controlling elements which guide and modify electron streams so that the circuit performs as its designer intended it to perform. Although they have vastly different influences in electrical circuits, it is just this difference that makes them so useful when used in combinations that have special jobs to do.

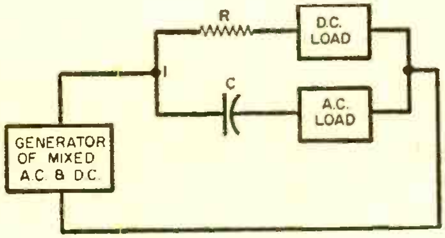
Generally, a resistor does not discriminate between different kinds of current; that is, if a resistor is rated at 1,000 ohms, it offers this resistance to any kind of current, either a.c. or d.c., and, in the case of alternating current, it makes no difference what the frequency of the alternations may be—the resistor still opposes the flow of current to the same extent as it opposes d.c.

A capacitor is a different "breed". It exhibits "selectivity" in its opposition to electricity. A capacitor may be chosen to provide an easy path for alternating current, while at the same time, d.c. is completely blocked. Another way to express this idea is to call a capacitor an open circuit for d.c., but a conductor for a.c. provided that it has sufficient capacitance and that the frequency of the a.c. is high enough.

As one might gather from this statement, the amount of opposition that a capacitor offers to the flow of a.c. depends upon two things: the size of the capacitor and the frequency of the current. An easy way to keep this relationship in mind is to remember that if *either* the capacitance of the capacitor *or* the frequency of the a.c. is *raised,* the opposition is *decreased.* Since the term "resistance" is reserved for resistors, the influence of a capacitor on the amount of a.c. that flows through the circuit is called the "reactance", but it is measured in ohms just like resistance.

Expressed mathematically, capacitive reactance, X_c, in ohms, equals $1/(2\pi fC)$, where f is the frequency in cycles-per-second and C is the capacitance in farads or f is in megacycles and C is in microfarads. This does not hold true at extremely high frequencies, but it does apply in all ordinary electronic equipment. The exact mathematical computation is not required for a general understanding of the working of simple circuits.

To illustrate the effect of both resistance and capacitive reactance in a practical circuit, consider the diagram. Suppose that a



certain electrical generator produces both a.c. and d.c. mixed with each other—a very common situation in electronics. Suppose further that there are two devices which we shall call "loads", one of which needs pure d.c. to operate properly, while the other requires pure a.c. A resistor and a capacitor properly chosen as to values can separate the a.c. from the d.c. and guide the two different currents along the desired paths. As the mixed currents arrive at point (1) in the circuit, the d.c. "sees" the capacitor as an open circuit through which it cannot flow, so it selects the resistor as its only other alternative path through the circuit; thus, the d.c. passes through the d.c. load. The a.c., upon "looking ahead", finds an easy path through the capacitor, while the one through the resistor appears to offer much more opposition. Therefore, most of the a.c. chooses the path through the capacitor and the a.c. load. The function of a resistor-capacitor (RC) combination in splitting up a.c. and d.c. and guiding the two different currents through different parts of the circuit is called *filtering*. Almost every schematic diagram in electronics contains one or more filter circuits in which a resistor and a capacitor are used to discriminate between a.c. and d.c.

The following quiz is intended as a self check. You should be able to answer all of the questions correctly if you have mastered the foregoing text. The answers appear on page 130.

QUIZ

1. Which of the two components, a resistor or a capacitor, exhibits changing opposition to the flow of current as the frequency changes?
2. Given a capacitor of .01 μfd., which of the following should be used to replace it if the designer wishes to reduce the reactance of the circuit—a .1 μfd. or a .001 μfd. capacitor?

3. Does the resistance of a resistor rise, fall, or remain the same as the frequency of the current flowing through it rises?
4. Does the phrase "blocking action" describe the functioning of a resistor or a capacitor?
5. What general name is applied to RC combinations used to separate a.c. from d.c.?

