PRACTICAL ELECTRONICS

NUMBER 1 • 50 CENTS

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Personal Two-Way Radio

•

Transistor Checker

Make this HOME INTERCOM page 54

SPECIAL HI-FI SECTION

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LOUDSPEAKER KIT
RECORD CARE AND STORAGE
TAPE EDITING
RE-RECORDING
TAPE ERASER
HI-FI IN YOUR CAR

Make this ELECTRONIC FLASH GUN page 24

Make this TRANSISTOR RADIO page 16

Electronic Photo Timer

•

Transistor Amplifer for Telephones

Practical Projects for Home, Ham Shack, Shop and Dark Room

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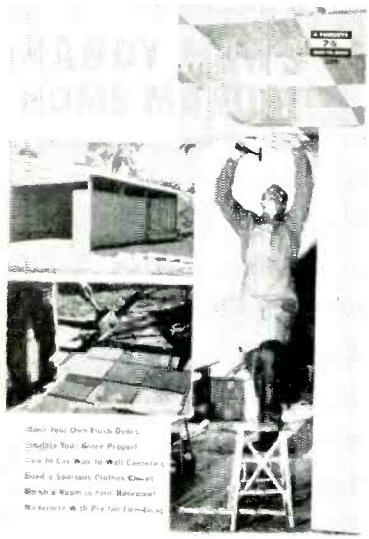

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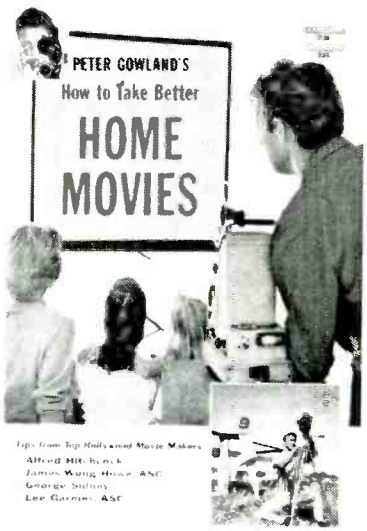

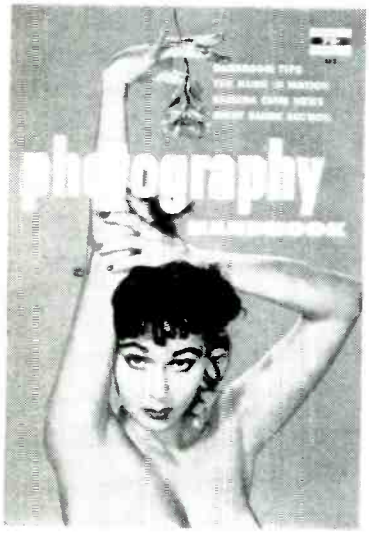

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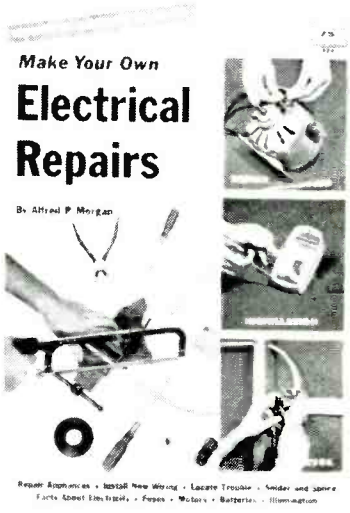

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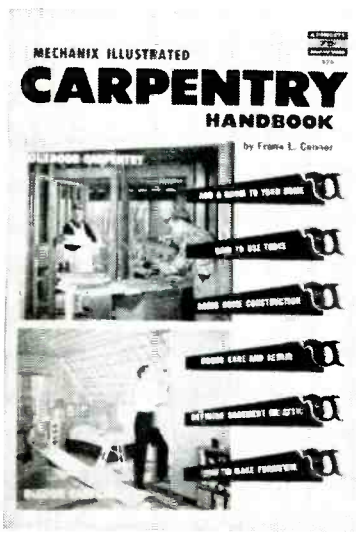

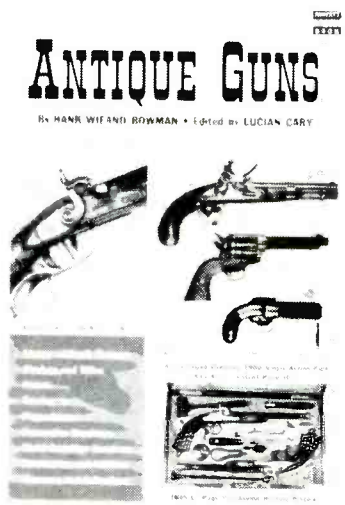

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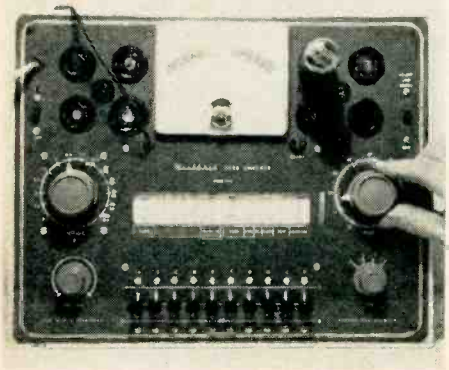

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GET IN ON THE TV BOOM!

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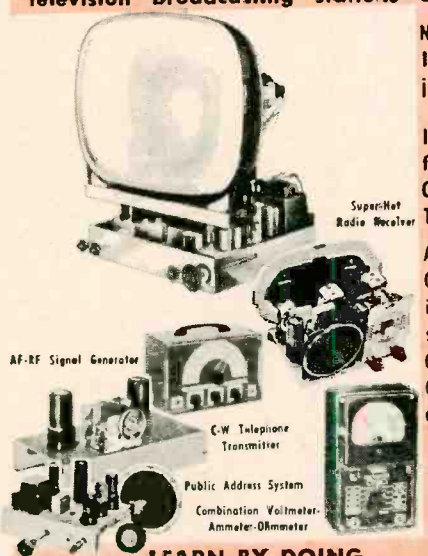
Now, while the boom is on in full force, is the time for you to think about how you can share in the high pay and good job security that this ever-expanding field offers to trained technicians.

Just figure it out for yourself. There are more than 400 television broadcasting stations operating right now and hundreds more to be built; more than 34 million sets in the country and sales increasing daily. Soon moderately priced color television sets will be on the market and the color stampede will be on.

All these facts mean that good jobs will be looking for good men. You can be one of those men if you take advantage of my training *now* — the same training that has already prepared hundreds of men for successful careers in the radio-television-electronics field.



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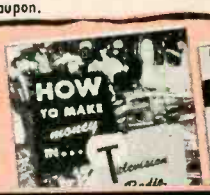

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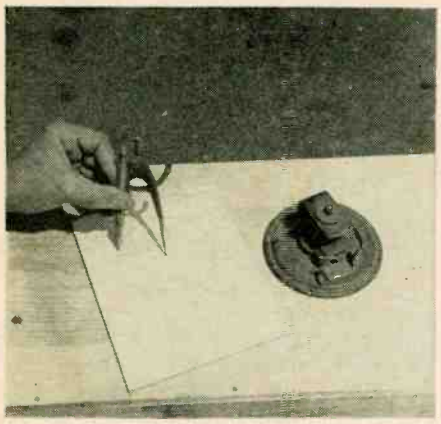
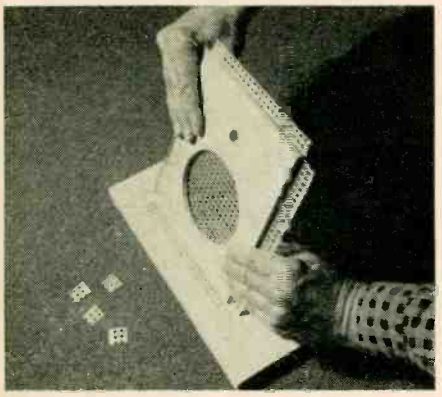
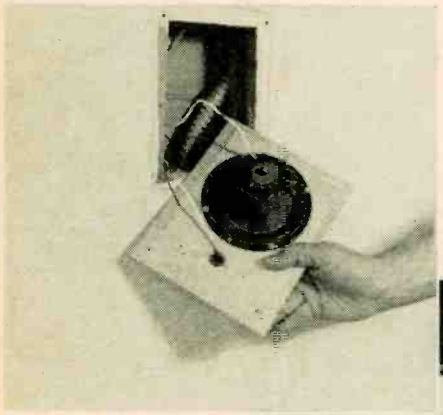
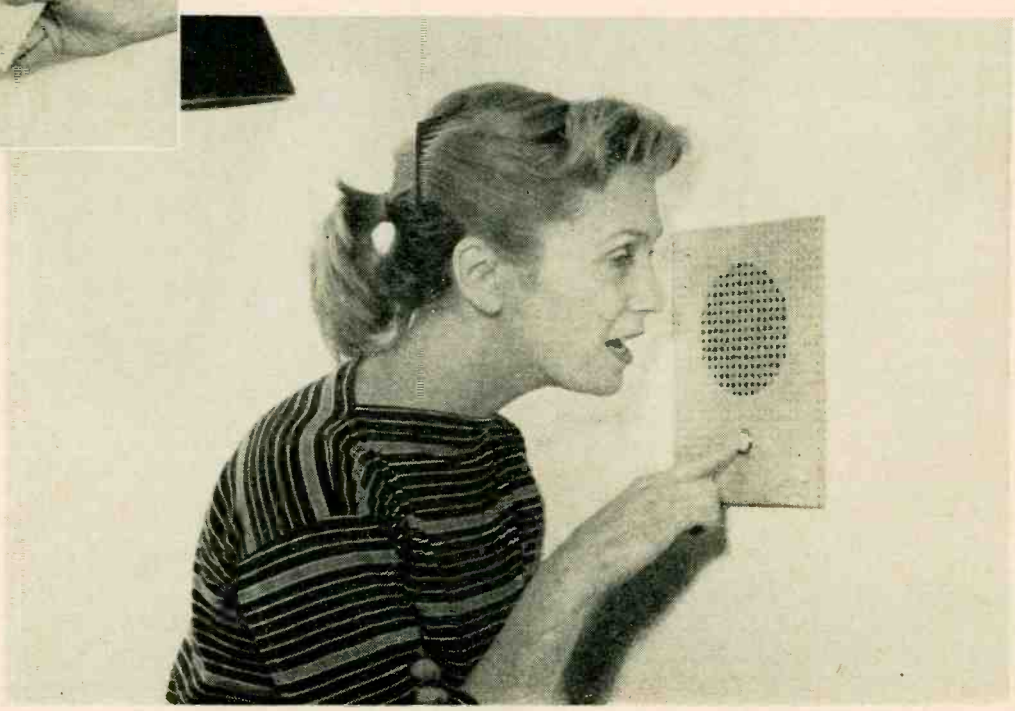






CONTENTS



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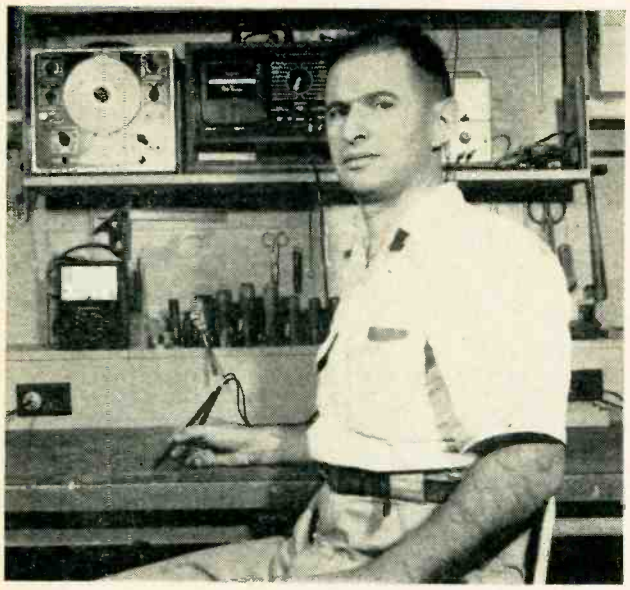

ROBERT HERTZBERG

A man of many interests, Mr. Hertzberg is equally at home with transistors and typewriters, cameras and cutting tools. These varied talents have served him—and a host of readers—well, for he has been by turns (and all combined) an electronic technician, engineer, writer-editor and magazine executive. Formerly editor-in-chief of MECHANIX ILLUSTRATED, Bob now spends his time traveling abroad, paying personal calls on friends acquired via the radio waves, and to writing magazine articles and books. He is well known to readers of the Fawcett specialized-book series for his excellent volumes on TV repair.

DONALD CARL HOEFLER

Mr. Hoefler has been engaged in electronics since it was little more than an after-hours "bull-session" topic for fledgling electrical engineers. He was for several years a flight radio officer with Pan American Airways, and later was associated with Major Edwin H. Armstrong, the inventor of FM radio. He was also a Naval radio instructor, and is currently engaged as sound engineer for RCA-Victor. In this latter post, he has been responsible for a number of innovations in magnetic tape techniques. Don speaks with the authority of broad experience, acquired throughout the United States and Europe.

PETER GOWLAND

Though perhaps best known as a connoisseur of feminine beauty and photographer of motion picture luminaries, Mr. Peter Gowland of Hollywood, has been a regular and frequent contributor to electronics and workshop publications for many years. Representative of his work in these latter fields, is the excellent article, "Four-Station Radio-Intercom," published in this magazine.

Those PRACTICAL ELECTRONICS readers, who are interested in moving-picture cameras, will find Pete's HOW TO TAKE BETTER HOME MOVIES, published in the Fawcett specialized book series, especially rewarding.

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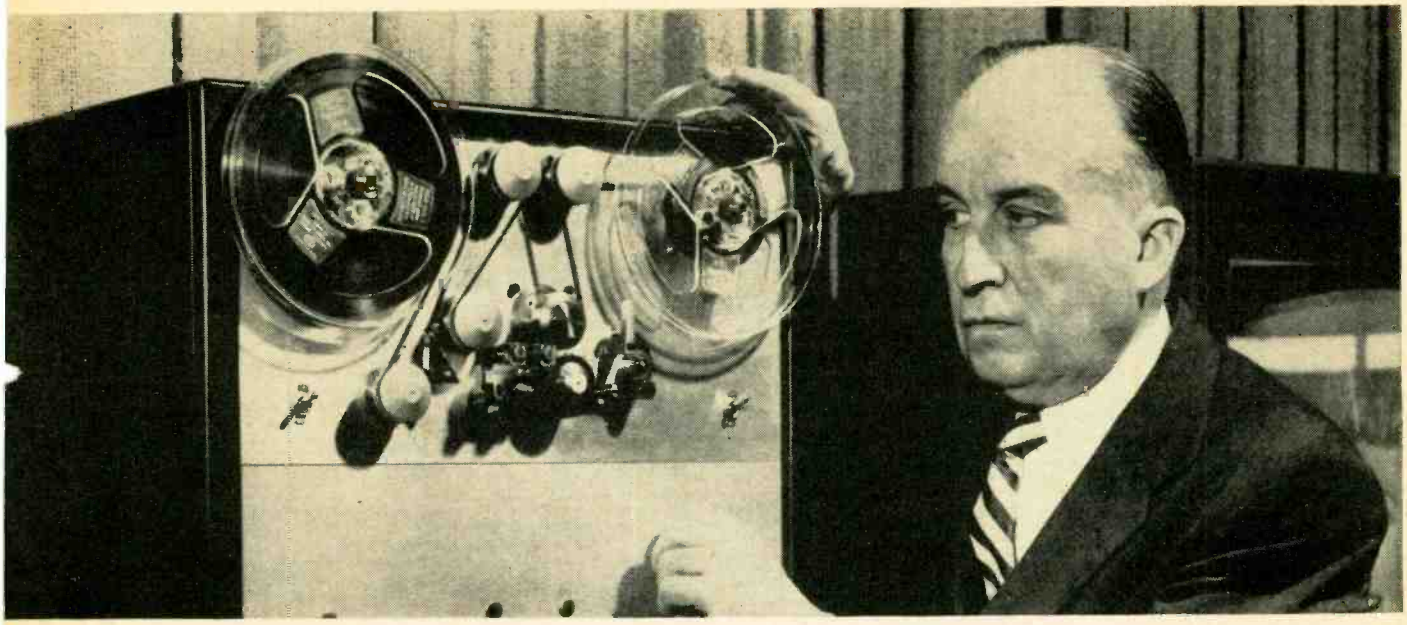
New Developments

A "hear-see" television tape player, electronic air conditioning, and light amplification, are among recent wonders from RCA's labs.

Pre-recorded TV selections are reproduced through a standard black-and-white set with the "hear-see" tape player.



No larger than most tape reproducers is the "hear-see" device, shown with Dr. Harry Olson, director of its development.

FOUR MAJOR DEVELOPMENTS in electronics requested five years ago by David Sarnoff, chairman of the board of the Radio Corporation of America, were presented to him by RCA scientists on October 1, 1956, to mark his 50th anniversary in the fields of radio, television and electronics. These are the new developments:

A room cooled or heated by electronic panels, operating in complete silence and with no moving parts.

A noiseless electronic refrigerator with no moving parts.

A home "hear-see" magnetic tape player which reproduces television programs through standard television receivers.

An electronic amplifier of light which amplifies by up to 1,000 times the brightness of projected light; and a practical application in the form of an amplifying fluoroscope for industrial X-ray use.

Electronic Air-Conditioning System

Demonstrated in a specially constructed room, the RCA electronic air conditioner is described as a truly revolutionary development—an air conditioning system which for the first time operates in complete silence, contains no moving parts, produces no heavy drafts, and can be used either to cool or to heat a room by the simple expedient of reversing the flow of direct electric current.

This system consists of large wall panels which become cold under the influence of direct electric current. With a reversal of the electric current, the same panels produce a heating effect. Employing new materials developed at RCA Laboratories, the system uses no motors, fans, pumps or other moving parts, but achieves room cooling or heating by both radiation and convection—the gentle circulation of air caused by differences in the air temperature. In the small RCA demonstration room used for display, the system is capable of maintaining a room temperature as much as 25 degrees cooler than the temperature outside. Used in reverse for room heating, the system is capable of maintaining a room temperature considerably more than 25 degrees warmer than the temperature outside, according to the RCA scientists.

The air conditioning system and the refrigerators operate on a principle discovered more than 120 years ago by the French physicist Jean Charles Peltier. In the so-called "Peltier Effect," the passage of a direct current through a junction of two dissimilar materials creates a cooling effect at the junction when the current moves in one direction, and a heating effect when the direction of current is reversed.

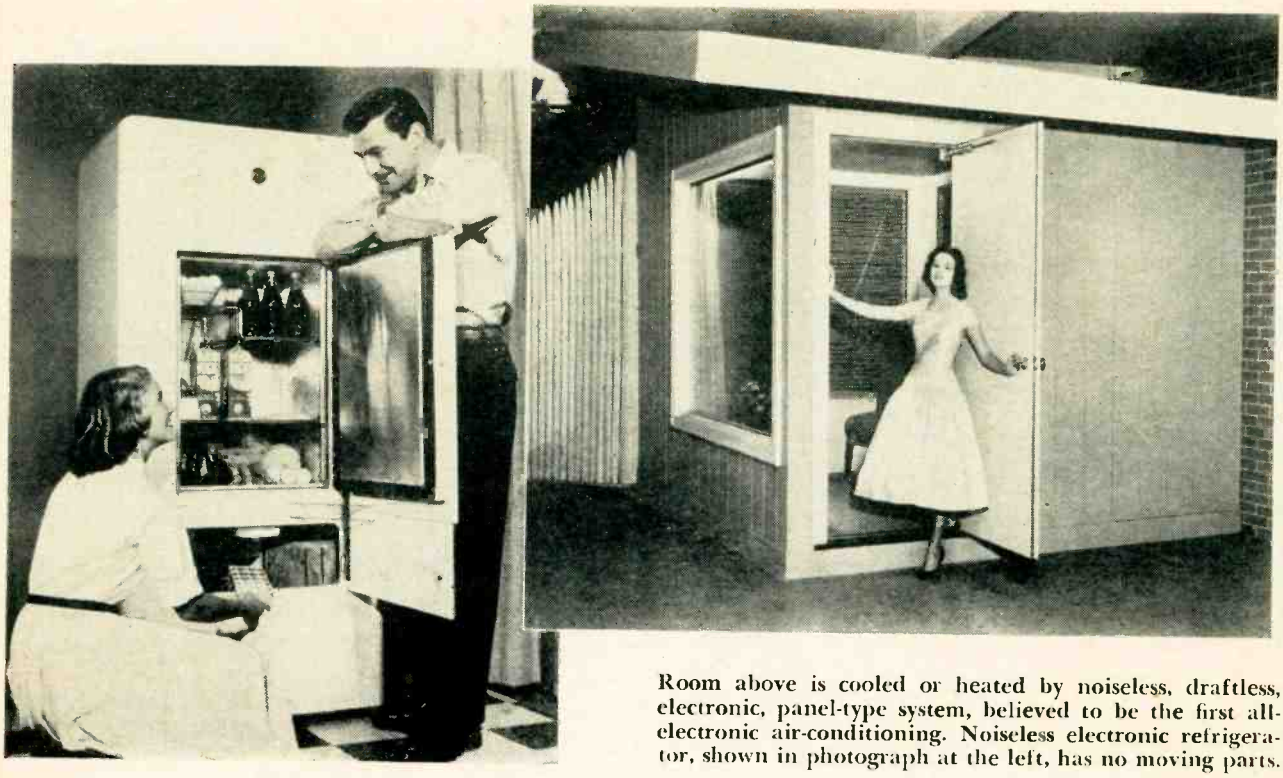
The Peltier effect has been applied in the following fashion to achieve the RCA room air conditioning system:

The passage of direct current through the thermoelectric junctions behind each of the small square plates on the wall panels causes heat to be carried away from the squares. At the other end of each junction is a set of small cooling fins which dissipate the heat. When the system is used for heating, the current is reversed, and the heat is "pumped" electronically into the plates from the air outside the room.

The panels replace a complete section of wall, so that the cooling or heating surface is in the room while the fins are exposed to outdoor air. Since the fins are only 4 inches long, they might normally be adapted to any architectural design by shielding behind a decorative panel.

Electronic Refrigerator

According to RCA scientists this appliance represents another major step toward practical refrigeration in a form which may supplement and diversify the art of refrigeration as we know it today. It operates on principles identical to those of the electronic air conditioning system. The refrigerator has a food compartment of 4 cubic feet, in which a temperature of 40 to 45 degrees is maintained, plus a 30-cubic-inch ice tray in which ice cubes can be produced. Like the air conditioner, the refrigerator is noiseless and has no moving parts.



Room above is cooled or heated by noiseless, draftless, electronic, panel-type system, believed to be the first all-electronic air-conditioning. Noiseless electronic refrigerator, shown in photograph at the left, has no moving parts.

Cooling in the food storage compartment is achieved with an array of thermojunctions similar to those used in the air conditioning system. These are mounted directly on the outside wall of the aluminum cooling compartment, and they dissipate through air-cooled fins the heat drawn from inside the compartment.

The ice tray rests on a slab of copper, to whose underside are attached several thermojunctions. Larger cooling fins are arrayed around the ice compartment assembly for removing heat.

"Hear-See" TV Tape Player

An outgrowth of the research program which developed the RCA tape recorder for color television broadcast use, the new "hear-see" home magnetic tape player for black-and-white television is a development of major significance in the field of home entertainment.

"Adding sight to the sound of recorded selections, this new device heralds the approach of a new era in the recording art," says RCA's Dr. E. W. Engstrom.

The "hear-see" home magnetic tape player for television, housed in a cabinet no larger than a high-quality magnetic tape sound reproducer, can play over a standard television set the pictures and sound of television selections pre-recorded on magnetic tape. Employing reels of various sizes, the player reproduces on the TV set black-and-white TV selections equivalent in running time to phonograph records, from tape only ¼-inch wide. The tape selections are recorded on the previously-developed RCA magnetic tape recording system for black-and-white and color television. Already under way is the next step—reproduction of pre-recorded "hear-see" tape selections in color.

According to Dr. Engstrom, research is in progress on development of a simple recording attachment for the tape player. Such a system, he said, would permit the home user to record his favorite incoming TV programs for repeated viewing, and to make original tape recordings at home for immediate or later playback on the television set.

Developed by a team of scientists and engineers under the direction of Dr. Harry F. Olson, Director of RCA's Acoustical and Electromechanical Research Laboratory, the novel tape player embodies techniques learned in the development of the earlier and larger RCA color TV tape recorder for broadcast use.

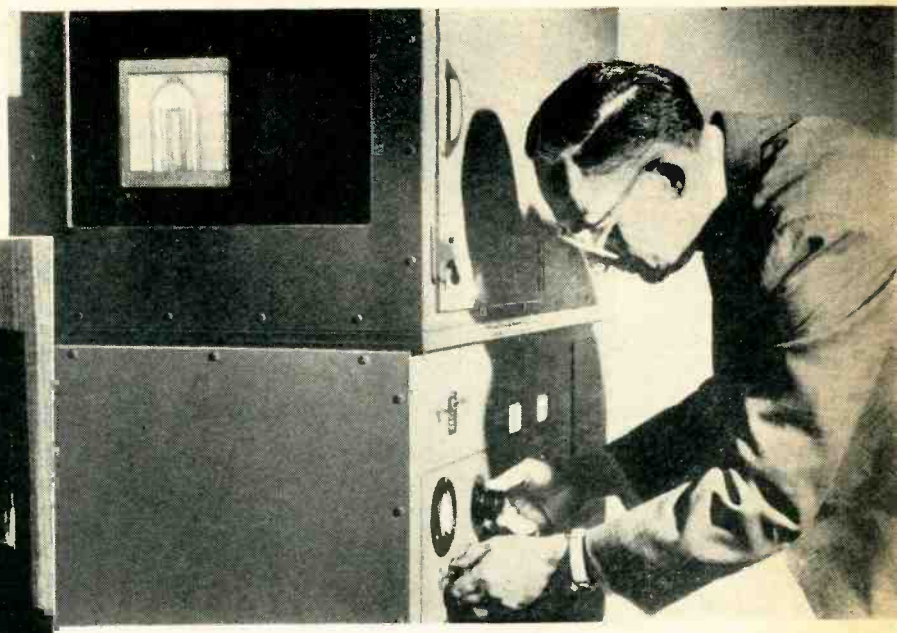
Pre-recorded tapes for the television tape player can be easily produced by techniques already proven in the RCA television tape system for broadcast use, and they can be marketed in the same fashion as standard phonograph records and sound tapes. As television itself has shown, the artistic possibilities of combining pictures with sound are limitless.

Electronic Light Amplifier

The new RCA electronic light amplifier, which can increase by up to 1,000 times the brightness of projected light images, is a development of major potential importance in the field of electronic display techniques.

"An amplifier of this type," says RCA's Dr. D. W. Epstein, developer of the device, "may find wide application in a number of areas. An example is radar viewing, where the observer frequently must cope with dim images, and where persistence as well as brightness are desired. Since the amplifier also converts invisible X-rays and infra-red images to bright visible images, other possible important uses lie in the military field and in astronomy."

Developed from an electronic light amplifier originally developed by Mr. Kazan and Dr. F. H. Nicoll, of the RCA Laboratories technical staff, the new device consists of a thin screen formed by two closely-spaced layers, one of photoconductive material and the other of electrolumines-



Electronic light amplifier, left, increases projected light's brightness 1000 times. Potential lies in electronic display, radar, etc. The amplifying fluoroscope, photograph above, can increase brightness of X-ray image up to 100 times.

cent phosphor. Between these is a very thin layer of opaque material to prevent feeding back of light. The layers are sandwiched between two transparent electrodes, and a voltage is applied across the entire assembly.

In operation, an extremely dim light image falls directly on the photoconductive layer, permitting a corresponding pattern of electric current to flow through to the electroluminescent layer. Under the influence of this current pattern, the electroluminescent phosphor emits light, forming a high-brightness image of the original picture. This process occurs because the photoconductive material acts as an insulator in the absence of light, but conducts current under the influence of light. The electroluminescent material remains dark until it is excited by an electric current, which causes it to emit light.

In a demonstration, an image too dim to be seen clearly by the human eye was projected against the photoconductive layer of the panel from a slide projector. On the other side of the panel, the image appeared as an extremely bright picture of television quality, formed by the light emitted by the electroluminescent phosphor.

The amplifying fluoroscope for industrial X-ray use is an application of the light amplifier with potential uses in a wide range of industrial inspection functions. It displays X-ray images 100 times brighter in greater contrast, and consequently with marked improvement in perceptibility of detail in comparison with present-day fluoroscopic screens. Consisting of a thin panel which can be substituted readily for the conventional fluoroscopic screen, the new device permits viewing of X-ray images in normally lighted surroundings rather than in the darkness needed for viewing by present techniques. Use of the amplifying fluoroscope also makes it possible to reduce X-ray intensity by as much as ten times and still achieve images of satisfactory brightness and contrast for direct viewing.

The ability of the light amplifier panel to convert X-rays to visible light made possible the development of the amplifying fluoroscope. In this application, X-ray shadow pictures falling on the photoconductive layer permit a corresponding pattern of electric current to flow through to the electroluminescent layer, which emits light corresponding to the original X-ray shadow picture.

The gain in brightness, plus the added clarity of the image displayed by the amplifying fluoroscope, will permit far more rapid and thorough X-ray examination of metal welds, castings, loaded ammunition, electron tubes, critical structures, and many other objects which must be inspected without being disturbed or destroyed.

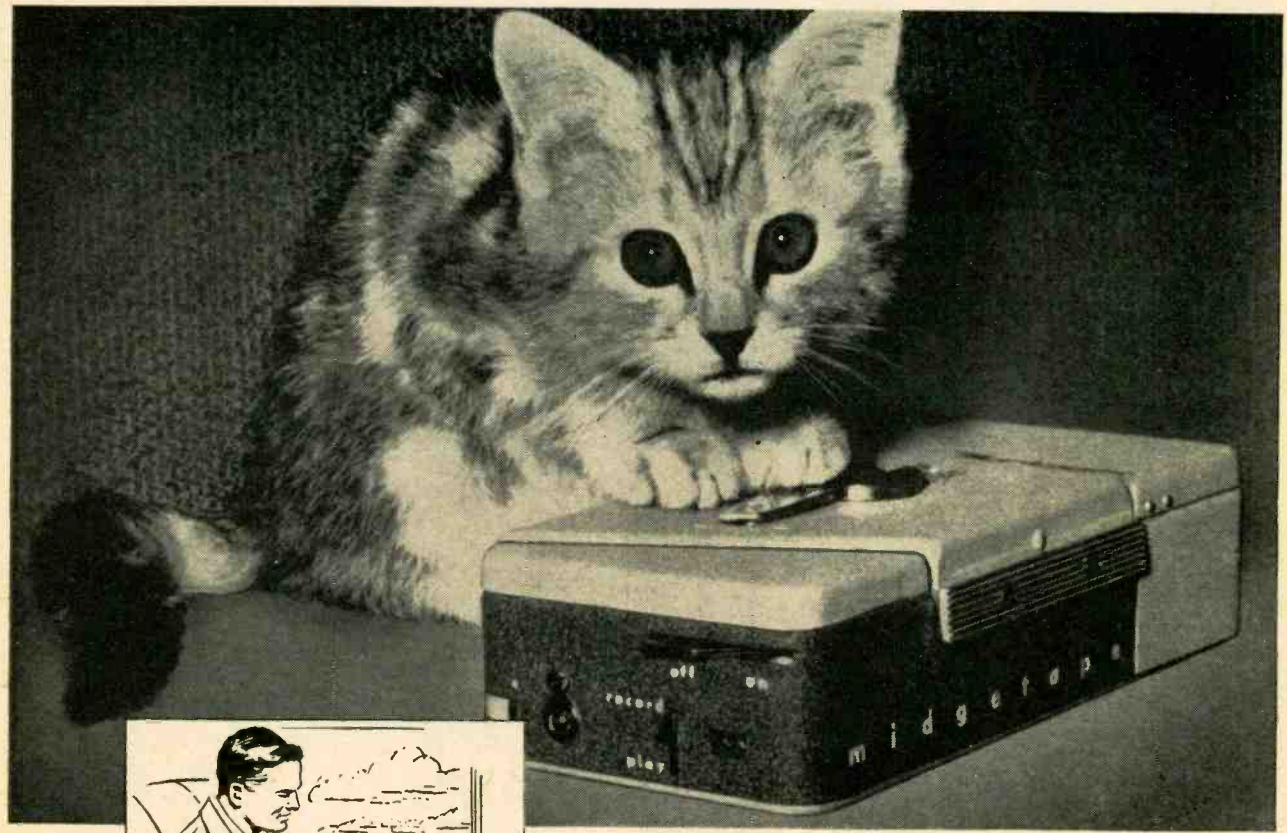
In a demonstration, the amplifying fluoroscope was shown in operation adjacent to a standard industrial fluoroscope screen of the type. Even in a darkened room, the fluoroscopic image on the conventional screen remained almost invisible until the eyes of the observers had become dark-adapted, and the visible image even then remained difficult for the eye to observe in detail. The same image appearing on the new amplifying fluoroscope, however, could be seen clearly and in detail even when the room lights were turned on. The sample examined with both screens was an electron tube.

The panel may be constructed in any desired size. The example shown in the demonstration was a square measuring 6 inches on each side.

Further research is expected to produce a photoconductive material which will respond with sufficient speed to changes in X-ray or light emission, making possible the development of an electronic amplifying fluoroscope for various medical uses. The present device, continues to emit its light for a few seconds after the X-rays have been cut off. This feature in the present device permits its use also wherever it is necessary to obtain an image that will persist for a few seconds after X-ray emission has been discontinued. •—*R. H.*

The Confidential Sound Recorder

The practical uses for these new pocket-sized recorders are almost unlimited.



American-designed "Midgetape" offers improved quality but limits the uninterrupted recording time to half an hour.

With miniature recorder, executive may dictate while en route to office.

Important telephone conversations can be recorded, considered later.

"LADIES AND GENTLEMEN," said the newsman, "for the next 47 seconds your TV screen will be absolutely dark. It will be dark not only because of the clandestine conditions surrounding the recording you will hear, but also because it will symbolize the bleakness of our city's future. Bleakness because of the tantilizing and tragic prospect of excitement through narcotics, drugs which even this very moment could be offered to your son or daughter by the most vicious elements this city has ever known. Listen."

As the screen darkened, those next 47 seconds galvanized the entire population of a midwestern city into action. For what they heard was purported to be an actual on-the-spot recording of a narcotics sale between a dope "pusher" and a drug addict, with the newsman playing the part of the youthful addict.

But the only part of this recording which was pure fakery was the newsman's acting. He actually *had* gained the confidence of the peddler, and he *was* buying dope, and he *did* in fact make an actual sound recording of the conversation which took place during one of these sales.

The manner in which the recording was made is a little

known by-product of the development of magnetic (wire and tape) recording. Today there are available recorders small enough to conceal in a coat sleeve, in a trouser leg, under a skirt, or even in a pocket. Microphones can be concealed under a necktie, in a tie clasp, or even—shades of Dick Tracy!—in a wrist watch. It is also possible to record both sides of a telephone conversation, without those annoying beeps.

To learn what has been going on here, we have to go back a few years. The time: World War II. The place: Nazi Germany.

The first inkling the Allies had that Herr Hitler's boys must have come up with something rather sensational in sound recording, came through listening to enemy radio broadcasts. There was a certain newscaster whose invective from Berlin was of particular interest to members of the Allied command. He was suspected of rather intemperate personal habits, and sometimes on the air he would seem to depart from his carefully-censored script and pass remarks which were nuggets of information for the enemies of the Axis. No one on our side ever thought he was *trying* to be friendly, but they welcomed his indiscretions all the same.

But as all good things must end, so suddenly, did this unexpected help. Never again did the radio oracle depart from the tortuous line of Nazi propaganda. But then something new appeared to puzzle the monitors. Although this spieler was regarded as an excellent speaker, even when well in his cups, there now were occasionally very embarrassing gaps in his delivery. Since "dead air" is the cardinal sin among broadcasters the world over, this new tack was completely baffling.

Finally an observant American corporal, who had been monitoring the broadcasts for many months, noticed another change in these broadcasts, that they were now consistently fifteen seconds late in reaching the air. But what possible connection could there be between delayed starts and occasional long pauses in the middle of the broadcasts? He pondered the question for days. He lay awake nights in the darkened barracks trying to fit the pieces of the puzzle together. Why had this heretofore unpredictable newscaster from Berlin suddenly become so absolutely reliable? Why was his program always late in going on the air, and always by the same amount? What was the explanation for those very long periods of dead air? At last, well after lights out one night, he thought he had the answers. But it would be some time before he could prove it.

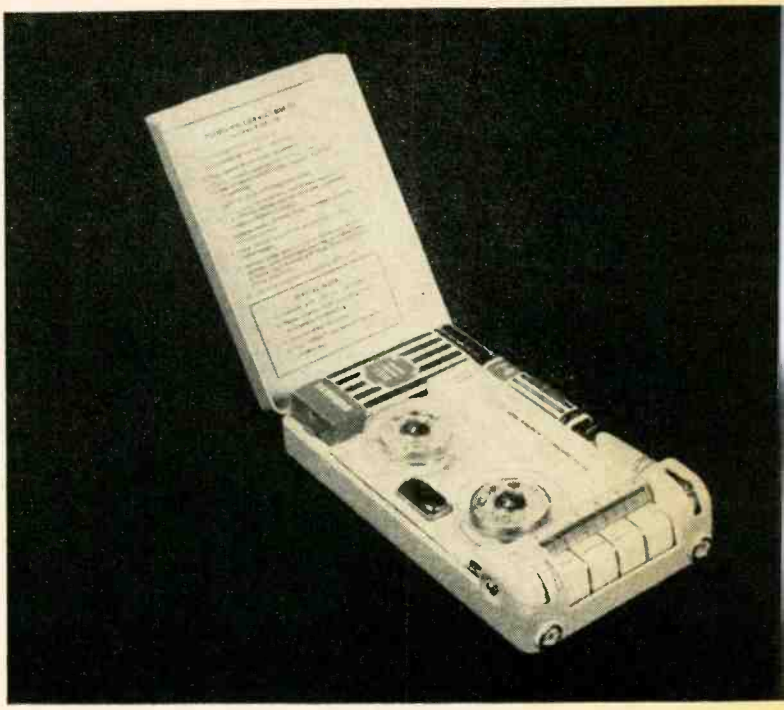
Knowing he had nothing to lose, however, he outlined the idea to his commanding officer. Suppose, he argued, the krauts had a way of *delaying* sound, of hearing it before it went on the air, and even of killing it before it were broadcast if it should be objectionable. This *could* jibe with the known facts. The only trouble was, no one had ever heard of a way to store sound for fifteen seconds, and then either release it to go on its merry way, or relegate it forever to oblivion.

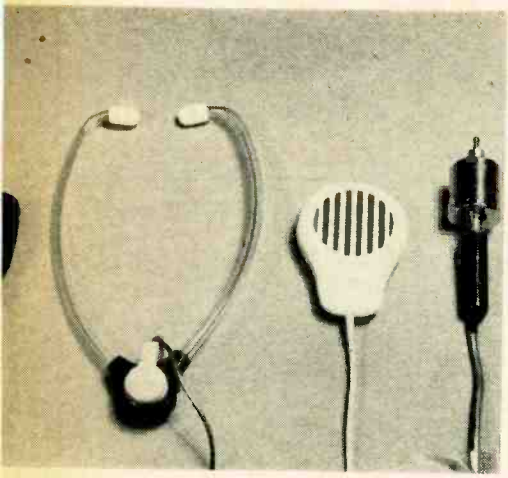
By the time the corporal was proven right, the newscaster's voice had long since disappeared from the air, and he, probably, from the face of the earth, poor fellow. But when a retreating Nazi demolition team had botched its job, and the Americans captured an enemy radio station intact, they saw a piece of apparatus which to them might well have come out of a science-fiction novel.

That discovery was the very foundation of what has become the burgeoning magnetic recording industry in America today. And the corporal's theories, incidentally, proved absolutely correct. By placing a considerable distance (and therefore time) between the record and playback heads of a magnetic recorder, the Nazis were able to use a censor who did his job just as the news was broadcast. The censor listened to the words of the newscaster, whose voice at that instant was not going on the air but only into the magnetic recorder. If ever he said anything which was out of line, the censor simply opened a key before the signal reached the playback head, so that that part of the signal never got on the air.

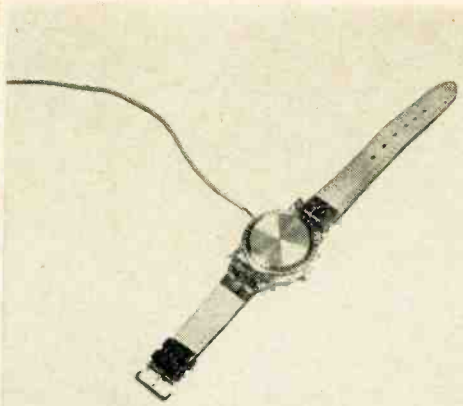
Employing wire, rather than tape, German-made "Minifon" is smallest and longest-playing of miniature recorders.

Standard recording time of the Minifon is 2½ hours, but this may be increased to 4 hours by a simple modification.





Minifon accessories: telephone lead, stenographer's headset, mike-speaker, and playback jack that plugs into radio or TV set.



Another of Minifon's accessories is this wrist-mike—evidence that Dick Tracy has a following among the German designers, too.

When worn, the wrist-mike appears only as a handsome chronometer making the pocket-size Minifon a confidential recorder indeed!

The Germans had no faith in anyone at that time, it seemed, for they had also developed a completely secret miniature recorder, which enabled them to snoop on their own members who were suspected of deviation. It also was used in espionage, but obviously with a great deal more difficulty.

An improved model of this secret recorder is today being manufactured in Hamburg, Germany, and is readily available to anyone in the United States through Lincoln Electronics, Lincoln Building, New York 17, N. Y. And it is performing more *sub rosa* jobs than its inventors ever thought of. Lawyers and private investigators are using it to obtain evidence for clients. Although such evidence is seldom admissible in court, when a person is confronted with a complete transcript of his very own words, a court trial often becomes unnecessary.