THE FARADAY SHIELD

MANY YEARS after James Clerk Maxwell, the famous 19th Century physicist, proved that magnetic fields are always accompanied by electric fields, engineers in electronics began to struggle with undesirable effects that these force fields create. The struggle is still going on.

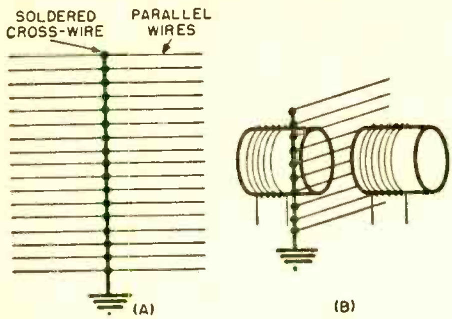
The "inseparables," as scientists sometimes term the magnetic and electric fields emanating from coils and wires carrying radio-frequency currents, must be cautiously handled to prevent one circuit from affecting another; otherwise, regenerative coupling, oscillation, and locking-in phenomena may destroy circuit performance. In planning the layout of radio receivers and similar gear, account is taken of these fields by enclosing coils in metal shield boxes or otherwise isolating them by means of aluminum, copper, or steel plates. The shielding metal is placed so that the fields are confined to the immediate vicinity of the coil.

At first glance, one might wonder how an aluminum shield can could prevent an electromagnetic field from penetrating it. It is common knowledge that iron and steel, being magnetic materials, are highly permeable and serve as good "conductors" for magnetic lines of force. Thus, when the lines impinge upon an iron shield can, they keep to the path of least resistance and follow the contours of the can. This keeps them from "getting out." Aluminum is non-magnetic, but it is a good electrical conductor; this characteristic enables it to arrest a magnetic field in an entirely different manner. Moving lines of force passing through aluminum induce eddy currents in the can. (These are random currents which represent a serious loss of energy which must be supplied by the field.) As the field loses its energy in the generation of eddy currents, it has little or no strength left to penetrate the metal and so remains within the confines of the shield.

An electric field terminates as soon as its lines of force encounter a good conducting surface. Hence, an aluminum or copper shield can prevents the "escape" of both kinds of fields, magnetic fields by eddy current losses and electric fields by conductive termination.

Suppose one wishes to make a shield which confines the electric field of a coil but permits the magnetic field unhampered passage. This problem is a serious one in metal locators where the capacitance of the ground to the search coil must be eliminated while the magnetic flux of the coil must be allowed to penetrate the ground. Solid plate shielding, or even screen mesh, between the coil and the ground is out of the question because of eddy current losses. The aim is to provide metal for the electric field termination without having eddy currents in the metal.

This objective is nicely achieved by using a Faraday shield. As illustrated, this kind



of shield is fabricated by gluing parallel wires to a cardboard sheet, spacing the wires apart by a distance equal to about two wire diameters. After the glue has set, a bare copper wire or strip is soldered across the rows at right angles; the assembly is then run to the common ground of the equipment.

A Faraday shield provides metal conductors to terminate electric lines of force while it offers no closed loops through which eddy currents can flow, so that magnetic fields penetrate it with no trouble.

BINARY NOTATION

A DIGITAL computer handles the manipulation of numbers by means of relays, lamps, and tubes which can rest in only one of two possible states: "on" or "off." Each of these states can, at best, represent a single digit so that only two different digits can be indicated by a single relay or tube, one for the "on" condition and the second for the "off" state. Our normal decimal system contains ten different digits (1, 2, 3, 4, 5, 6, 7, 8, 9, and 0). Fortunately, there is a numbering system that is just right for digital computers — the binary method of notation. By adhering to simple rules, any number may be written with only two digits: 1 and 0.

To illustrate, a string of "2's" raised to successively increasing powers (from right to left) is written across the page.