Law enforcement officers everywhere are using it, not so much for trial evidence, as for fact-gathering. If the investigator is in direct contact with the suspect, he may conceal the recorder on his person. If not, he may be able to hide it in the subject's room, or to arrange a telephone wire tap. Due to its extremely small size, the miniature recorder can be hidden almost anywhere. It is truly an amazing example of the art of miniaturization.

The original German prototype, now sold in this country as the *Minifon*, is both the smallest and the longest-playing of several such types now available. It measures only 1⅜x3⅞x6⅝ inches and weighs a mere pound and three-quarters. Standard recording time is 2½ hours, although this may be increased to 4 by a simple modification which slows the motor speed.

Not all of the applications of miniature recorders are cloak-and-dagger stuff, of course. On the contrary, most of the recorders sold are employed for perfectly ordinary business uses. Even then, however, some of the side effects of these remarkable devices, the Minifon and Midgetape, can be extremely exciting.

There is a world-famous medical researcher, for example, who now does all of his corresponding by recording while riding the commuter train between his home in Connecticut and his laboratory in New York. He figures he used to spend two hours every day in such routine chores. Now this work is done even before he enters the office. As soon as he walks in, he hands the recorder to his secretary and proceeds to the laboratory. That saving of two hours a day means at least ten hours a week, 520 hours a year. Who knows how many lives may be saved by some great medical discovery being made that much sooner, all due to the time saved by a miniature recorder?

The American versions of minicorders use tape as the recording medium, while the Minifon uses wire. Since the tape is at least one mil thick and a full quarter-inch wide, while the wire is only two mils in overall diameter, it stands to reason that a lot more wire than tape can be crammed into a small space. This is the reason for the Minifon's tiny size yet tremendous capacity.

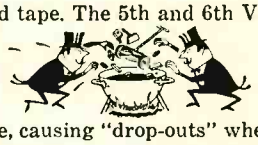
The Midgetape, an American design, uses a standard tape cartridge, with a tape speed of 1⅞ inches per second. Its size is 1⅞x3⅞x8½ inches. The use of tape provides improved quality and better signal-to-noise ratio, but it limits the uninterrupted recording time to a half-hour. Since the Midgetape employs a manual crank rewind, rather than motor rewind as in the Minifon, along with a long-life mercury battery, it does require less frequent replacement of batteries. It would seem, then, that the choice of a miniature recorder will depend largely upon its intended uses.

A large portion of this book was dictated to a Minifon by the author while riding a train between his home in Bucks County, Pennsylvania and New York City. The Minifon's outstanding features of portability and recording time made it the obvious choice for me. But another fellow of our acquaintance likes to tinker with automobile engines, and he uses a Midgetape to record the operating sounds of its various parts. Since fidelity of sound is very important to him, and his commutation runs are relatively short, he chose the tape job.

But we've never seen anyone who, after spending just a few minutes with a miniature recorder, can't think of literally dozens of things to do with it. Some at home, some on the job, some humorous, some slightly larcenous, and some just for fun. Try one. They grow on you. •—*D. H.*

The 7 Old-Fashioned Villains of Tape Recording

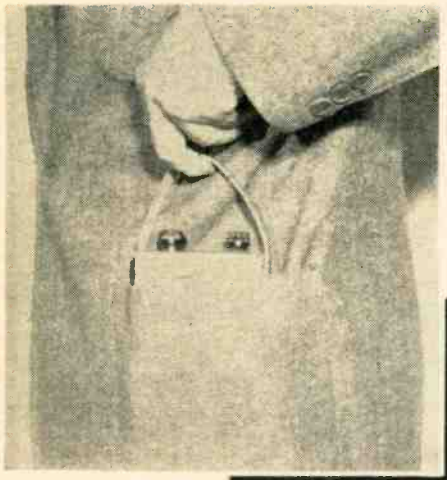
...and How irish BRAND FERRO-SHEEN Foiled Them All

Once upon a time, 7 Old-Fashioned Villains like this  were wreaking endless woe on Decent People with Tape Recorders. The 1st Villain was Oxenscheid the Oxide Shedder.  He scraped away at the crumbly oxide coating of old-fashioned tape and gummed up tape recorders with the shedding particles. The 2nd Villain was Wearhead the Head Wearer.  He filed down the magnetic heads with the abrasive coating of old-fashioned tape. The 3rd Villain was Frickenshaw the Frequency Discriminator.  He dragged down the high-frequency response of old-fashioned tape through inadequate contact between the "grainy" coating and the head. The 4th Villain was Noysenhiss the Noise Generator. He generated tape hiss and modulation noise  as a result of the random vibrations and irregular flux variations caused by the uneven magnetic coating of old-fashioned tape. The 5th and 6th Villains were Dropofsky the Drop-Out Artist and Pringlethorpe the Print-Through Bug.  They put nodules and agglomerates into the oxide emulsion of old-fashioned coated tape, causing "drop-outs" whenever these trouble spots lost contact with the record or playback head, and inducing "print-through" on the recorded tape when the extra flux at the trouble spots cut through adjacent layers on the reel. The 7th Villain was Brattleby the Embrittler. 

He dried out the plasticizers in old-fashioned coated tape and embrittled irreplaceable recordings. Then: OCTOBER, 1954! That's when a very un-old-fashioned little man by the name of F. R. O'Sheen  announced that he had developed the revolutionary new **irish FERRO-SHEEN** process of tape manufacture and presto!  the 7 Old-Fashioned Villains were sent a-scurrying with cries of "Confound it – Foiled again!" Yes, F. R. O'Sheen had made the new magnetic oxide lamination of **irish FERRO-SHEEN** tape so smooth-surfaced and non-abrasive, so firmly anchored and homogeneously bonded to the base, so free from nodules and agglomerates, that the 7 Villains were evicted – for good! **Moral:** Don't let Old-Fashioned Villains do you out of your hi-fi rights!  Just say "No, thanks" to ordinary coated tape and ask for F. R. O'Sheen **irish FERRO-SHEEN**, that is! ORRadio Industries, Inc., Opelika, Alabama.

Pocket-Size Transistor Radio

In just one evening, you can build this miniature portable radio yourself from a simple kit. Completed, it's small enough to fit inside a pocket or purse.



The transistor radio occupies only about half of an ordinary coat pocket. Its chassis fits in a small leather carrying case.

IMAGINE A TRANSISTOR RADIO so small that it can be carried in a coat pocket or purse, and so sensitive that it picks up World Series broadcasts in the New York subway! This remarkable little receiver is fun to use and to demonstrate, not merely because of its performance, but also because you can usually stun friends with the casual statement,

"Oh, it's just something I threw together in an evening."

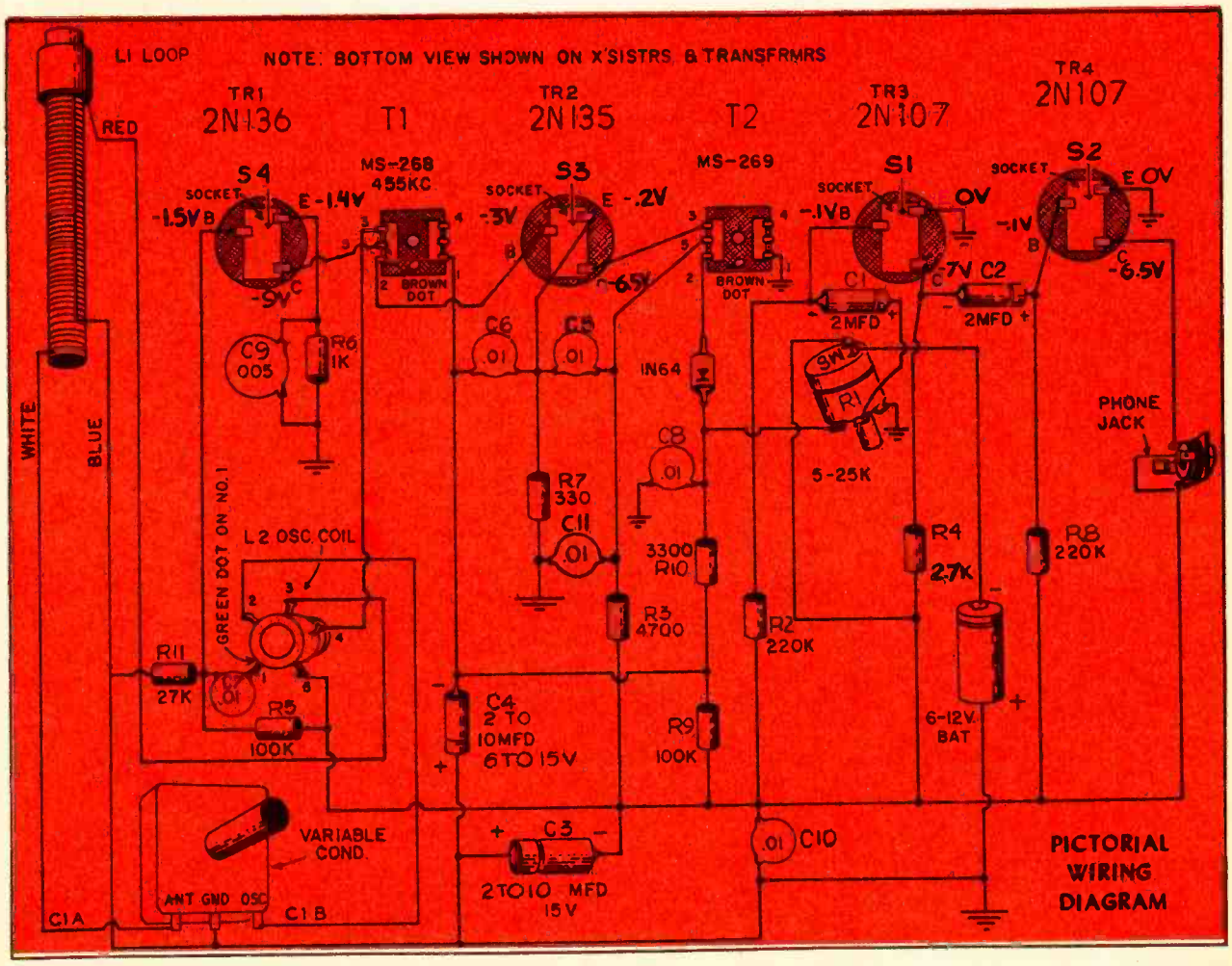
And you'd be telling the truth. Known as the "KT-94" and put out by Lafayette Radio of New York as a complete kit, the set is a simple and highly satisfying kitchen-table project. A punched and formed chassis, measuring all of 3¼ by 4 inches, holds the miniaturized components. Assembly of the latter takes about fifteen minutes. The real work is the wiring, which must be done with care and a very slender soldering iron because the parts are small and close together.

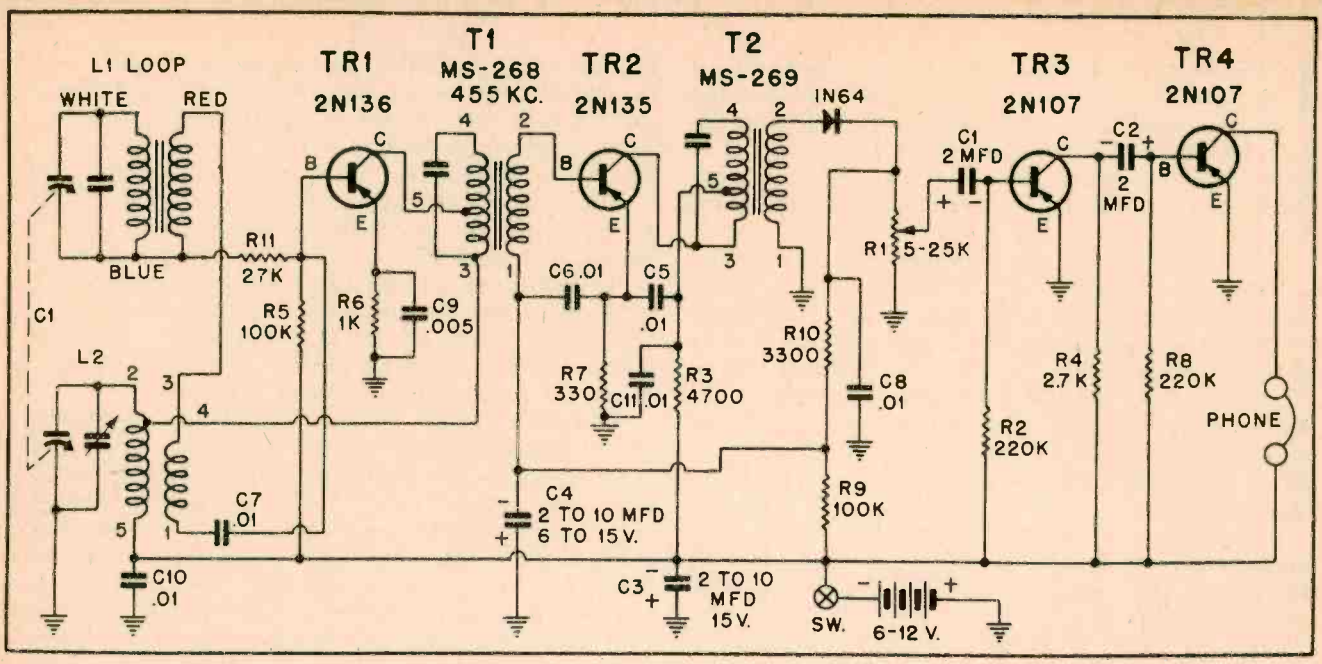
The chassis, complete with its own 9-volt battery, slides snugly into a leather carrying case. All that shows on the top are two small knobs for tuning and volume control, and an earphone jack.

The KT-94 derives its "sock" from its full superheterodyne circuit. This uses four transistors and a germanium diode, and a built-in "loopstick" antenna. The latter is slightly directional; that is, the case must be turned back and forth a little to bring in stations at maximum volume. All the energy required by the transistors is furnished by a single dry cell of a new type, developed especially for transistor service. Although it is about the size of a common "C" size flashlight battery, it is rated at 9 volts rather than 1½, and has both long life and excellent recuperation. The writer inadvertently left his KT-94 on from a Saturday night to the following Monday morning, and thought surely it would need a new battery. However, after the set was turned off and the battery allowed to rest for an hour, it bounced right back with its original pep. The total current drain from the battery, by actual measurement, is only 8 milliamperes; that is, 8 thousandths of an ampere.

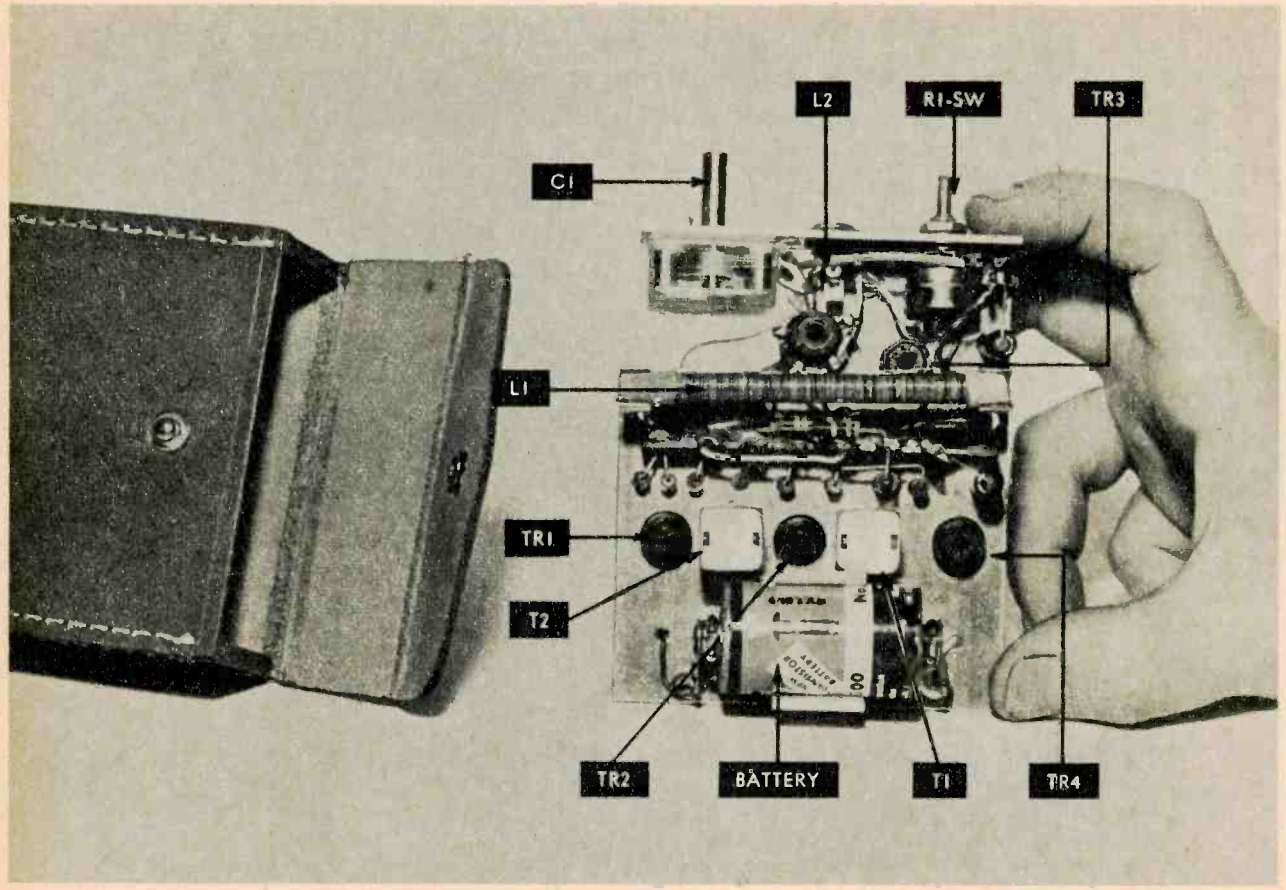
In its basic form, the KT-94 is intended for earphone operation with a single ear piece of the hearing-aid type. As such, it can be used in complete privacy.

On local stations the volume is usually great enough to permit the attachment of a small loudspeaker, in place of the earphones. However, if full loudspeaker operation is desired, it is better to use the KT-96. This is a combination of a two-inch dynamic loudspeaker and a two-transistor push-pull audio amplifier stage, all complete with its own battery in a red plastic case just about the size of a package of ordinary cigarettes. A cord with a miniature phone plug on each end connects the earphone jack of the receiver to the input jack of the KT-96. The battery circuit of the latter goes on automatically when the plug is inserted in the jack, and off when it is removed. The output of the tiny "squawk box" is enough to fill a whole apartment. The sound is somewhat tinny, as you might expect from a small speaker, but speech is reproduced very well. •—*R. H.*

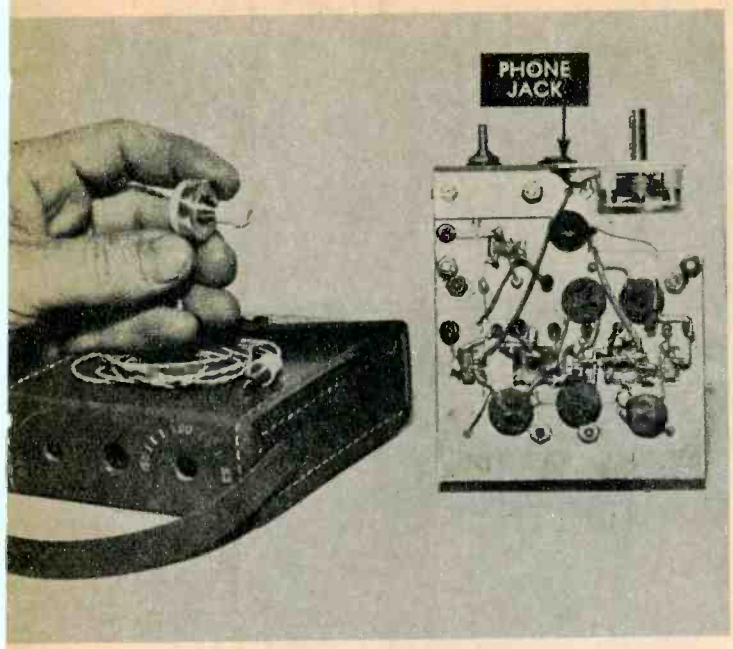




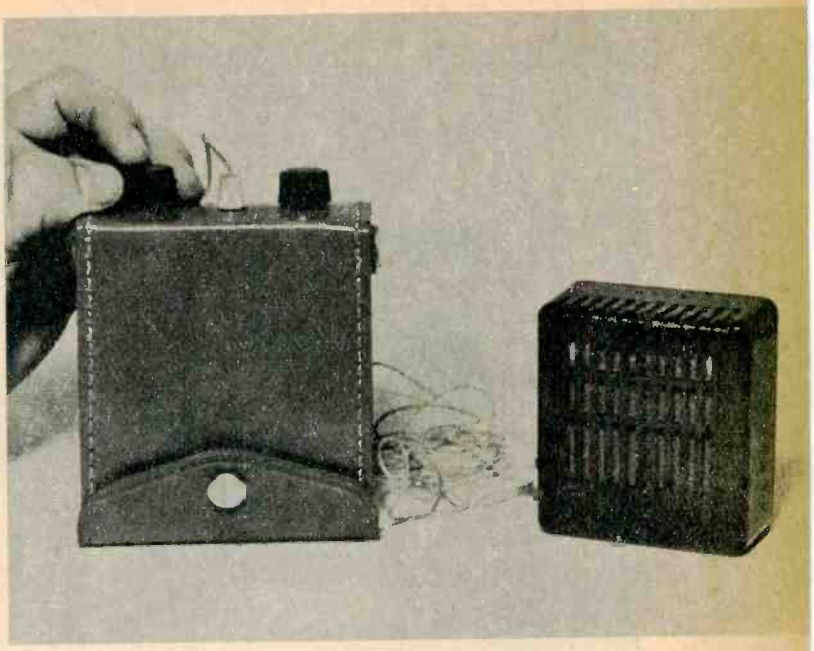
Above is a complete schematic diagram of the transistor portable radio. Arrangement is conventional, time-tried superheterodyne. "1N64" is germanium diode, used as second detector. Switch SW is combined with volume control R1.



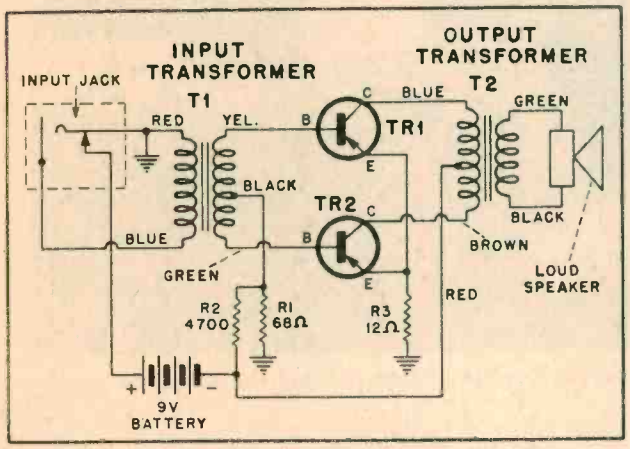
This is a top view of chassis, removed from carrying case, with parts marked to correspond with schematic diagram. Battery has snap connectors and fits in U-shaped clip. Other parts are very small. Transistors are size of an eraser on lead pencil. Tiny transformers T1 and T2 measure merely ½ inch square by ¾ of an inch in height.



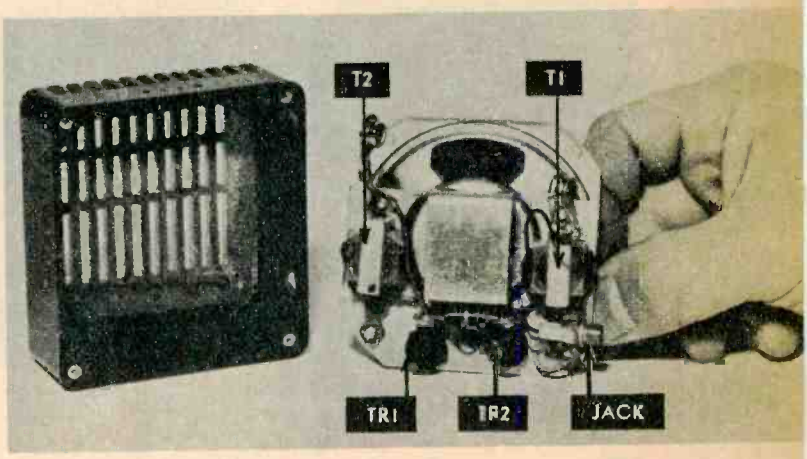
At right is underside of chassis. Round objects are small fixed capacitors. Hand resting on leather case holds earphone with its soft rubber end piece which fits in the ear.



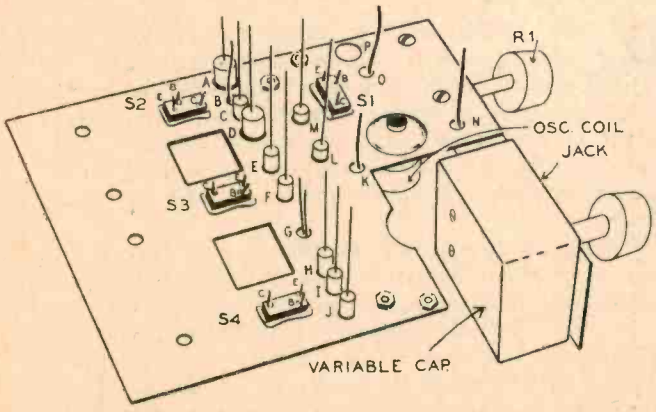
Loudspeaker unit on right contains its own amplifier and connects to receiver proper by a flexible cord. Speaker measures 2¾x3x1¼ inches; set, 3¾x4¼x1⅜ inches.



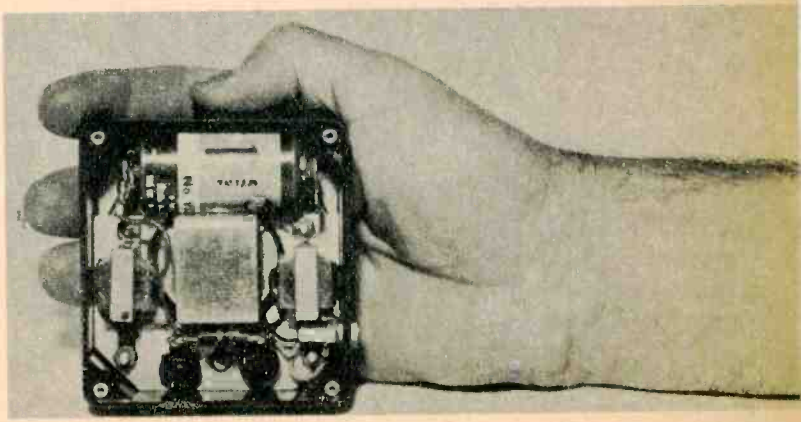
Hook-up of loudspeaker box is very simple. Battery circuit is controlled by input jack. On transistor symbols TR1 and TR2, "B" is base, "C" collector, "E" emitter.



Two-transistor amplifier is built on chassis that surrounds the end of the tiny loudspeaker. Shown here is amplifier unit out of the carrying case and with the battery removed.



Wiring is simplified by having various small resistors and capacitors, lettered A through M, sitting vertically in holes in chassis. Pig-tail leads go to next soldering point.



With the back panel of the loudspeaker box removed, complete unit is shown with the battery in position. Unit is so small it can actually be concealed in palm of hand.

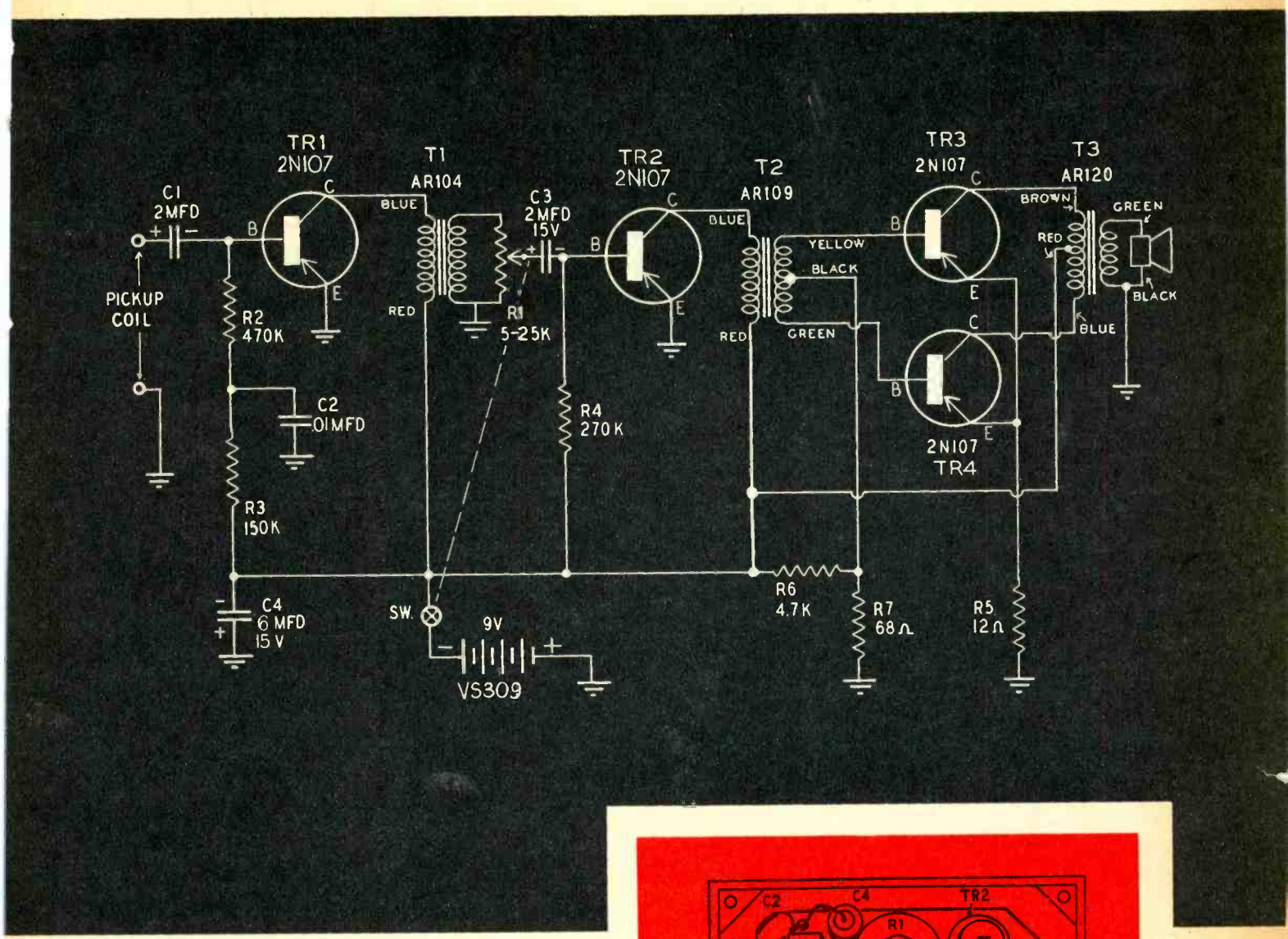
When the tiny new amplifier is utilized, listening is not restricted to the person holding the telephone receiver.

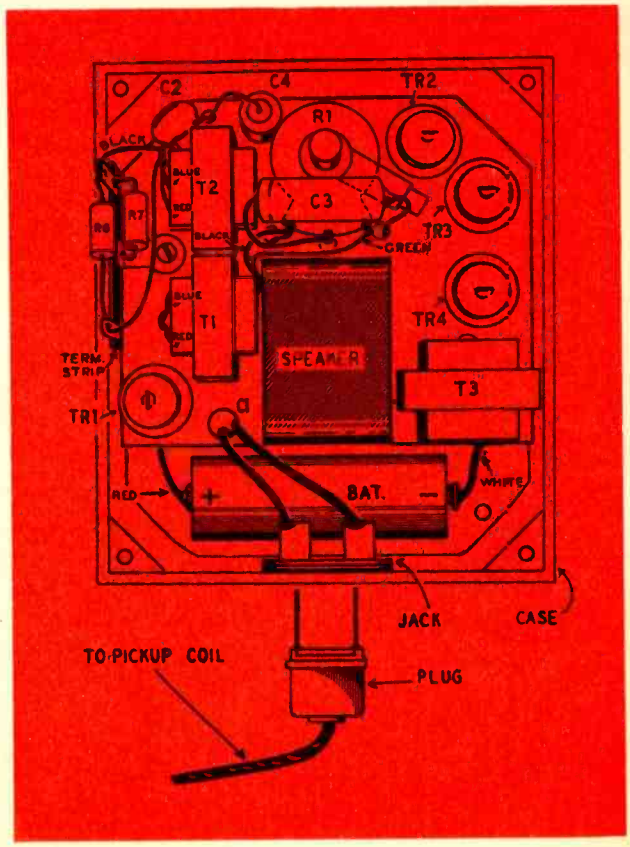
Transistor Amplifier for Telephones

There's no need to repeat the other end of your conversation for your family—you can buy a handy amplifier in kit form.

DO YOU EVER MAKE or receive a long-distance telephone call to or from a dear friend or relative, and then repeat the conversation several times for the benefit of other members of the family as they stand around anxiously? This is not only an unsatisfactory method of group communication but also an expensive one, as the overtime charges build up each time the phone is handed to another person.

A unique little transistor amplifier, sold in kit form by Lafayette Radio of New York, puts an end to the problem. Existing telephone wires and equipment are not disturbed in any way. The only connection between the phone and the amplifier is a magnetic one, and takes the form of a flat pick-up coil measuring 4½ by 1½ inches by ¼ inch thick. This is merely placed next to or under the phone (the best position is determined by experiment), and the amplifier then reproduces conversations through a small loudspeaker.



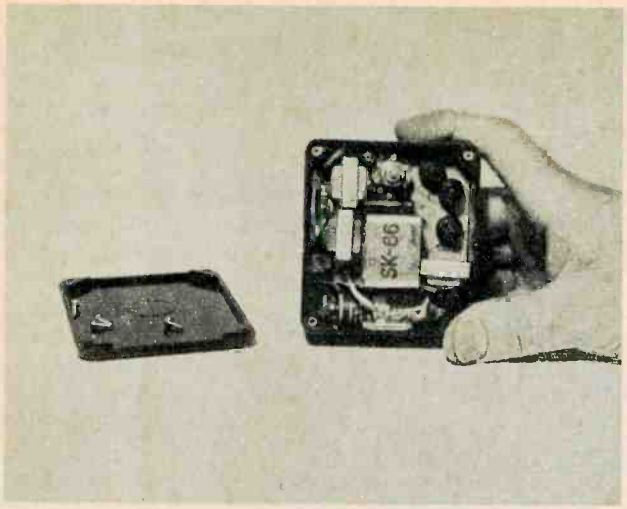


Circuit of telephone amplifier is conventional and straightforward. The letter "K" after resistor values indicates 1,000; therefore "150K" means 150,000 ohms. Pictorial wiring diagram shows parts marked as in schematic above.

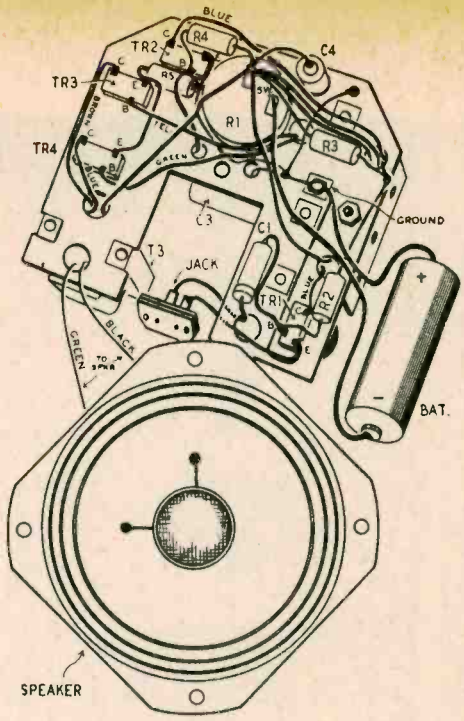
What makes the amplifier-speaker combination so unusual is its size. In a molded plastic box measuring only 3¼ by 2¾ by 1⅜ inches overall—a mere handful—are neatly fitted the following: a three-stage, four-transistor audio amplifier, a two-inch dynamic loudspeaker, and the nine-volt battery that powers the whole thing. The entire amplifier is built onto a horseshoe-shaped little chassis that surrounds the loudspeaker. On the chassis are three thumbnail size transformers and a combination switch-volume control.

Assembly and wiring are simple, but require close care because of the size of the parts.

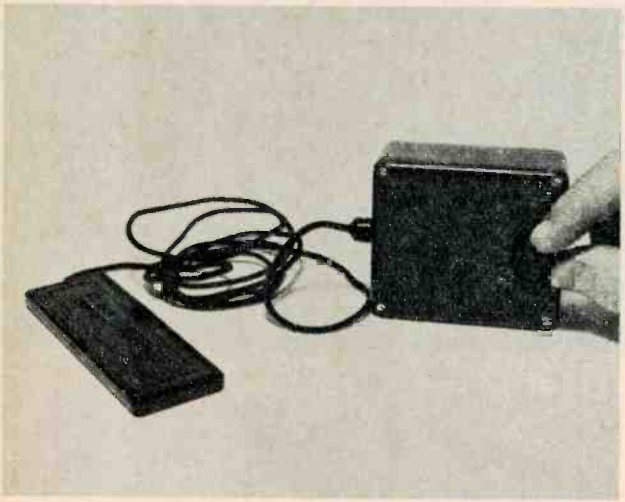
The performance of this amplifier is little less than incredible. With the pick-up coil properly placed, the volume is usually enough to overload the loudspeaker, and must be reduced by means of the control. In the quiet of a home, a whole roomful of people can listen to a conversation. In an office, "conference calls" can quickly be arranged.



Remove back cover of case to see amplifier. Center section marked "SK-66" is loudspeaker end. Battery is at bottom.



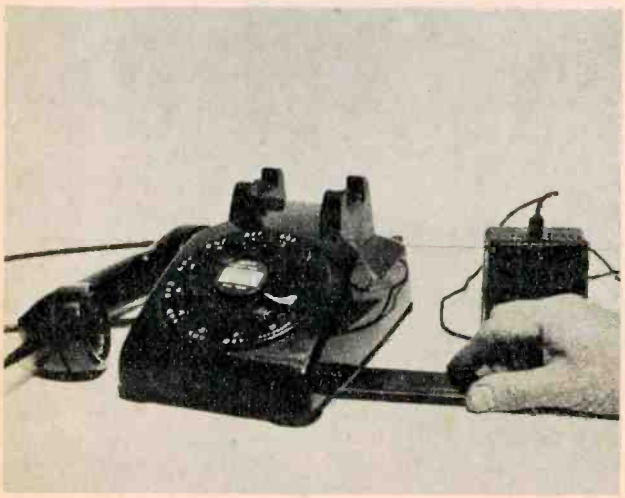
Under-chassis wiring of amplifier is shown in the diagram above. Special amplifier chassis is furnished with kit.



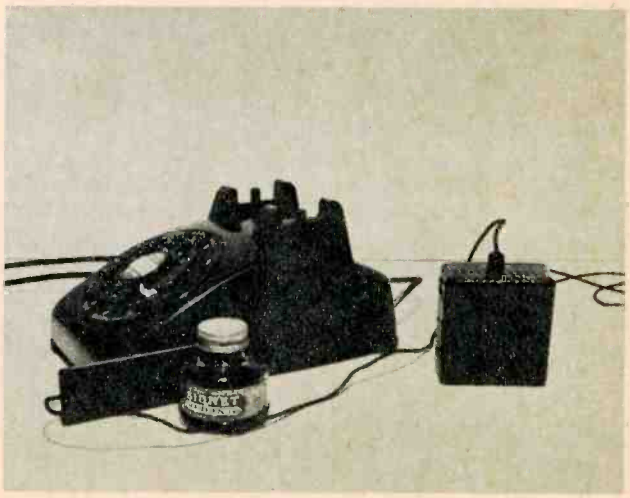
Knob at right end of amplifier case is for combined switch-volume control. Telephone pick-up coil leads to input.

Because the unit is self-powered and is ready for use an instant after the switch is turned on, initial demonstrations of its capabilities are sure to be sensational. The writer carries it in a coat pocket or his brief case whenever he goes visiting, and it is always good for fifteen minutes of animated discussion. Children particularly are fascinated by it, although they certainly are accustomed to radio and TV loudspeakers.

It is entirely possible to feed part of the output of the amplifier to a tape recorder and to record entire phone conversations. However, certain important legal problems arise in this connection. It is best to consult the local business office of the telephone company and to learn how far you can go without risking law suits. On interstate calls it is definitely necessary to indicate that a recording is being made. The laws regarding intrastate calls vary. •—*R. H.*



To get best position for pick-up, take phone off cradle so that dial tone is on and try coil all around the base.



Support pick-up coil by blocking it with a small object. You may have to experiment with speaker position, also.

Electronic Timer

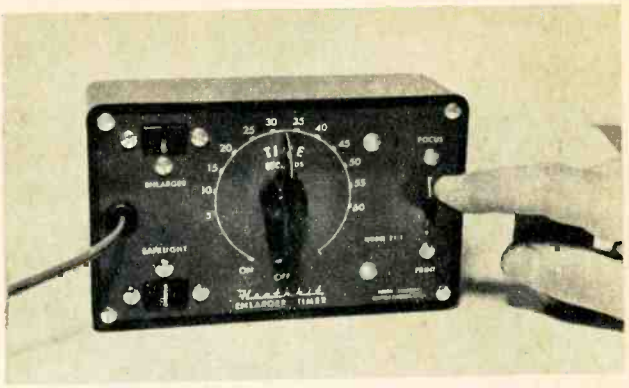
Photo enlarging is greatly simplified by this handsome, easily-assembled kit job.