2^8 2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0
(256) (128) (64) (32) (16) (8) (4) (2) (1)

According to the rules of arithmetic,

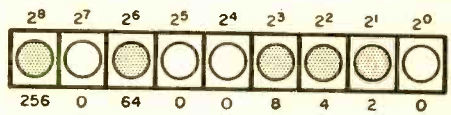
any number raised to the zero power, like 2^0, is equal to one, so we have written (1) under 2^0. Two raised to the first power (2^1) is 2, two raised to the second power is 4 ($2^2 = 4$), two raised to the third power is 8 ($2^3=8$), and so on. Using only the digits 1 and 0 we can write a number, say the number 28, by placing either 1 or 0 under the appropriate members of the string. The rule here is that the member of the string is to be counted or added in when 1 appears under it and is to be ignored when 0 appears under it as in the example below (writing the number 28):

	2^4	2^3	2^2	2^1	2^0
	1	1	1	0	0
This is really........	16 +	8 +	4 +	0 +	0

Thus, in binary notation the number 28 is written 11100.

A second example should aid in clarifying this procedure. The number 49 is written 110001. In your mind, place these digits under the members of the string starting at the right. This gives $1 + 16 + 32 = 49$. Note that the "0's" under 2^1, 2^2, and 2^3 were instructions to ignore these numbers and to exclude them from the addition.

Suppose that a computer has somewhere along its progression of indicators, a bank of 9 lights upon which has just appeared a number in binary notation as shown in the illustration. The digit 1 is



signified by a lighted lamp while 0 is indicated by an extinguished lamp. What number is it?

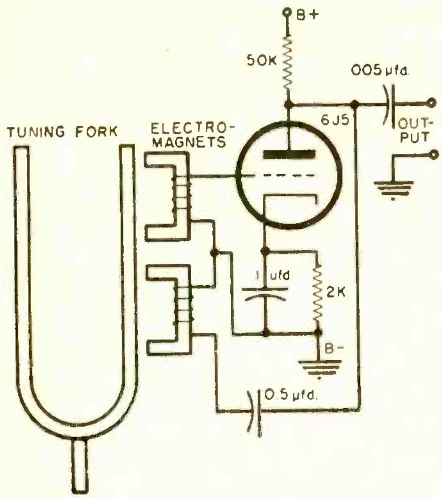
Here, the computer answer bank has given the binary number 101001110 or the sum of 256, 64, 8, 4, and 2, to yield 334.

To increase the range or the size of the numbers, all that need be done is increase the length of the string going left toward larger and larger powers of 2. Although this may seem an uneconomical use of lamps and relays, it does enable great accuracy and reliability to be obtained from equipment which is a combination of simple elements.

TUNING FORK OSCILLATORS

According to some of our best engineers, particularly those engaged in work involving multiplex communication systems, the venerable tuning fork is still the most stable generator of sine waves that has ever been designed. Multiplexing is a system of communication in which several messages may be sent simultaneously via a single radio-frequency channel. Unless the frequency standards of the multiplex network are rigidly stable, erratic performance is to be expected. One of the greatest transcontinental and transoceanic communications companies in the world relies almost exclusively upon electrically driven tuning forks to maintain its multiplex functioning perfectly the year round.

An ordinary tuning fork has a natural frequency of vibration which depends upon its physical stucture (mass, length of tines, etc.). When the fork is coupled to an oscillatory circuit like that shown in the figure,



it becomes the "tank" circuit and is kept vibrating at constant amplitude by the interchange of magnetic effects in the electromagnetic coils.

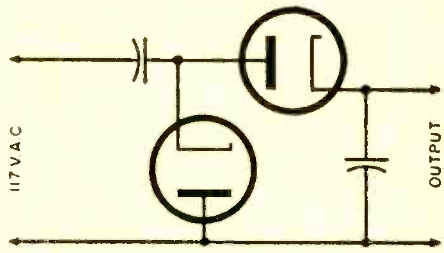
As in the explanation of any other oscillator, we begin by assuming that power has been applied and a steady plate current is flowing in the triode. Any chance vibration or tremor or variation in the plate current moves the tine adjacent to the coils toward or away from them. Assume that the movement is toward the coils. As the mass of iron approaches the magnetic core, the flux between the poles is altered ever so slightly, causing an induced voltage across the grid coil winding. The polarity of the induced voltage is such that, as it is applied between grid and ground, it charges the plate current in the triode amplifier to produce further movement of the tine in the same direction as it started.