CONVENTIONAL TIMING DEVICES intended for control of photographic enlargers use either a spring-wound clock mechanism or a self-starting synchronous motor, coupled to a switch. They are satisfactory while new, but they usually develop corrosion troubles in the unavoidably damp atmosphere of a darkroom. A different approach to the situation is represented by the all-electronic timer. Here the timing cycle depends merely on the setting of a very simple variable resistor in combination with a fixed capacitor. The combination determines the flow of current through a type 6D4 tube, and this current energizes a small relay that in turn controls the AC line to the enlarger. The circuitry is very simple, construction easy, and operation quiet and reliable.

A kit job, the Heath "Enlarger Timer" shown in the photos took the writer just two hours to assemble, start to finish. Housed in a black plastic instrument case, the timer has a really professional look. The range of control is from 5 to 60 seconds, which can be calibrated with surprising accuracy against the sweep second hand of an electric clock. Actually, any slight variations from the figures on the panel are not important. In making test strips from a negative, the technique is to try several different exposure times, and then to duplicate the one that gives the best results. Once the central knob is set, the identical exposure can be repeated over and over again. The knob itself does not turn with each "print" cycle, as with mechanical timers, but remains stationary.

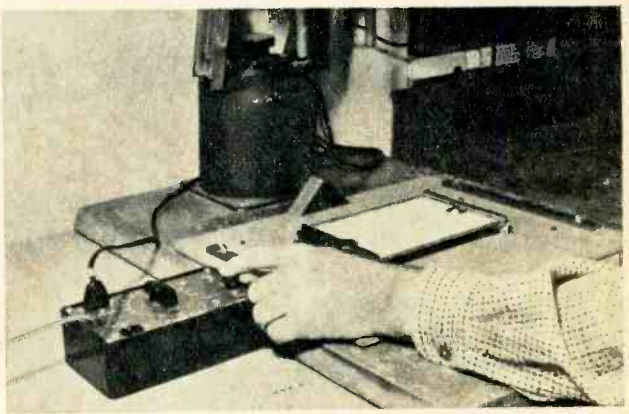
Outlets are provided on the panel for the enlarger and a safelight. With the "FOCUS-PRINT" switch in its center or neutral position, the enlarger is off and the safelight on. When the switch is pressed to PRINT, the enlarger goes on and the safelight off. If the safelight really is safe (that is, if it does not fog the enlarging paper), it can be kept on all the time.

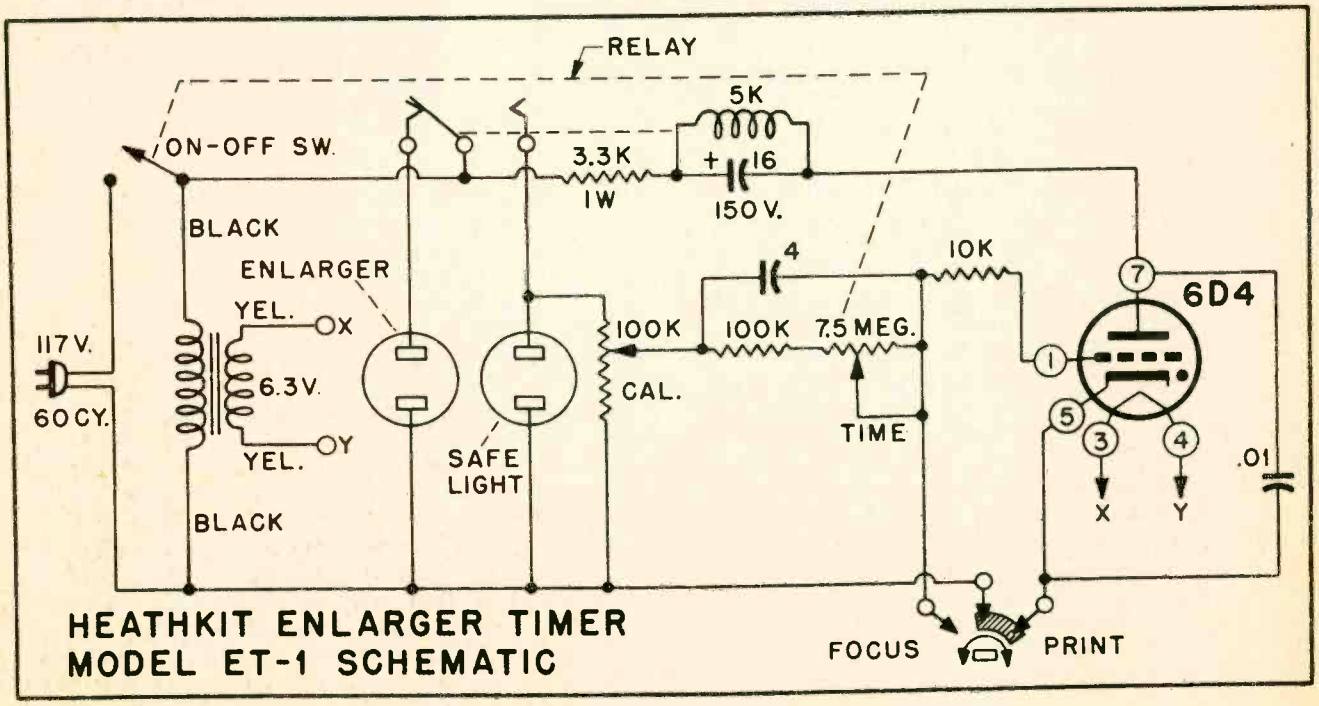
The timer takes about five seconds to warm up. •—*R. H.*



Main control switch, right, stays closed on "Focus." When pressed once to "Print," it starts enlarger timing cycle.

Placed by enlarger, timer is a valuable darkroom addition. Calibration is made through hole under center timing knob.





Typical application of completed Knight electronic flash "gun" to a twin-lens reflex camera is shown at left. The "Sync" cord from the camera plugs into side of the gun.

Parts of the shoulder-slung power source: case, with switch, outlet and safety resistor in flap; AC power unit; 300-volt dry battery and large storage capacitor.

Shoot Pictures at 1/700th Second!

Available in kit form, this eminently satisfactory electronic flash unit enables you to do just that.

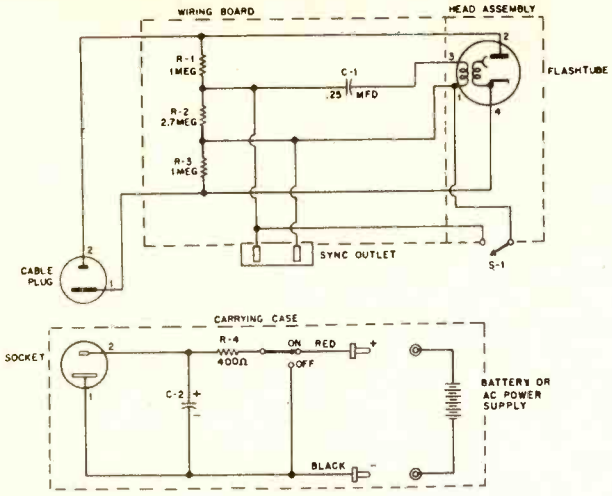
IN "ELECTRONICS HANDBOOK," Fawcett Book No. 319, there appeared a statement to the effect that electronic flash units are kindergarten stuff for any radio man or electronics technician. This has produced a flurry of letters, all of which indicate that photography is the major hobby of people in these categories.

"If they're so simple," readers ask, "why isn't there a decent 'gun' in kit form on the market at a reasonable price?"

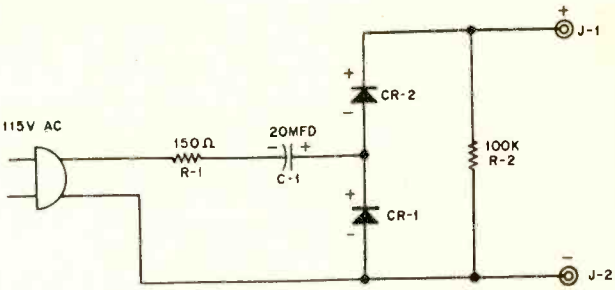
There have been several that this writer wouldn't touch, literally, with the proverbial ten-foot pole. Why? Because they had too many hundreds of volts running around in flimsy cases with too little insulation. However, he is now happy to report on a brand new electronic flash unit that he built up very successfully from a kit. It is safe for two reasons: first, because the voltage has been kept down to the relatively low point of 300 volts, and second, because good components and adequate insulation protect the user against shock. It is the Knight job, marketed by Allied Radio Corporation of Chicago.

The outfit consists of a "gun" assembly and a leather-cased power source. The gun, made of light aluminum tubing, contains three small resistors R-1, R-2 and R-3 and one capacitor C-1; see schematic diagram. The flash tube is fitted with a standard four-prong radio tube base, and plugs into a socket in the right-angled head of the gun. The trigger transformer, needed to fire the flash, is built into the base of the flash tube itself.

The power source represents a rather clever piece of designing. In the flap of the leather case are an on-off switch and an outlet for the plug from the gun. Inside, the right compartment is occupied by a husky 1100-microfarad storage capacitor. Alongside is just enough space for either of the following: 1) A standard 300-volt dry battery; 2) An AC power pack of exactly the same dimensions as the battery. Both units are fitted with jacks for quick insertion and removal. It takes about seven seconds to switch from battery to AC pack, or vice versa. The AC unit uses two selenium rectifiers in a very simple circuit. It can be assembled and

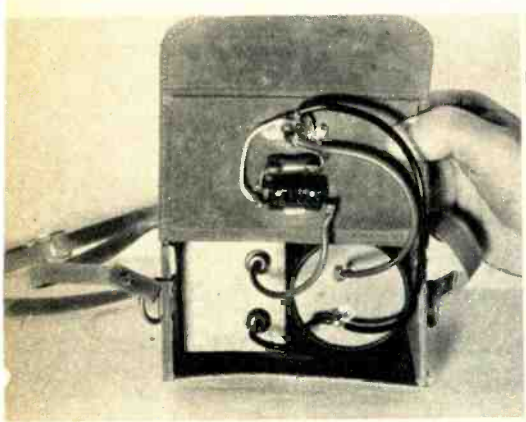


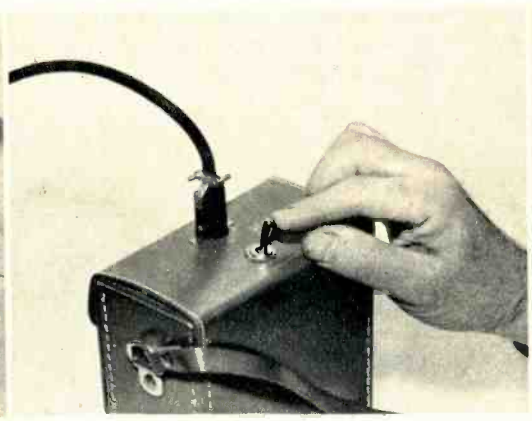
Tube of the Knight electronic flash unit can be fired manually by switch S-1 in top of gun case, or automatically by camera shutter contacts connected to the synch outlet.

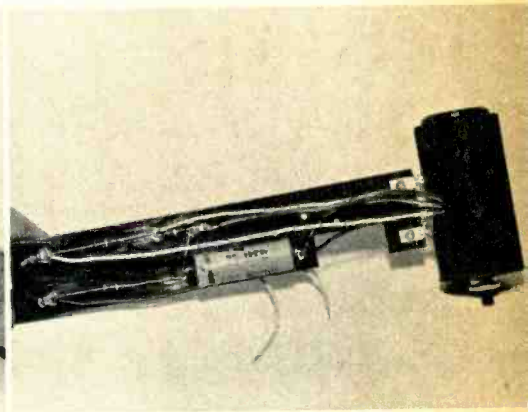


Jacks J-1 and J-2 of the AC power unit take red and black plugs of the carrying case wiring. CR-1 and CR-2, center, are the selenium rectifier. R-1 and R-2 are two resistors.

Capacitor is on right, dry battery on left, in photo at left below, showing interior of power source. Connecting wires are heavily insulated. AC unit would fit same space occupied by battery. Line cord exits through slot in case's top edge. Cord from camera-mounted flash gun fits outlet on front edge of flap, center photo. Toggle switch turns on high voltage or makes equipment "safe." Inner assembly of "gun" is essentially a Bakelite strip holding voltage-divider resistors and trigger capacitor. This strip slides into tubular case, with cord to power source coming from bottom of it.







wired by any hobbyist in approximately fifteen minutes.

The battery is obviously required for outdoor shooting, or indoor work that involves much moving around. The AC pack is recommended for all possible jobs, as it has practically unlimited life and costs only about $3.75 in the first place. There's a good reason for saving the battery: it costs about eight bucks!

The AC pack plugs directly into the house line. It has no on-off switch of its own, and really doesn't need one. When you're finished shooting, just yank out the line cord —gently, of course. The toggle switch on the leather case controls only the 300-volt DC circuit. It is a single-pole, double-throw switch. In the "on" position, it passes the 300 volts from either the battery or the AC unit through resistor R-4 and allows it to charge up the storage capacitor C-2. In the "off" position, it opens the 300-volt circuit and puts resistor R-4 directly *across* C-2, thus discharging any energy left in the latter. The resistor gets quite warm for about ten seconds, showing that it is doing its job. Without this safety feature, C-2 could retain its charge for days, and then give the unwary owner of the equipment a nasty wallop if he touched the red and black leads.

A universal mounting bracket is included with the kit. This fits all 35mm and small reflex cameras, and is readily adapted to larger ones.

Not included with the kit is a cord to connect the flash outlet on the camera with the "Sync Outlet" on the side of the gun. This is a camera store item, and must be matched to the particular camera on hand. The outlet on the gun is a standard two-prong power type fitting, and takes any two-prong attachment plug.

The duration of the flash produced by this Knight unit is about 1/700th second, fast enough to "freeze" a playful baby or pet. The flash tube is supposed to be good for 10,000 or more flashes. If you average 50 pictures per month, which is a rather high rate of shooting, this means that the theoretical life of the tube is about 14 years. You'll probably drop it or step on it long before that. •—*R. H.*

Sound in Three Dimensions

The effect of this system is practically unbelievable until you've actually heard it.

THE DUST HAS HARDLY SETTLED from the excitement generated by the advent of high fidelity, and already the electronic world is confronted by an even newer, more exciting form of sound reproduction. This new phenomenon usually goes by the name of stereophonic sound, although it is also called binaural, stereosonic and 3-D sound.

But no matter what it is called, it already is making obsolete the ordinary old-fashioned monaural sound most of us know today. The effect of this system, the added dimension it gives to sound reproduction in the home, is absolutely unbelievable until one has actually heard it. The difference is every bit as dramatic as the difference between black-and-white and full-color photography.

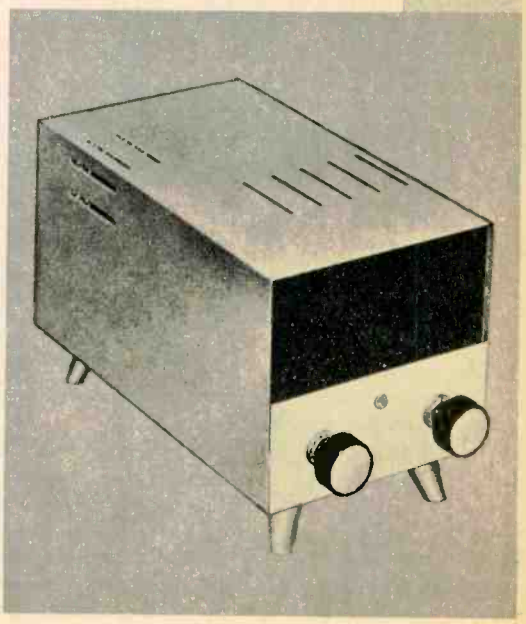
The excellence of this system is no surprise to the engineers who have been nursing it along in the laboratories for so many years. It has even had public exposure from time to time over these years, without any terrific demand being built up. The surprising thing now is that the public hears it, likes it, wants it.

Walt Disney used a form of stereo sound in "*Fantasia*." The Bell Telephone Laboratories long ago showed their stereophonic sound-film system. WQXR in New York has been presenting stereo broadcasts for several years. Cinerama has a form of it; so does Cinemascope. Yet none of these systems has captured the public fancy as has stereo recordings on tape for home use. More and more, at hi-fi shows and audio exhibitions throughout the country, the exhibitors demonstrating stereotapes and stereo reproducing systems are the ones drawing the big crowds.

Often one sees a visitor wandering aimlessly from exhibit to exhibit, seemingly bored and dazed by the cacaphonic onslaught to his eardrums, until he comes within hearing of a stereo demonstration. Immediately his eyes brighten a little, he cocks his ear in the direction of this new sound—and he's hooked. In he goes to hear a little more of this new sound, and ever after the old non-stereo stuff seems

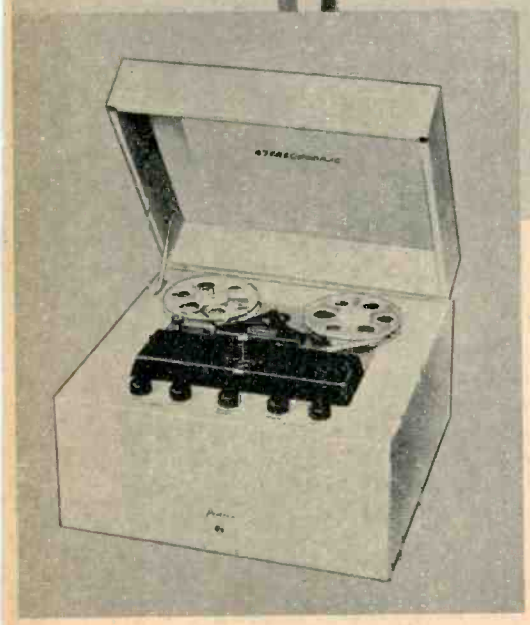
Stereo sound involved two separate recording and reproducing channels. The Celeste model by VM is a monaural tape recorder.

However, you can convert the Celeste recorder to stereo or 3-D sound by the addition of second speaker, second amplifier.



Adding stereo to the existing system is relatively simple with two preamplifiers and one power amplifier manufactured by Bogen.

Ampex system offers stereo reproduction, half- and full-track monaural tape playback, 2-speed half-track recorder.

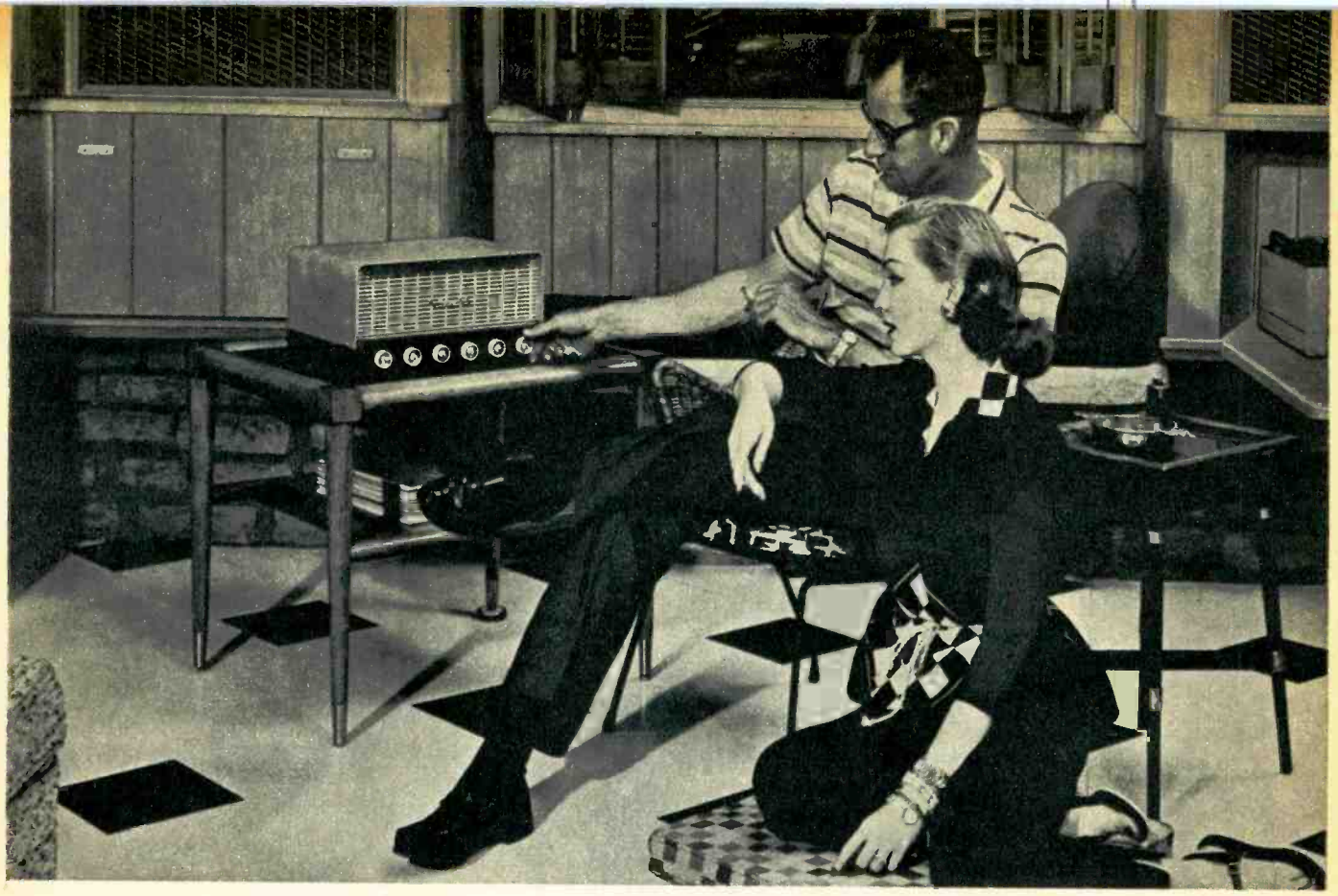


This stereo tape player, made by Pentron, has two pre-amplifiers and can play either the in-line or the staggered tape.

just about as bright and fresh as last week's newspaper.