When the tine has reached the limit of its swing, it reverses its motion and begins to move away from the electromagnet. As it does so, the induced voltage is in a direction which diminishes the magnetic pull and permits the fork to move away.

Each succeeding cycle of vibration has just the tiniest bit more amplitude by virtue of the feedback from the amplifier tube. This continues until a balance is reached and the fork vibrates with constant amplitude at its natural frequency. This gradual build-up of amplitude may be watched on the screen of an oscilloscope; as one watches, the height of the waves slowly increases over a period of several minutes until the oscillation becomes stabilized.

POWER SUPPLY QUIZ

1. **The ripple frequency of a full-wave rectifier operating on a 60-cycle power line is:**
   (a) 30 cycles-per-second; (b) 60 cycles-per-second; (c) 120 cycles-per-second.
2. **A resistor connected across a filter capacitor for the purpose of discharging the capacitor after the power is turned off is known as a:**
   (a) damper; (b) quencher; (c) bleeder.

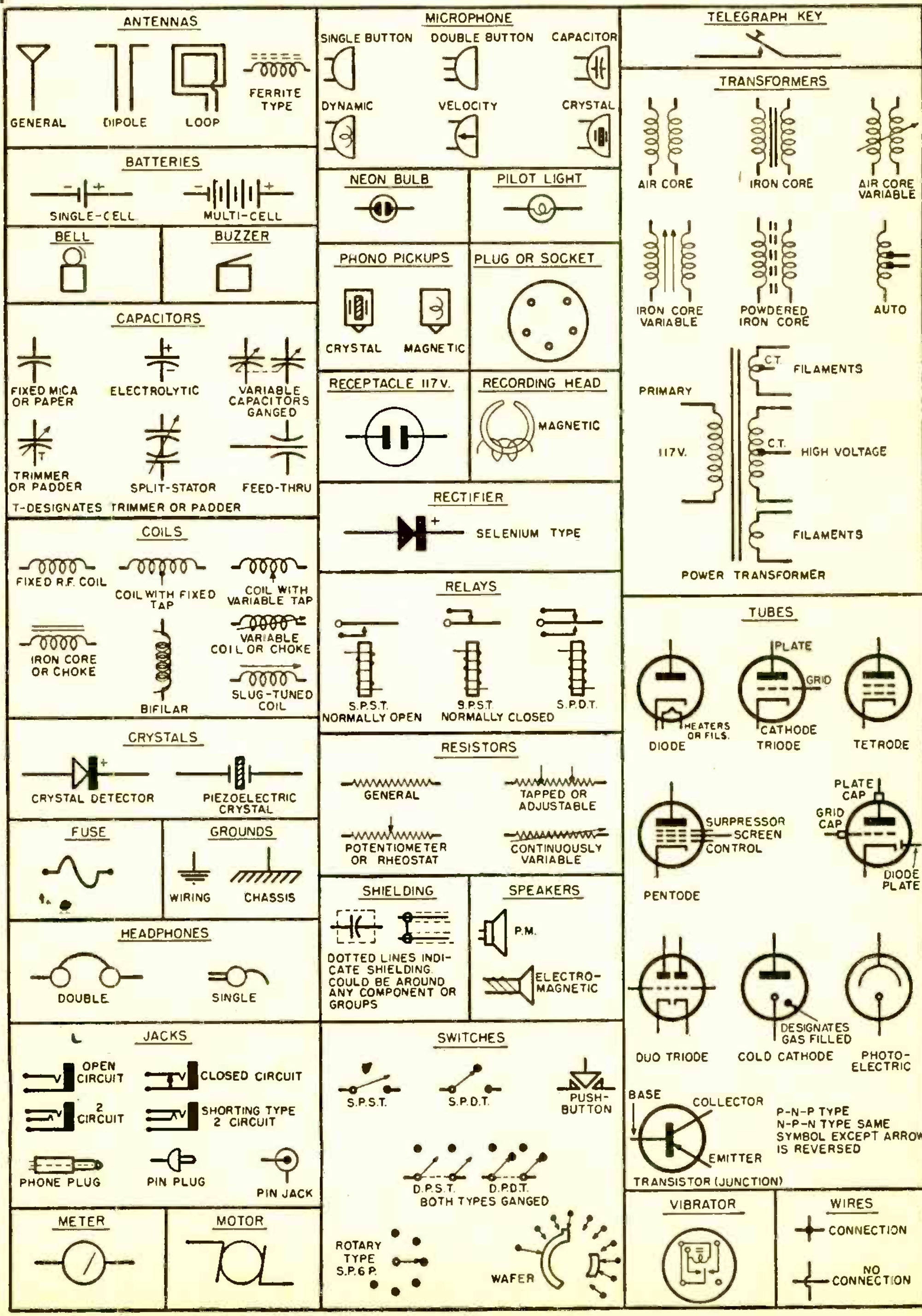


3. **The output voltage of the rectifier circuit shown in Fig. 1 is approximately:**
   (a) 110 volts; (b) 155 volts; (c) 310 volts.
4. **As compared with a choke input filter, a capacitor-input filter will provide:**
   (a) more output voltage; (b) less output voltage.
5. **As compared with a choke-input filter, a capacitor-input filter will provide:**
   (a) better regulation; (b) poorer regulation.
6. **If the iron core of a filter choke becames saturated:**
   (a) the inductance will increase; (b) the inductance will decrease; (c) the inductance will remain the same.
7. **The no-load output of a power supply is 200 volts. Under full-load conditions, the output drops to 180 volts. The percentage of regulation is:**
   (a) 20%; (b) 10%; (c) 5%.
8. **The cathode of a rectifier tube should be brought up to operating temperature before the plate voltage is applied:**
   (a) when the rectifier is a mercury vapor type; (b) when the rectifier is a vacuum type with two diodes in one envelope; (c) when the rectifier is a vacuum type with a metal rather than a glass envelope.
9. **The inverse peak voltage rating of a rectifier tube should be at least equal to:**
   (a) the r.m.s. value of the a.c. input; (b) the peak value of the a.c. input; (c) twice the peak value of the a.c. input.