The basic principle of stereo is an effort to complement more perfectly the hearing mechanism. It is the fact that we have two ears that enables us to tell from which direction a sound is coming, even though we may not be able to see the source. But with ordinary monaural reproduction everything seems to be coming from the same place—the loudspeaker; or worse yet, the reproduction is so jumbled and confused that it is impossible to tell just which sounds originated where.

But with stereo reproduction, using just two speakers properly placed, the sound immediately takes on a spaciousness and perspective which defies comparison. Instead of now sounding as if it were coming from two points rather



than one, the music actually seems to come from definite locations, behind the speakers, in front of them, even *between* them. If the singer accompanied by orchestra was at stage center during the original recording session, the sound of her voice will now seem to come from right smack in the middle of those two loudspeakers. If the reader finds this hard to believe when he sees it in print, he shouldn't dismiss it lightly. It still seems incredible even when you're right there hearing it with your own two ears!

Stereo sound involves two completely separate recording and reproducing channels. Just as there is always some difference in loudness and time between sounds arriving at each of the two ears, so this principle is used in the setting up of two different recording channels. When duplicate tapes are made for public sale, the recorded sounds from one channel appear on about half of the tape width, while those of the second channel occupy the other half of the tape.

The tape reproducer in the home then has two separate playback heads, one to scan channel 1 and another to scan channel 2. It also must have two separate playback amplifiers, two separate sets of cables, two separate audio power amplifiers, and two complete and independent loudspeaker systems. The setup is undoubtedly more complex and expensive, but the outstanding results more than justify the investment.

While complete stereo systems are availble for those who are just beginning in hi-fi, those who already have a sizeable investment in audio gear need not junk it. Chances are it can be easily augmented and incorporated into a complete stereo hi-fi system. More and more tape recorder manufacturers are offering modification kits or factory changeovers for converting monaural tape systems to stereophonic.

But whether buying a conversion or a whole new system, the stereo fan must be careful to avoid the confusion surrounding the recording of tapes today. Some manufacturers offer tapes which have comparable sections of each channel directly opposite each other, while others make their tapes with one channel displaced lengthwise from the other. Some manufacturers even make both types.

When the channels are directly opposite, the two tape reproducer heads are of course directly over one another and are said to be *in-line* or *stacked.* But when the two tracks are displaced, the two heads of course must conform, and are then said to be *staggered.*

Some, but not all, stereotape reproducers can be switched from stacked to staggered operation at will. Since it is still too early to tell which type is to become standard, or when such standardization is likely to come, the poor audiophile finds himself in a quandry.

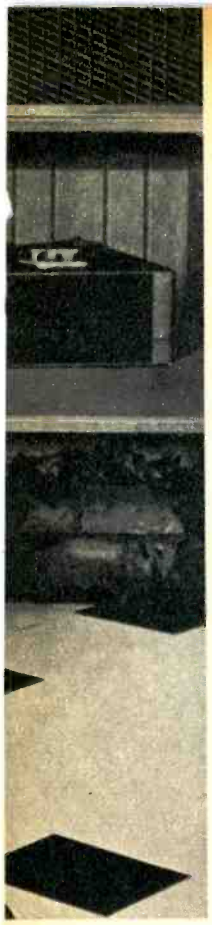
The best he can do is try to get a reproducer which is compatible with both methods. If this is not possible, then he will have to standardize at least in his own operation. He will examine catalogs of the various tape libraries and determine which type has most of the music he will want to hear. Then he will get a tape reproducer of that type, and will thereafter purchase tapes of that type exclusively.

For the hi-fi fan who is expanding his system to stereo, it is strongly advisible for him to duplicate parts of the system he already has. This is particularly true of speaker systems, and to a somewhat lesser degree of power amplifiers. Since the equalizer-preamplifier is required strictly for phono reproduction, it will not be necessary to duplicate these units for stereotape. Having both channels identical will simplify the accurate balancing of the system.

The three main elements in a stereo reproducing system, then, are as follows:

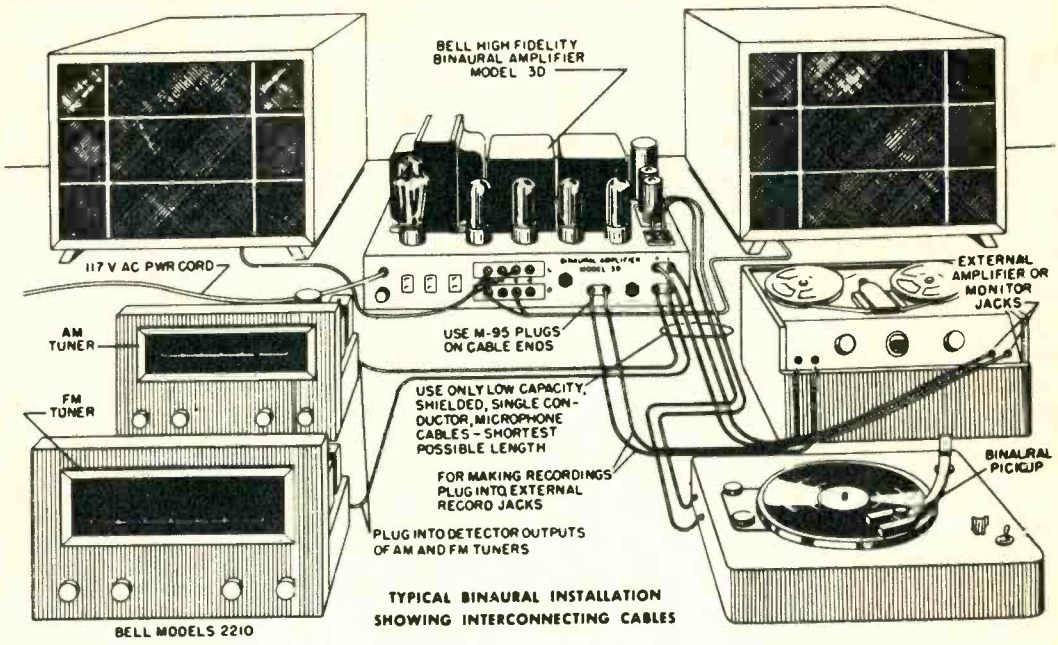
1. A stereo tape reproducer (with heads stacked, staggered, or both)
2. Two power amplifiers (preferably identical)
3. Two loudspeaker systems (preferably identical)

All of this can add up to a rather sizeable piece of change, so think twice before you even listen to it. For once you hear a stereo setup, you won't be able to rest until you can beg, borrow or steal one for your very own! •—*D. H.*



Those who have a sizeable investment in audio gear can readily supplement existing equipment to include stereo. However, complete stereo systems are available. Lovely installation, left, is by Bell.

Three types of stereophonic reproduction are included in the complete Bell system shown below: tape, AM-FM simulcasts, and Cook binaural discs. System is little more complex than the monaural.



TYPICAL BINAURAL INSTALLATION SHOWING INTERCONNECTING CABLES

Radio Station WQXR, New York City, makes special binaural broadcasts in which AM and FM are combined.

Tone-Arm Kit

The big news in tone arms: the Audax arm is available as a kit for only $15.

Combination of pickup and arm must move with maximum compliance, minimum friction. Audax is rated very high.

IN A CERTAIN SKYSCRAPER OFFICE, which commands a magnificent view of New York City, there is a conspicuously mounted statement which describes the headaches and heartaches of pioneering in American business. This is the tower occupied by Mr. Maximilian Weil, founder of the Audak Company and an audio pioneer for several decades.

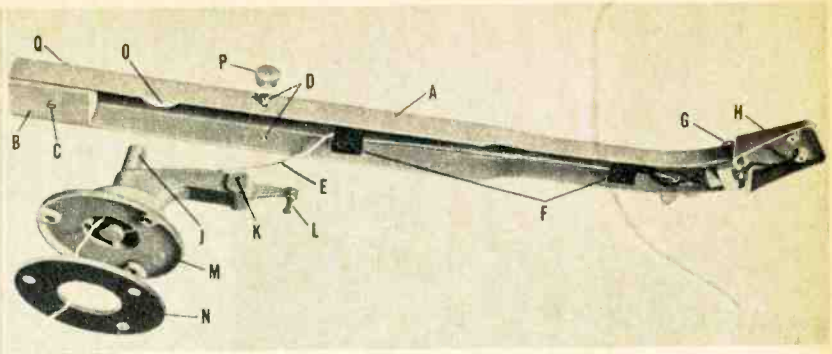
Mr. Weil knows well the rocky road traversed by those who chart unknown territory. He knows of public reluctance to accept new ideas. And he also knows the chagrin of his fellow businessmen, when they have to improvise a delaying action while they prepare to meet unforeseen competition.

All of this is merely part of the game to Mr. Weil, however, who has managed to spark controversy in the audio industry for many years. And true to his convictions, Mr. Weil has once again loosed a bombshell in the hi-fi market, repercussions of which will be felt far and wide.

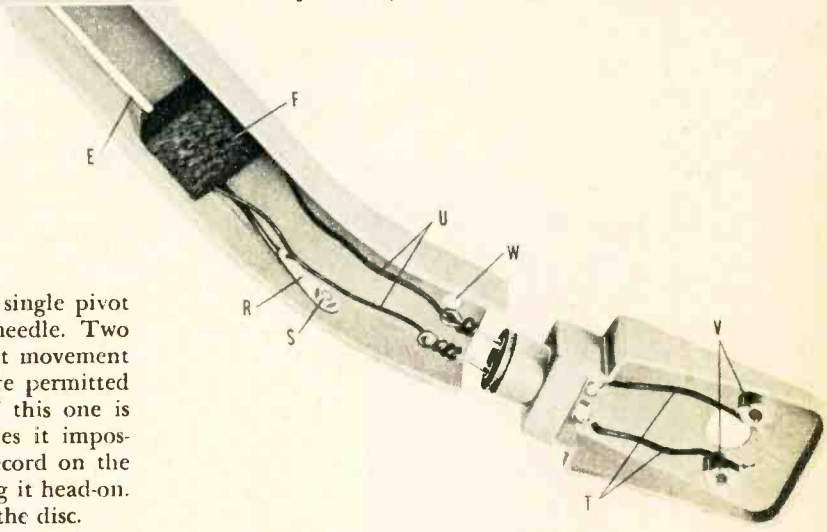
The big news this time is that the fine Audax tone arms —long regarded as among the very best with price to match —are now available in kit form at a price of only fifteen dollars, approximately. Assembly can be done by the beginner in about twenty minutes (although he could turn around and do a second one in half that time), with no tools other than a small screwdriver or even a nail file. When finished, the owner has an arm which is even better than one rated "blue chip" by the leading consumer testing organization.

The basic function of any tone arm is simply to permit the pickup to track the grooves of a phonograph record, and to do so as unobtrusively as posssible. This means that the combination of pickup and arm must move with maximum compliance and minimum friction.

These demands are satisfied to a remarkable degree in the Audax arm by having the moving parts actually touch each other at only three needle-like points. The rotating



Left, the kit as it comes boxed. Above, compass-pivot point feature of Audax arm is shown at points D and K. Height is adjusted by insertion of rings N, while pressure is adjusted by counterweight B at the far left.



Above, cartridge case is cut away at sides to permit observation of stylus at all times. Knockout hole between mounting holes V allow insertion of control for "turn-around" cartridges. Case is attached to arm by screw through W, electrical connections U are made through pin-jack setup.

lateral movement of the arm is seated over a single pivot point, much in the manner of a compass needle. Two similar points at either side of the arm permit movement in the vertical direction. While some arms are permitted to swing full circle, the lateral movement of this one is restricted to about ninety degrees. This makes it impossible for the pickup to be dropped on the record on the wrong side, with the advancing groove meeting it head-on. Such operation would mean certain death for the disc.

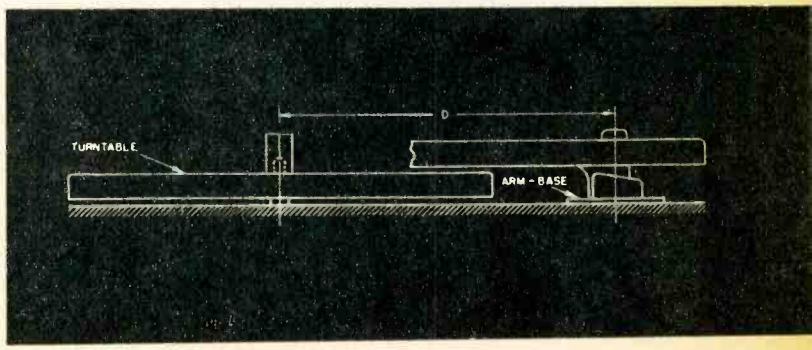
Parts which require lubrication are permanently prelubricated at the factory. Felt damping blocks are pretreated with adhesive, and simply pressed into place. Any pickup of current manufacture will fit the cartridge housing. Those with dual styli and a twist control on top are installed by removing a decorative knock-out button and passing the control through the opening which remains. All one need do is assemble quickly, mount, and play.

Mounting a tone arm is usually rather tricky, but Audak has worked out a system which is simple and fool-proof. The gimmick which makes this possible is nothing more than a small piece of cardboard tubing, cut to precise length and furnished in the kit as a "gauge-tube." With a record on the turntable, this tube is placed over the center spindle so it rests on the disc. Then when a ruler or small level, resting with one end on the tube and the other end on the pivot knob of the arm, is perfectly horizontal, the arm mounting height is correct.

Height adjustment is made simply by selecting one or more circular lift-pads which are inserted between the pivot base and the motor board. Finally, the correct mounting point for minimum tracking error is established by measuring off the proper distance between the center of the tube and the pivot knob.

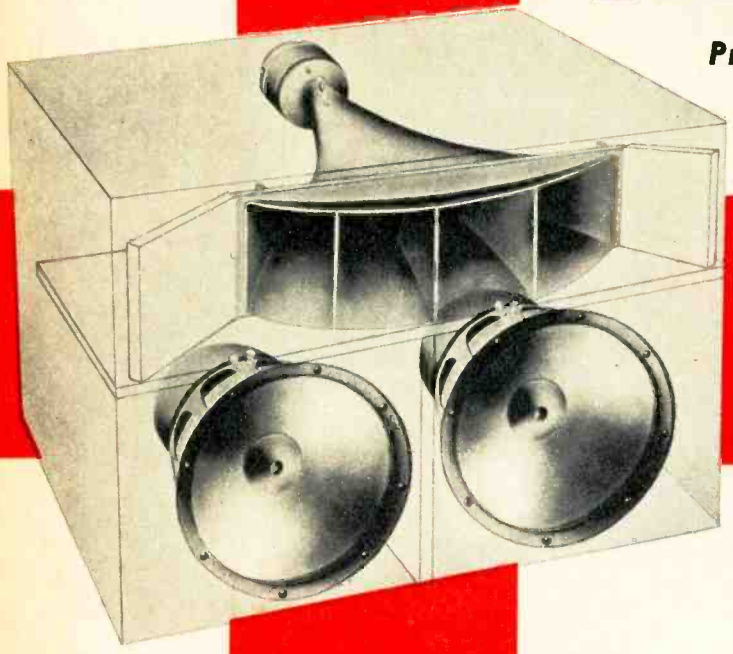
And so, with the expenditure of just fifteen bucks and a very little elbow grease, the audiophile has an arm which ranks with the very best. •—*D. H.*

Use of paper tube over spindle permits height determination by placing a ruler or level from top of tube to top of pivot knob. D designates the correct mounting position.



Something New in Loudspeaker Kits

Professionally engineered by Altec-Lansing and produced in kit form by Heath, this rig has something distinctive to offer.



The Heath "Legato" system features two 15-inch Altec-Lansing cone-type speakers for the woofer, plus a multicellular tweeter horn.

DO-IT-YOURSELF KITS for the hi-fi fan have become more numerous and varied in recent years, and the remaining gaps in the field are rapidly being filled. The recent offerings of the Audak tone arms and Bogen amplifiers in kit form are just two more examples of the way the audio industry is meeting the demands of the consumer.

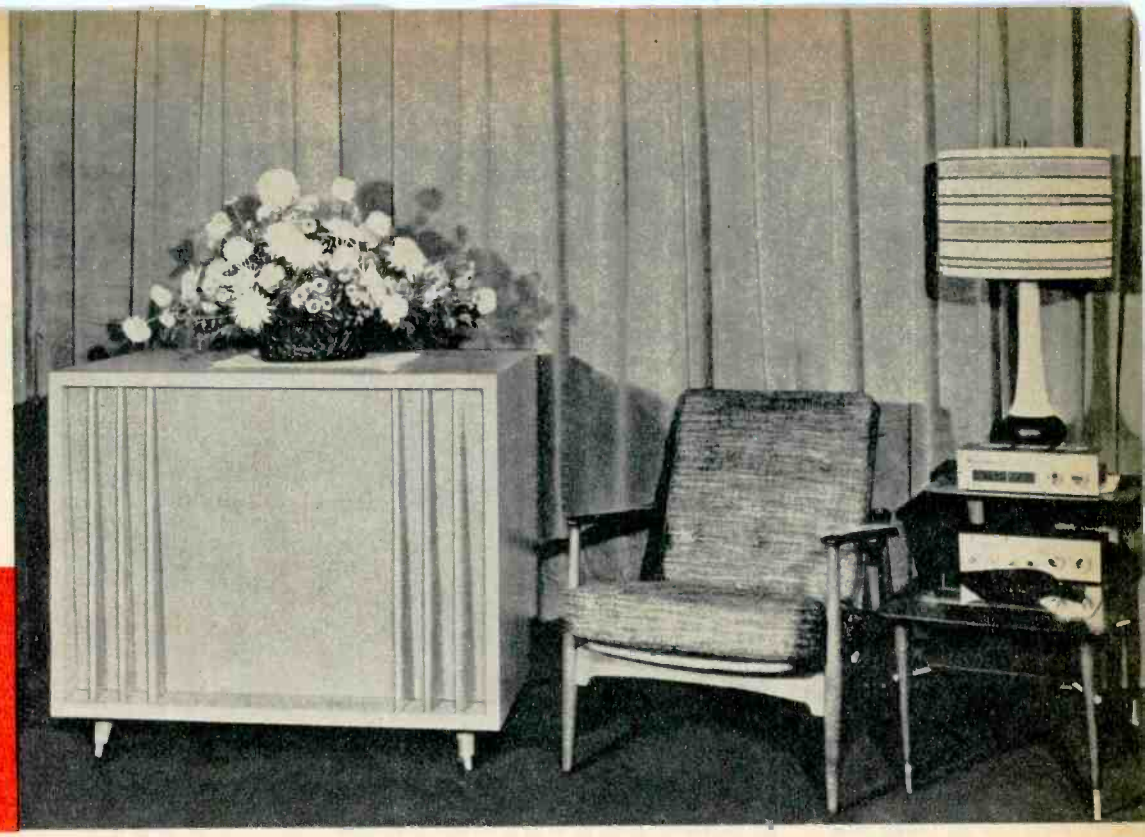
Loudspeaker kits were naturals for the kit approach from the beginning, for knock-down kits of various woodworking projects have been commonplace for years. Until fairly recently, however, most loudspeaker kits involved enclosures only, and were usually private designs of small manufacturers. Seldom were these enclosure kits intended specifically for use with a given speaker, and almost never was a complete system of enclosure, speaker and electrical components offered in kit form.

This picture has changed dramatically, of course, as the major speaker manufacturers, such as University, Jensen and Electro-Voice have tried to meet the demand for just such complete kits. Until now, however, the engineering philosophy of one major company, Altec-Lansing, has been conspicuously absent from the kit market. But all of this has been changed now, as Altec engineering has combined talents with the Heath Company, leading manufacturer of kits.

Altec engineers were pioneers in sound reproduction in motion picture theaters, and in home high fidelity equipment as well. They are decidedly not as razzle-dazzle as some latecomers to the hi-fi business, but their engineering is soundly conceived and solidly executed.

There is one point on which they have seemingly been at odds with most of the industry since the outset, but they are very definite in their convictions. These have to do with the number of elements in a speaker system. Motion picture theaters, of course, were among the first to employ two-way systems consisting of "woofer" and "tweeter." Even though in high-power systems, there may be several low-frequency woofers and several high-frequency tweeters, all of the woofers work together in the identical range, as do all of the tweeters.

Although a two-way system is nearly the only type ever



Cabinet styling is available in both contemporary and traditional designs, and in either light (imported white birch shown here) or dark (African mahogany) fine woods.

encountered in professional practice, be it motion pictures, radio or TV, most of the hi-fi speaker manufacturers have gone beyond into three- and even four-way systems. The basic argument seems to be that there should be a "choir" of speakers, perhaps one for each musical instrument range. Some even theorize that the ideal system would comprise a near-infinite number of speakers, perhaps one for each tone in the scale.

These changes have been stoutly and consistently resisted by Altec. They argue, very simply, that the ideal system would comprise only *one* speaker. But since this theoretical ideal is not presently possible in practice, then the next best thing is a simple two-way woofer-tweeter system. They say that since the problems of crossover and acoustic phasing are inherent in multiple systems, they should be held to a minimum by reducing the number of elements to a minimum.

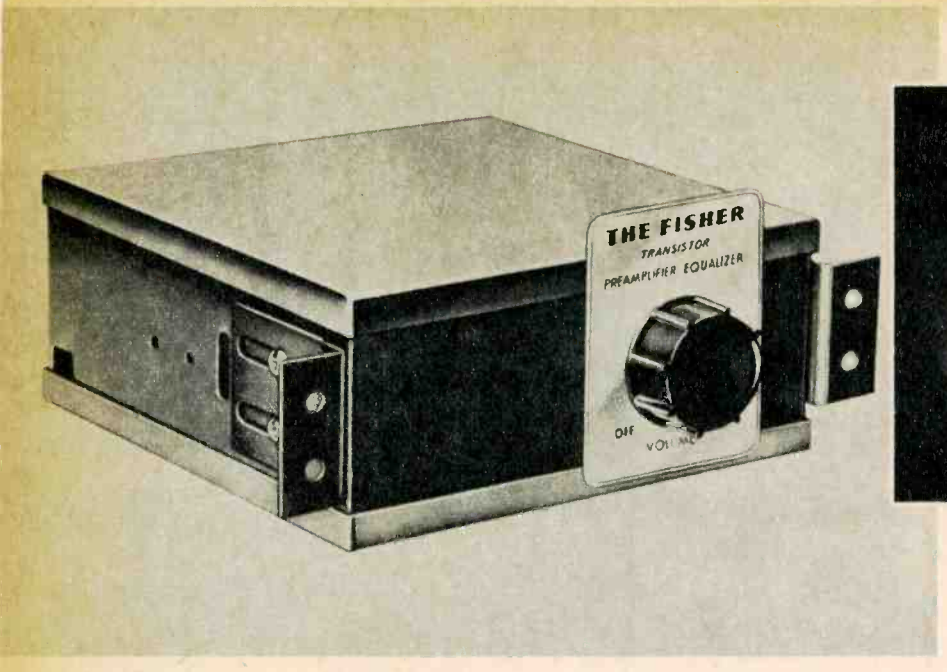
But until now, any audiophile who agreed with this theory had the option of paying a rather fancy price for incorporating it into his hi-fi system, or simply doing without. Now, however, it is possible to build a Heathkit, engineered by Altec and employing Altec theater-type speakers, for only $325 to $345.

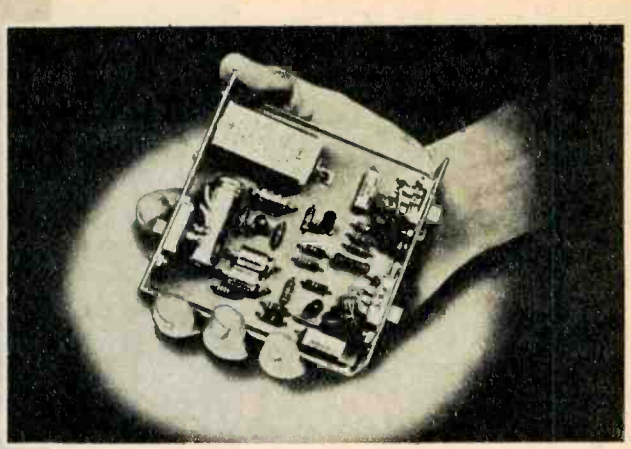
Known as the Heath "Legato" system, it features a modified infinite baffle enclosure measuring about 41x22x33 inches. Inside it there are two 15 inch Altec-Lansing cone-type speakers for the woofer, and a multicellular tweeter horn. The single crossover frequency is 500 c.p.s. Frequency response is flat within 5 db from 25 to 20,000 c.p.s.

Since the Altec boys are real "bugs" on the subject of phasing problems in crossover networks of multiple-speaker systems, they have given particular attention to what they call "C-P" (critical phasing). As a result, they claim a smoothness of transition between low and high frequency so fine that it is literally undetectable even in acoustic measurements in their own anechoic chambers.

Cabinet styling is available in both traditional and contemporary designs, in either light (imported white birch) or dark (African mahogany) woods. Although it will take the careful workman about a week to build this system, it is well worth the effort. •—*D. H.*

The Heathkit speaker is available for a list price of from $325 to $345, depending upon cabinet style. Speakers are theater-type, have a modified infinite baffle enclosure.





At left and above, the Fisher All-Transistor Equalizer-Preamplifier, the first all-transistor product in the hi-fi field; compactness, power conservation are assets.

The Transistor Goes Hi-Fi

Transistors in low-power applications are already threatening the existence of triode tubes in hi-fi equipment. Here are two examples.

AS THE TINY TRANSISTOR has shown itself capable of absorbing more and more of the duties of the vacuum tube, it was inevitable that it would also invade the field of hi-fi. Since transistors are of such recent development, they have not yet advanced to the stage where they are capable of developing large amounts of hi-fi audio power, but in low power applications they are already threatening the triode tube.

To Fisher Radio goes the honor of having developed the first all-transistor product in the hi-fi field, the Fisher All-Transistor Equalizer-Preamplifier. Riding hard on its heels was the Lafayette 3-Transistor Hi-Fi Preamplifier Kit. This is a small do-it-yourself project, and although it does not have as elaborate circuitry as the Fisher, it is nevertheless hi-fi in every sense of the word.

Most of today's transistors are of the junction type, which has largely superseded the point-contact type originally developed in the Bell Telephone Laboratories. The junction transistor consists of a "sandwich" of three tiny wafers of germanium—a semi-conductor—of opposing polarities. Thus if a negatively-polarized slice of germanium is sandwiched between two positive slices, the unit is said to be a *P-N-P* transistor. Similarly, if a positive wafer is between two negative ones, the transistor is an *N-P-N* unit.

The "filling" in the sandwich, regardless of its polarity, is called the *base*, while the two outer layers are known as the *emitter* and *collector*, respectively. Both types of transistors, since they have three elements, can serve the functions of some triode vacuum tubes, but at only a fraction of the operating power, and without any heater or filament at all. The relative functions of the elements in tubes and transistors is as follows:

Triode Vacuum Tube	*P-N-P Transistor*	*N-P-N Transistor*
Cathode	Emitter	Base
Grid	Base	Emitter
Plate	Collector	Collector

In construction, a small wire is connected to each of the three transistor elements. The unit is then encased in a hermetic seal, and the wires, which are insulated from one another are brought out through the case. Manufacturers employ mainly one of two methods for identifying the conductors.

In one style the lead of collector is simply widely-spaced from the other two. Another method employs a red dot on the casing to identify the collector. (See drawings at center of opposite page.)

The three transistors in the Lafayette kit are all General Electric type 2N190. This is a *P-N-P* unit, specifically designed for audio applications, with a cutoff frequency of one megacycle. Identification of the collector is by means of a widely-spaced lead.

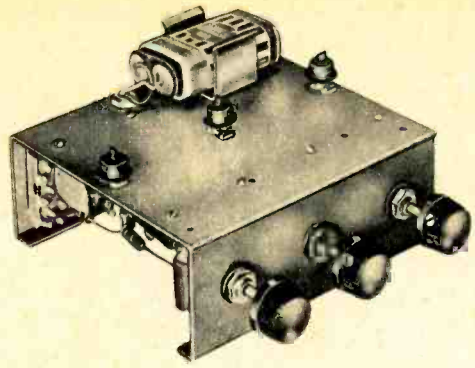
This unit provides 40 db of gain, which is quite sufficient for even the lowest level devices. Input combinations for either phono or mike include high level with high impedance, low level with high impedance, and low level with low impedance. Output is from 0.5 to 1 volt at high impedance.

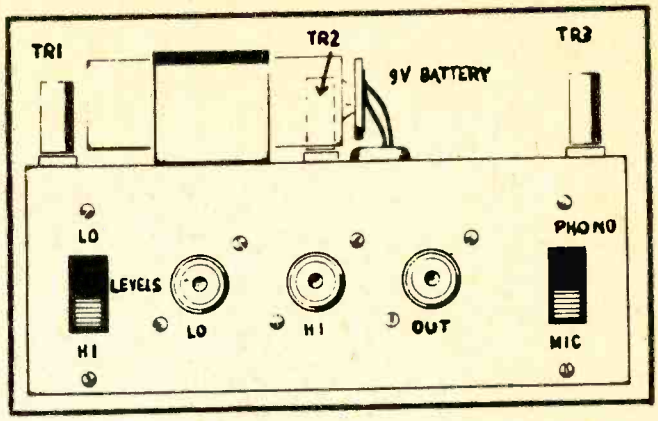
Since the unit employs transistors throughout, hum and microphonics are non-existent. The inherent noise level is around 50 db below signal for both high and low impedances sources. Frequency response is from 20 to 20,000 cycles per second.

Battery operation (9 volts) permits installation as a remote amplifier, with cable runs of up to 175 feet to the associated equipment.

In addition to the input selector controls, there is an on-off switch, volume control, and bass and treble tone controls.

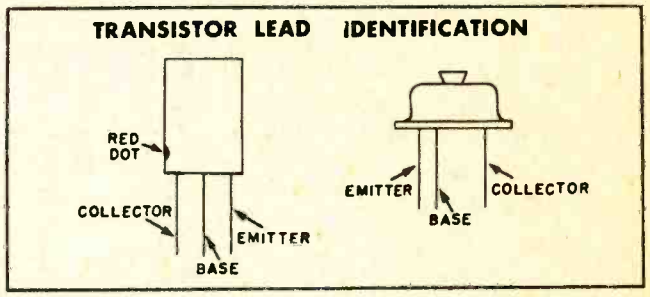
With hi-fi power amplifier ratings now breaking 100 watts, it will be some time before the transistor entirely supplants the vacuum tube in the audio field. But don't write off the possibility. In electronics *anything* can happen! •—*D. H.*





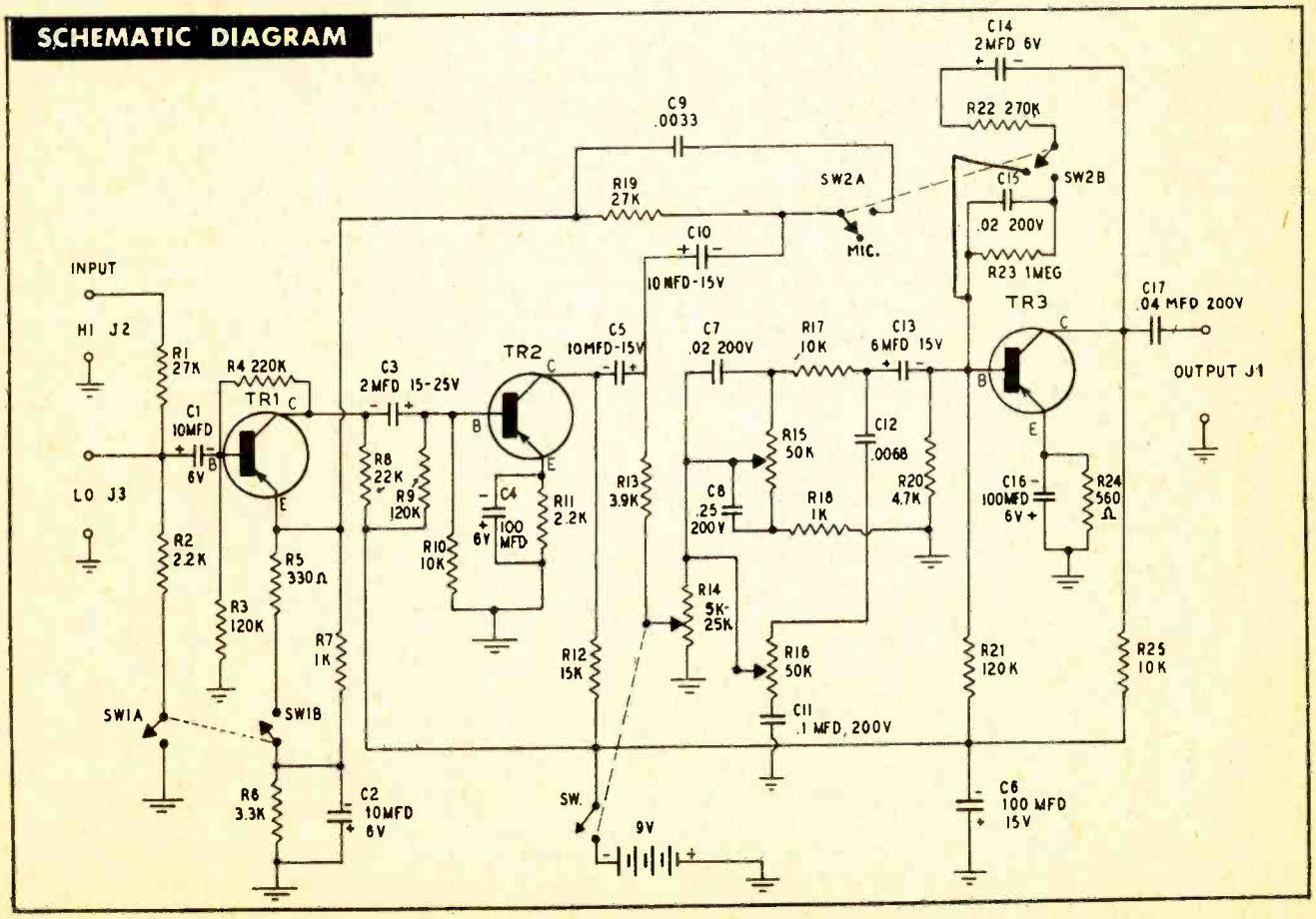
Above, Lafayette 3-Transistor Hi-Fi Preamplifier Kit represents high-fidelity quality in every sense of the word.

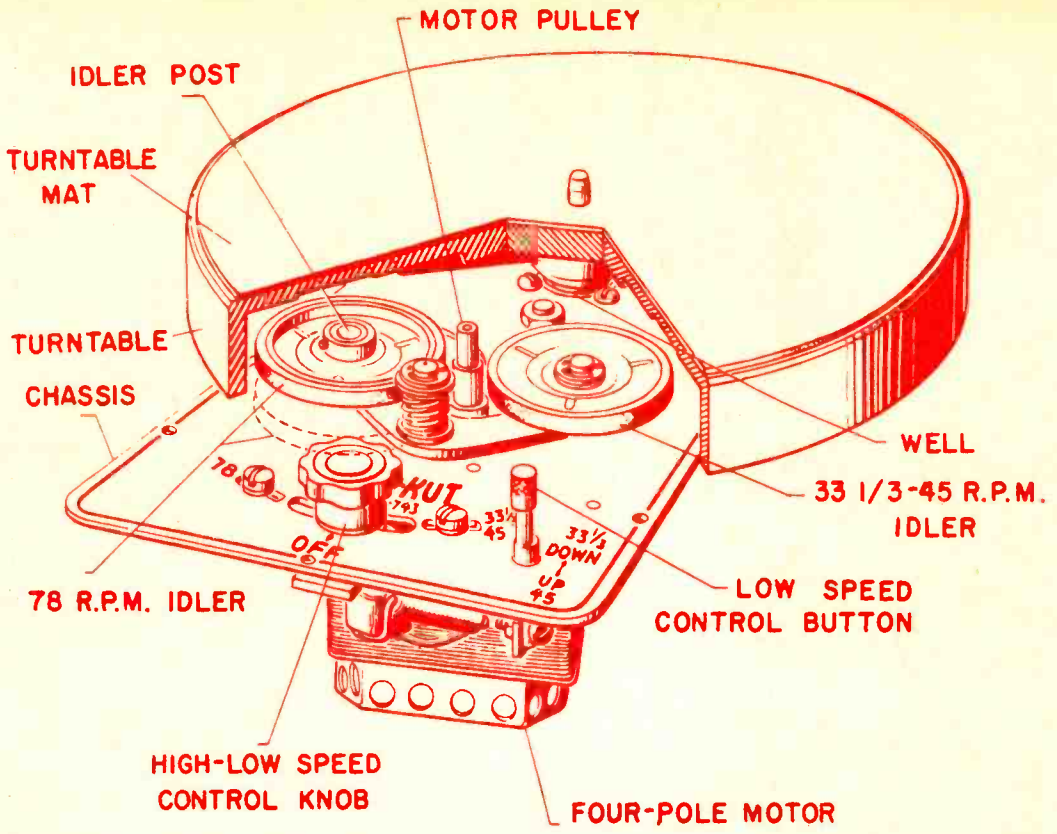
Above, right, a rear view drawing of the Lafayette kit; transistors used are all General Electric type 2N190.



Right, a diagram of typical transistor structure; below, schematic drawing of wiring of 3-transistor pre-amp.

SCHEMATIC DIAGRAM





Cross-section drawing of turntable illustrates an ideal type: motor is four-pole, idler system is used, table is heavy.

What'll You Have—Turntable or Changer?

The buyer will have to analyze the compromises necessary with each before deciding.

THE FIRST PURPOSE of a phonograph turntable or changer is to rotate a record in exactly the same manner as the master disc was recorded. This sounds simple but it isn't. The record changer adds the functions of placing a number of records on a turntable in sequence, playing them without any further human attention. This sounds complicated and it is.

The high-grade turntable is a remarkable piece of design, coupled with exceedingly careful craftsmanship. The changer is the same thing times ten. Still there is recurring controversy in the industry and among audiophiles concerning which device is the best for them. Confusion is often compounded by the fact that the changer, by far the more complex structure, is often lower in price.

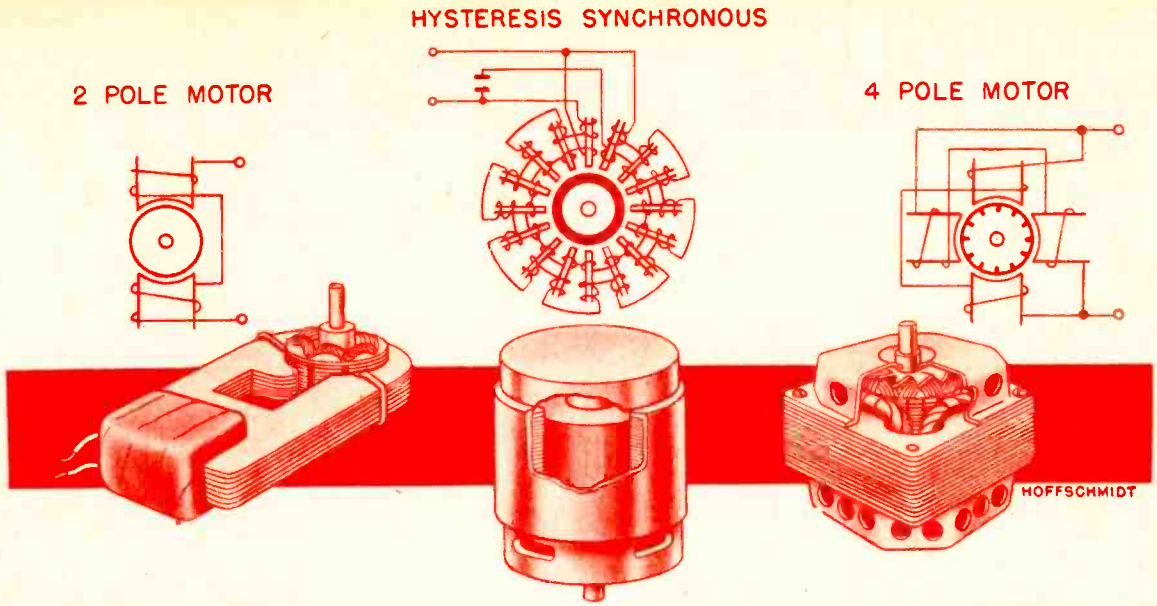
The turntable, whether or not it has an associated changer, must rotate at a speed which is precise and constant. If it doesn't move at precisely the same speed of the original recording, reproduction will be off pitch. If the movement isn't constant, the pitch will waver, resulting in "wow" or "flutter."

This means that the motor and power train must be carefully machined, and the motor should be fairly husky. It absolutely must be of the 4-pole or hysteresis synchronous type. The latter is better for avoiding low-frequency "rumble," although as a practical matter the difference is almost academic. The hysteresis type is also the more expensive, of course. Some improvement in the motion can be effected by the flywheel action of a heavy table. This is almost always done with the better turntables, almost never with changers. The table should be of a non-magnetic material, especially if magnetic type cartridges are to be used. Nearly all turntables and changers now meet this requirement.