10. **The type of filter capacitor used most commonly in the power supplies of radio receivers is:**
    (a) electrolytic; (b) mica; (c) paper.

The answers will be found on page xxx. Ten correct is excellent; nine correct, very good; eight correct, good; seven correct, fair; and six or less, poor.

END

STANDARDIZED WIRING DIAGRAM SYMBOLS



GLOSSARY

a.f.c.—Automatic frequency control: (1) control of the frequency of the local oscillator in a superheterodyne to keep the receiver in tune with a desired station; (2) control of the frequency of the horizontal oscillator in a television receiver to keep the horizontal deflection in step with the horizontal deflection at the television studio and thus to keep the picture steady horizontally.

a.g.c.—Automatic gain control, control of the amplification of an amplifier so that its output is approximately constant in spite of variations in the input signal; especially such control in television receivers to reduce variations in picture contrast produced by variations in r.f. signal strength.

a.v.c.—Automatic volume control (a.g.c. used in radio receivers to reduce variations in sound volume produced by variations in r.f. signal strength).

choke—An inductance used especially to present a high impedance to a wide range of frequencies. Filter chokes are used in rectifier-type power supplies to remove from the d.c. output hum components equal to the power line frequency and its harmonics; audio-frequency chokes are used in audio amplifiers and radio-frequency chokes are used in r.f. and i.f. amplifiers, to present a high impedance load to a vacuum tube or to block unwanted signals.

crystal—1. Rectifying crystal, one which passes electric current more easily in one direction than in the other and thus can be used to change alternating current to pulsating direct current; made of such materials as germanium, silicon, copper oxide, galena, and carborundum. 2. Piezo-electric crystal, one which transforms mechanical energy to electrical and vice versa. Such crystals, made of Rochelle salt or barium titanate, are used in microphones and phonograph pickups. When cut to a certain size and shape, a piezo-electric crystal, usually made of quartz, can be used as a resonant circuit, to control the frequency of an oscillator or as a frequency-selective filter.

decibel—A measure of the ratio between two power levels or of a power level with respect to a designated reference level. Basically, the number of decibels is ten times the logarithm of a power ratio. One decibel is approximately the smallest difference in sound power which can be detected by the average human ear.

db of feedback—The number of decibels by which inverse feedback in an amplifier reduces its over-all gain and distortion.

detector—A circuit used to recover an audio or video signal from a modulated radio signal.

electrolytic capacitor—A type of capacitor in which the dielectric or insulator is a thin film of oxide deposited on one aluminum or tantalum plate and an electrolyte is used between the insulator and the other plate. This type of capacitor provides a larger capacitance in a given volume than any other type. However, except for special a.c. electrolytics, this type can be used only in circuits where voltage of constant polarity is applied to it.

elevator—Control surface of an aircraft which regulates its pitch attitude (level, climbing, or diving).

feedback—Returning part of the output of an amplifier stage to the input of the same or a previous stage. Negative or inverse (out-of-phase) feedback decreases the gain and distortion of the amplifier; positive (in-phase) feedback increases gain and distortion and may produce oscillation.

frequency response—The relative ability of an amplifier, loudspeaker, or other device to respond to different frequencies.

glow plug—A type of internal-combustion engine used in models, in which starting is assisted by a filament in the combustion chamber, which is energized by an external battery.

harmonic distortion—Distortion consisting of addition to the signal of components whose frequencies are multiples (harmonics) of the original signal frequency. It is produced by an amplifier or other device which is nonlinear (does not give the same ratio of output to input for all input amplitudes).

heterodyne—A different frequency (beat) produced by combining two frequencies.

hole—Absence of an electron normally present in an atom; a positive charge. The action of some transistors often is explained by referring to movement of holes or positive charges, rather than movement in the opposite direction of electrons or negative charges.

microammeter—A meter for the measurement of current flow, which is calibrated in microamperes, or millionths of an ampere.

milliampere—One-thousandth of an ampere.

modulated—Varied in amplitude, frequency, or some other quality. Radio-frequency signals are modulated in order to carry signals of lower frequency, such as sound or picture signals.

multitester—A meter which is a combination of a voltmeter, an ohmmeter, and (often) an ammeter.

octal—Designation of one of the standard types of tube base or the socket to fit it. The base has eight equally spaced pins and a centrally located boss, which is made of insulating material and has a key to prevent improper insertion of the tube in the socket. The loctal tube base is similar, except that its pins are smaller in diameter and the central boss is of metal and has a groove which fits a one-turn spring in the socket, to hold the tube.

oscillator—A vacuum-tube or transistor circuit or other device which produces an alternating-current power output without mechanical rotation.

plate dissipation—The part of the power applied to the plate circuit of a vacuum tube which does not appear as signal output, but is dissipated as heat in the plate of the tube.

push-pull—An arrangement of two vacuum tubes in an amplifier so that the input signal is applied in opposite phases to the two tubes and the signal outputs are combined in phase. This arrangement reduces even-harmonic distortion.

regeneration—Positive feedback in detectors and amplifiers. Increases gain and distortion and may produce oscillation.

saturate—To reach the maximum possible value of some quantity, such as magnetization in the core of an inductor or electron flow in a vacuum tube from cathode to plate.

servo-motor—A special electric, hydraulic, or other type of motor used in control apparatus to convert a small movement into one of greater amplitude or greater force.

signal generator—A test instrument providing electrical power substantially similar in amplitude, frequency, and other qualities, to signals found in electronic equipment.

signal tracer—A test instrument for detecting the presence of a signal in electronic equipment and, with some signal tracers, measuring its amplitude, frequency, or other qualities.

superheterodyne—A receiver in which all incoming radio-frequency signals are mixed with the output of an oscillator to produce a heterodyne or beat frequency. The oscillator frequency is variable so that the beat produced with any desired signal can be adjusted to a certain frequency. The beat-frequency signal is fed to a fixed-frequency (intermediate-frequency) amplifier, where greater and more uniform gain and selectivity can be obtained than at the original radio frequency.

superregenerative—A type of regenerative detector in which the tendency to oscillation is controlled by a quenching voltage of ultrasonic frequency which periodically allows the gain to increase, then reduces it. The quenching voltage can be produced by the detector tube itself or by a separate oscillator. This type of detector has great sensitivity, but poor selectivity.

tone control—1. In a radio receiver or an audio amplifier, means provided to change the relative response to audio signals of different frequencies; effects which can be produced are treble boost or attenuation and bass boost or attenuation. 2. In radio control of models, a system wherein the radio signal is modulated by audio tones and control is achieved by keying the modulating tones on and off, instead of keying the r.f. carrier.

v.t.v.m.—Vacuum-tube voltmeter, a voltmeter using one or more vacuum tubes to increase the sensitivity of the basic meter movement, so that measurements can be made in a circuit without drawing much current and without disturbing very much the normal operating conditions of the circuit. May also be a combination voltmeter, ohmmeter, and ammeter. END

ABBREVIATIONS

a.c.—alternating current
a.f.—audio frequency
a.f.c.—automatic frequency control
a.g.c.—automatic gain control
AM—amplitude modulation
amp.—ampere
ARRL—American Radio Relay League
a.v.c.—automatic volume control
BCI—interference with broadcast reception
b.f.o.—beat frequency oscillator
cps—cycles per second
c.t.—center-tapped
c.w.—continuous wave
db—decibel
dbm—decibels above one milliwatt
d.c.—direct current
d.c.c.—double cotton covered (wire)
d.p.d.t.—double-pole, double-throw
d.p.s.t.—double-pole, single-throw
DX—distance
elec.—electrolytic
FCC—Federal Communications Commission
FM—frequency modulation
freq.—frequency
GMT—Greenwich Mean Time
hi fi—high fidelity (of sound reproduction)
hy.—henry
i.f.—intermediate frequency
K—kilo (one thousand)
kc.—kilocycle
M—mega (one million)
ma.—milliampere
mc.—megacycle
meg.—megohm
mike—microphone, microfarad
mil—milliampere
m.o.p.a.—master oscillator, power amplifier
mu—amplification factor
μfd.—microfarad
μμfd.—micromicrofarad
mw.—milliwatt
m.w.—medium wave
PA—power amplifier
p.a.—public address
PM—phase modulation, permanent magnet (speaker)
pos.—position (of a switch)
pot.—potentiometer
pri.—primary
R-C—resistance-coupled
R/C—radio control
rect.—rectifier
res.—resistor
RETMA—Radio-Electronics-Television Manufacturers Association
r.f.—radio frequency
r.m.s.—root mean square
sec.—secondary
SN—self-neutralizing (escapement)
s.p.d.t.—single-pole, double-throw
spkr.—loudspeaker
s.p.s.t.—single-pole, single-throw
s.w.—short-wave
SWL—short-wave listener
sync.—synchronization
t.—turns (of a coil)
trans.—transformer
TV—television
TVI—interference with television reception
u.h.f.—ultra high frequency
v.—volt
v.f.o.—variable frequency oscillator
v.h.f.—very high frequency
VR—voltage regulator
v.t.v.m.—vacuum-tube voltmeter
vu—volume unit
w.—watt
wpm—words per minute
xmtr.—transmitter

ADVERTISERS' INDEX

MAY 1955 ISSUE

RESISTOR-CAPACITOR CIRCUIT QUIZ

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POWER SUPPLY QUIZ

(Questions on page 126)

1. c	2. c	3. c	4. a	5. b
6. b	7. b	8. a	9. c	10. a

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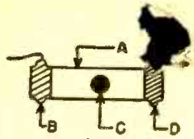
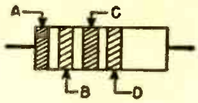


(A)



(B)

RETMA COLOR CODE CHART

COLOR	VALUE	MULTIPLIER
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10,000
Green	5	100,000
Blue	6	1,000,000
Violet	7	10,000,000
Grey	8	100,000,000
White	9	1,000,000,000

TOLERANCE CODE

Gold—±5% Silver—±10%
No Color—±20%

The ohmic value of a resistor can be determined by means of the color code. There are two standard methods of indicating this value.

In Fig. A, the body (A) and end (B) indicate the first and second digits of the value while the dot (C) indicates the multiplier to be used. The tolerance of the unit is indicated by the end color (D). For example, if the body (A) is green the number is 5; if the end (B) is grey the second number is 8. If the dot (C) is red the multiplier is 100 or two zeros should be added. The resistor is then a 5800 ohm unit. If the end (D) has no color, the tolerance is ±20%.

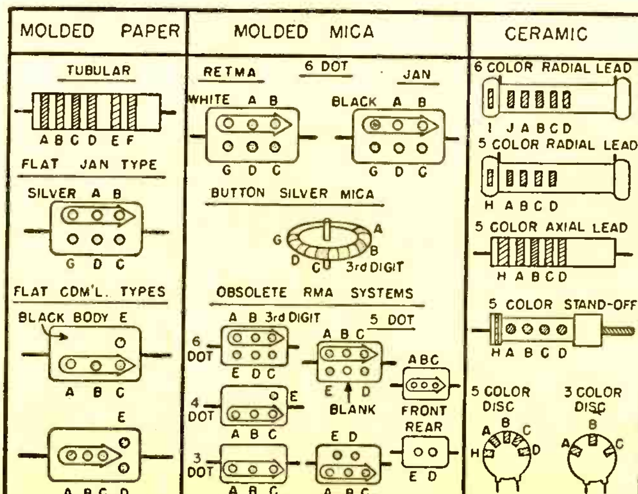
In Fig. B, the first two stripes indicate the first two digits; the third stripe the multiplier; the fourth stripe the tolerance. Thus, if stripe (A) is green, (B) is grey, (C) is red, and (D) is silver, the resistor is a 5800 ohm, ±10% unit.

CAPACITOR COLOR CODE

	MOLDED PAPER		MOLDED MICA		CERAMIC	
Color	Multiplier	Tolerance	Multiplier	Tolerance	Multiplier	Tolerance
Black	1	20%	1	20%	1	20% or 2.0μμfd.*
Brown	10		10		10	1%
Red	100		100	2%	100	2%
Orange	1000		1000	3% (RETMA)	1000	2.5% (RETMA)
Yellow	10,000	5%	10,000		10,000	
Green				5% (RETMA)		5% or 0.5μμfd.*
Blue						
Violet						
Gray					0.01	0.25μμfd.*
White		10%			0.1	10% or 1.0μμfd.*
Gold	0.1	5%	0.1	5% (JAN)		
Silver		10%	0.01	10%		
None		20%				

*Capacitance less than 10μμfd.

Capacitance is given in μμfd. Colors have same values as on resistors, except as indicated in tables. Colors (A) and (B) are for first two digits; (C) is for multiplier. (D) is for tolerance. (E) and (F) give voltage rating in hundreds of volts; (E) is used only for ratings less than 1000 volts, (E) and (F) for first two digits of ratings 1000 volts or more. Values of colors for (E) and (F) are same as in resistance values. (G) is class or characteristic of capacitor, (H), (I), and (J) give temperature coefficient. (G), (H), (I), and (J) are not listed in the tables, since this information is seldom needed by the average home builder.



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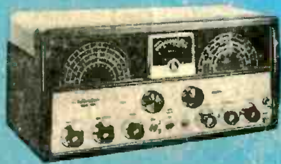

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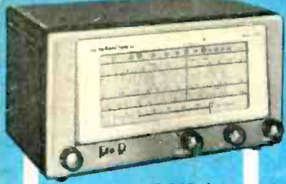

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