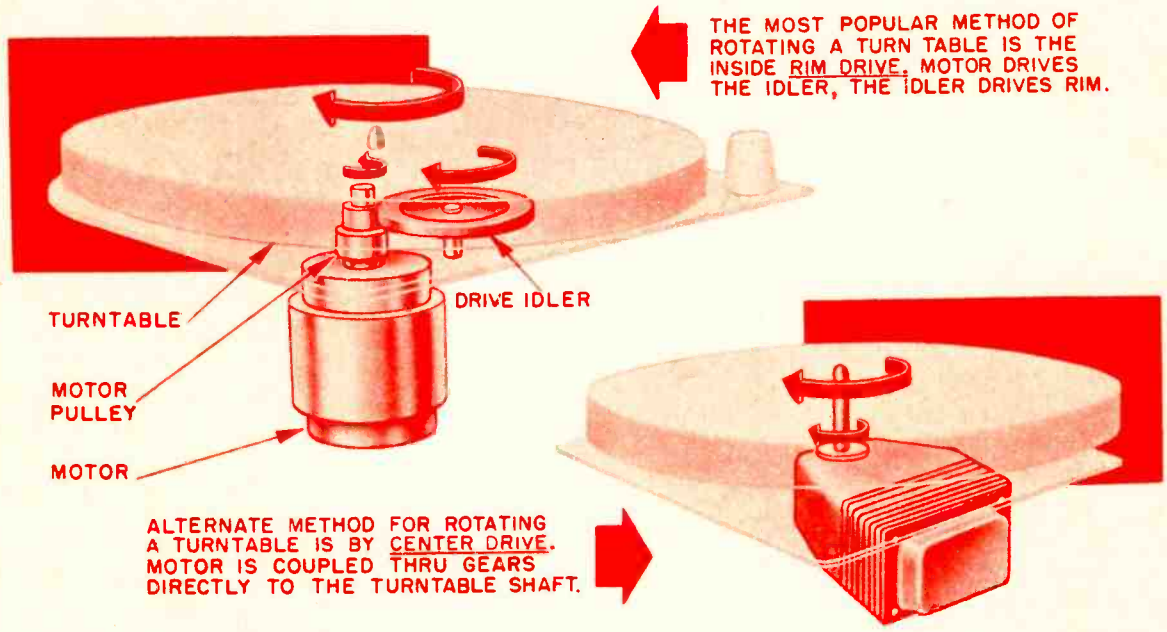
Power from the motor may be applied directly to the center shaft through a gear train, or to the rim through a set of idlers or belts. A decade or so ago, most of the professional units employed center drive, while cheap equipment used rim drive. Consequently the idea got around that center drive was better. Today however, rim drive systems are much improved and generally preferred. They eliminate the troublesome gear box, are much cheaper to construct and repair, and their perfomance is at least the equal of center drive systems.

Obviously the same general design principles are employed in both turntables and changers. The only way to account for the price differential, then, is in the quality of materials and workmanship. On these counts the turntable wins hands down.

An important question the audiophile must ask himself is whether or not the better quality of the turntable is to him significant. The greater convenience of the changer is undeniable, and any audiophile wants to know what he is



Three types of turntable motors are shown: hysteresis synchronous is best for avoiding low-frequency "rumble."



Two methods of turntable rotation are shown; center drive is not used much today, is usually more expensive to repair.

getting in return for giving up this convenience and spending more money in the bargain. Perhaps he should begin by asking just what that extra convenience is costing him. He should bear in mind that all changers exhibit at least some of the following disadvantages:

1. Abrasion between groove surfaces when records are stacked.
2. Possible damage to center holes or edges, from the platforms.
3. Wear on the center hole as the spindle remains stationary while the record rotates.
4. Change of stylus angle with respect to record as height of stack varies.
5. Possible sacrifice of motor smoothness in favor of more power to operate changer mechanism and move heavy stack of records on turntable.
6. Slippage of disc as it is played on stack.
7. Slowing of turntable as stack weight increases.
8. Uneven groove wear at inner section of record, as underneath extension of pickup arm begins to bear against pawl and ratchet mechanism.
9. Exceedingly difficult maintenance and adjustment.

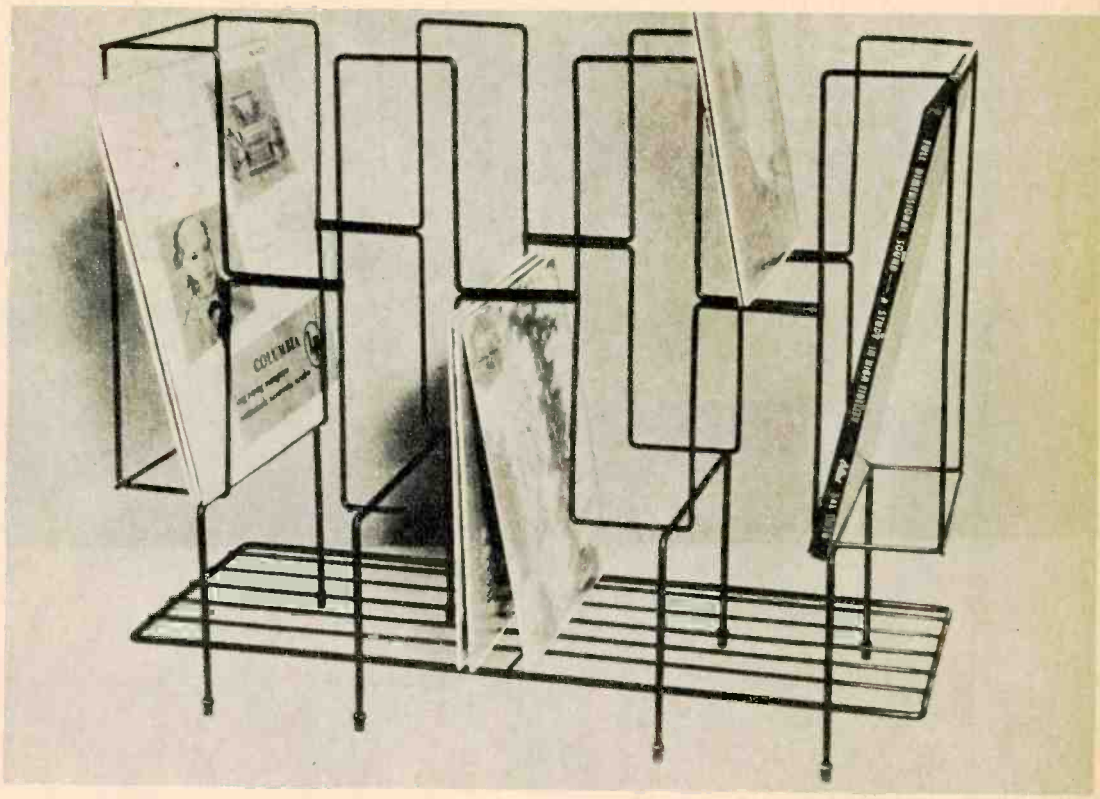
The best turntables, while they have none of the disadvantages of the changer, also lack that very important advantage of convenience. On the other hand, there is probably no changer which can match the best turntables in speed regulation, wow, flutter and rumble.

The questions the prospective purchaser must consider, then, will be answered somewhat differently by almost every individual. Probably the uppermost question will concern the relative importance of the changer's convenience, or conversely, the relative annoyance of changing records manually every few minutes. Next he will want to consider the quality of reproduction. For the very best at this state of the art, a high-grade turntable is a must. If, on the other hand, a little less can be tolerated—and the difference is often academic—then the changer shouldn't be ruled out.

Thus there can be no universal answer to this question. At least it is not on the horizon at this moment. Each design represents some compromises, and the individual must decide for himself which compromises he is prepared to make. •—*D. H.*

Arrest Those Disc Destroyers!

Protect your investment in records with the best possible care.



Records will warp if stored in any position other than the absolute vertical. Handsome racks like this one by Leslie Creations of Philadelphia make proper record storage a simple matter.

HOW LONG will a phonograph record last? One proper answer to that very big question could be *indefinitely.*

Since the modern record is made of a plastic of the vinyl resin family, which at normal temperatures is almost inert chemically, it is hardly at all subject to the ravages of time. It is only the use *or abuse* to which a record is subjected which determines its life span. With proper care a record can have a long reproductive life, providing its owner with many hours of happy listening. But if maltreated, its life can be snuffed out in minutes, or even seconds.

Let's examine certain disc destroyers, with an eye toward what we can do to stop them dead in their tracks. While it would take some effort to break a vinyl record, it can become bent, scratched, scorched, chipped and downright dirty.

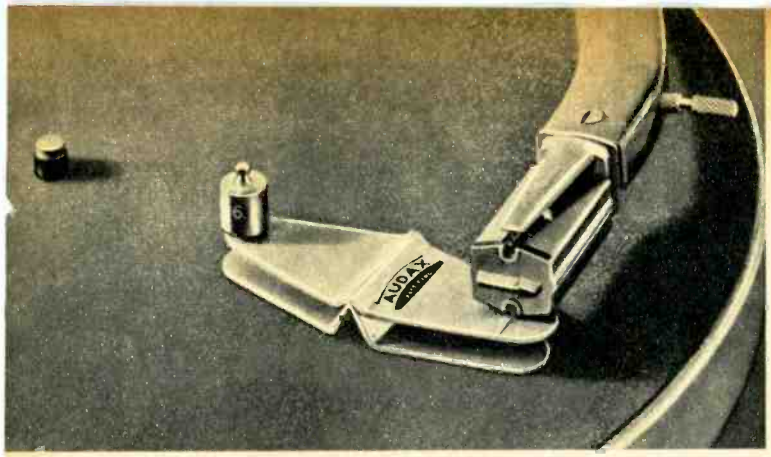
Now consider the dirt problem first, because that is probably the most deceptive. A few flecks of dust here or there don't really seem very significant until you remember that the full width of the groove on an LP record is something less than *three thousandths* of an inch. Your eyes are a lot larger than that, but you know what a tiny speck of dust can do when lodged in one of them. A phono stylus pushing that dust against soft plastic groove walls, under pressures of 5 to 10 tons per square inch, can cause a lot of damage, too.

Dirt adheres to records because of two main attractions: static electricity and greasy hands. Since no hands, regardless of how clean, can avoid depositing oily prints on the record (unless you want to wear white photographers' gloves all the time), a first principle of record care is *never touch the grooved surface with the hands.* Instead, always hold the disc only at the edge and in the label area.

The static problem is a little trickier. There are several radioactive attachments available for neutralizing static, along with various kinds of anti-static rags, liquids and even sprays. There is no doubt that these items are as effective as the manufacturers claim, but generally they create as many problems as they minimize. The better practice, then, is simply to keep dirt away from the records as much as possible, and when it does appear, remove it before playing.

Dust jackets now provide much better protection than was once the case. Most of the better records now come in a double thickness jacket, with an inner envelope of plastic, glassine or cardboard. When these are used, it is best to insert the record in such a way that the open end of the inner envelope is against the closed end of the outer one. This provides a baffle seal which is almost completely impervious to dust when the record is stored.

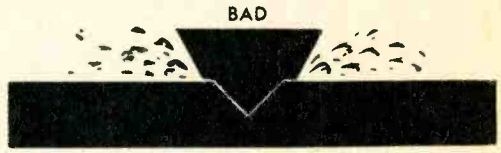
But despite all precautions some dust does find its way onto record surfaces, and it must be removed before the disc is played. The best means by far is blowing the dirt off. Since few hi-fi hobbyists are equipped with compressed air bottles or air compressor pumps, this is a little inconvenient. The ordinary household vacuum cleaner, however, works quite well when connected to work as a blower. A



Important to record care are weight exerted on them and stylus condition. Weight of the tone arm is readily checked by Audax's balance scale, left. Drawings below show how a worn stylus can damage your records.

GOOD STYLUS PICKS UP HIGH FREQUENCIES; POOR ONE SKIPS THEM AND DAMAGES RECORD

GOOD—STYLUS IN GOOD CONDITION RESTS ON SIDES OF GROOVE.



BAD—CHISEL-LIKE, WORN OUT STYLUS SINKS INTO BOTTOM OF GROOVE AND SCRAPES MUSICAL IMPRESSIONS OFF GROOVE WALLS.

fairly good pressure can be built up when the crevice-cleaning tool is used, and this can be increased by partially obstructing the opening by wrapping a piece of tape over the end.

The next best method is a slightly dampened cloth or sponge. The fine cellulose sponges sold for photographic work are very useful. The record is held flat, with one edge against the chest and the opposite edge with one hand held vertically. The sponge is then applied with the free hand rubbing gently but firmly in a circular motion.

Bending and warpage in records seldom occurs through playing, but is usually due to improper storage. Nearly everyone has seen records that have stood in a store window on a hot sunny day, looking as if they had just been poured out of a molasses can. It isn't hard to guess then that excessive heat is a prime disc destroyer. And the avoidance of this problem is equally simple: *keep records away from heat.* As long as records are not stored in direct sunlight, or near stoves or radiators, ordinary room temperatures will never hurt them. One more precaution: watch out for friends who have a tendency to put burning cigarettes on any convenient flat surface. Not only have many fine furniture finishes been ruined in this fashion, but so have far too many records.

Records will also warp if they are stored in any position other than absolute vertical. Leaving them stacked on a changer after playing is asking for trouble. Not only is the weight of the stack and the heat of the equipment liable to damage the records, but there may be injury to the changer mechanism. An even worse practice is to shut off the system in the middle of the program, with part of the record stack still suspended by the drop mechanism. All of this can be summed up by another rule: *records should never be left on a turntable or changer except when they are actually in use.*

When stored in the library, records should stand vertically in their dust jackets. Stacking horizontally on a shelf is nearly as bad as on a turntable, and leaning over at a 45-degree angle is even worse.

Scratching and chipping of records could be caused by almost any abuse, of course, but even when used as intended they are susceptible to damage. When removing a disc from its dust jacket it is wise to compress the side edges slightly, so that the opening buckles outward and permits passage of the record without scuffing its surfaces.

When setting up or removing a changer stack, particular care must be taken. Since the sensitive recorded surfaces are directly against each other, it is imperative that they be placed on and removed from one another vertically, *not* slid off sideways.

Correct operation of the reproducer is also an absolute must. Just as records should never be left on a turntable when not in use, so the tone arm must *never* be permitted to rest on a record when it is not actually playing. The hard stylus need only be knocked across the playing surface once, to plow a gash that will render the record useless.

When in playing position, the stylus should be at right angles to the plane of the disc, not tilted forward, backward or sideways. The stylus pressure should be adjusted to the lightest weight recommended by the manufacturer, usually somewhere between 5 and 12 grams. The tone arm should be initially mounted as specified by the manufacturer to eliminate tracking error, a factor in reducing not only distortion, but record wear as well.

There is perhaps more confusion about the matter of stylus material than need be. Let it be understood at the outset that there is no such thing as a permanent needle. Even diamond, the hardest material known, will wear out when used as a phono stylus. On the other hand, almost any material of the correct size, shape, and smoothness will be satisfactory as a phono stylus for a little while, anyway. This means that the argument that records sound better when played with diamond styli is false.

Osmium is the cheapest in initial cost, but it also wears out fastest. Diamond is the most expensive initially, but it lasts the longest. Sapphire is between the two both in cost and wear. Any stylus with a worn tip is a potential menace to the record grooves, and by the time you can hear the difference in reproduction the damage is permanent. This means that periodic inspection of the stylus by microscope or shadowgraph is mandatory. Most dealers are now able to provide this service.

The advantage of diamond—the *only* advantage—as opposed to sapphire and osmium, is that it will deliver more hours of playing time per dollar invested. For this reason the diamond is to be preferred over all other stylus materials. But at the same time it should be remembered that the others will deliver just as good quality sound for a briefer period, and for those with pinched budgets it is completely acceptable.

Follow these principles and you will give your precious records the best life insurance they could have. •—*D. H.*

Re-recording: Disc to Tape

Want to create a taped library of music from a record collection? Here's how.

ANYONE WHO HAS A HI-FI SYSTEM with a tape recorder is missing a real good bet if he doesn't make tape copies of his disc library. There are numerous advantages to such a system, but probably the most important is that it will prolong the life of records almost indefinitely.

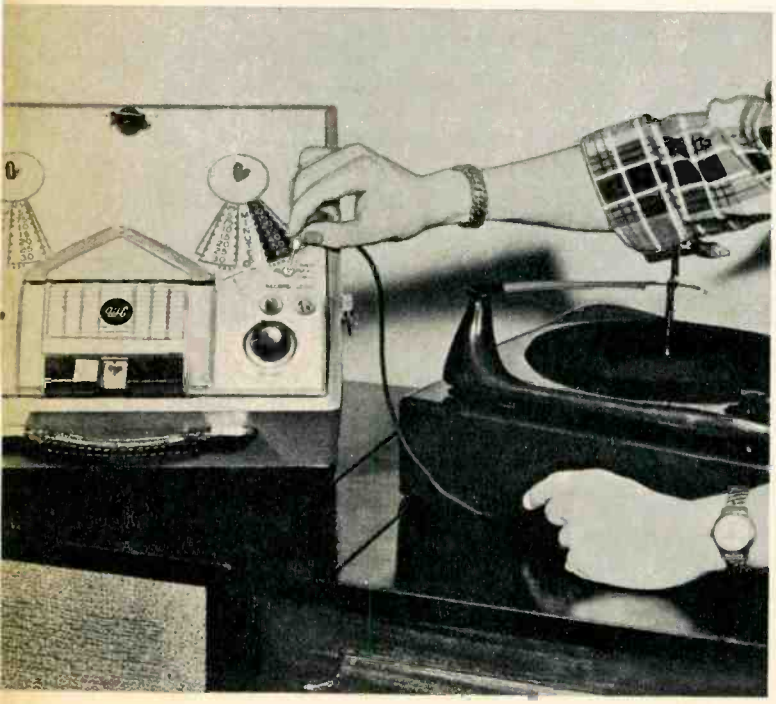
If your library consists of many old shellac pressings which are both fragile and irreplaceable, why subject them to more wear and tear? Why risk the possibility that they may be broken and lost forever? Just one more playing is necessary to make your tape rerecording, and then the precious disc can be stored in your archives—and you can rest easy.

Dubbing to tape is really quite simple, but you can do it better if you observe a few of the tricks employed by professionals. Nearly all of the hi-fi amplifiers today have a "bridging" output jack which is used to feed a tape recorder input. Using this connection in no way disturbs the normal operation of the system, so you can listen directly over the hi-fi speaker as the tape is made. Similarly, most tape recorders have an input connection intended for using the signal from the amplifier output. Connection is made simply by plugging in a cable from the appropriate amplifier output jack to the proper recorder input jack.

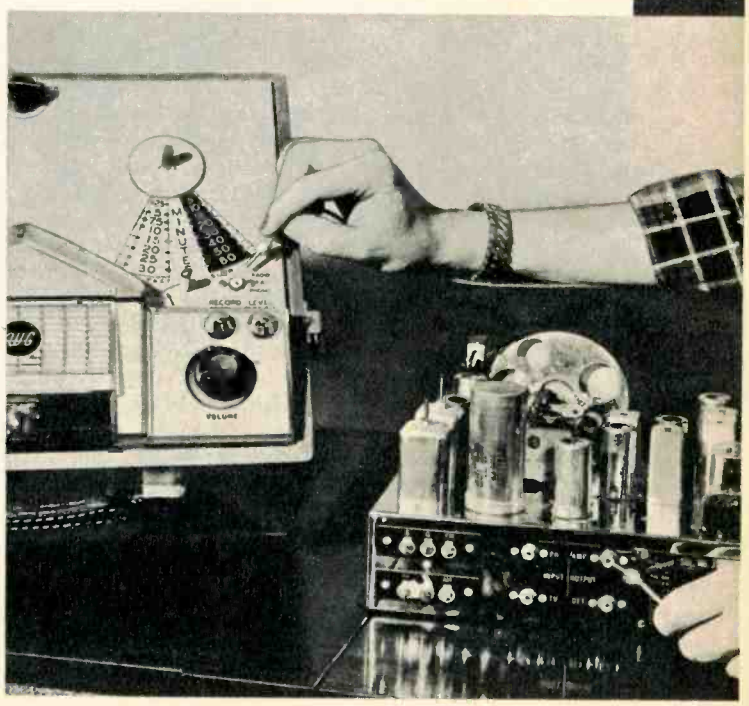
If you don't have such an interconnecting cable, you can get a "Hi-Fi Jumper Cable" from one of the mail order houses, such as Lafayette Radio.

Begin by selecting the first record to be dubbed, and play it through your system in the usual manner. Adjust the volume to a comfortable level, and choose your equalizer and tone control settings for the sound you want on the tape. Then adjust the volume control on the tape recorder for the correct indication as specified by the manufacturer. Now you are ready to "cue up" the disc and begin recording.

Cueing a record is done so that the first actual sound heard will be the beginning of music or voice on the recording, without any preceding surface noise,



To record directly from turntable to tape, phono cable on turntable is connected to a low gain input on tape recorder.



Alternative method of recording from tuner is to connect by shielded cable the tuner output to low gain tape input.

Above, CBS announcer Dick Noel sets up equipment for recording discs on tape; the process is not an involved one

Noel first identifies the long-playing tape he is making by recording an announcement of piece, composer, orchestra.

The disc to be taped is "cued up" by manually turning it until sound begins, then turning it back two revolutions.

clicks, pops or scratches. This is done by keeping the volume control fully closed until the very instant sound is to begin, and then opening up the control to the previously established setting. The only trouble is, how can you tell when sound begins if the volume is turned down?

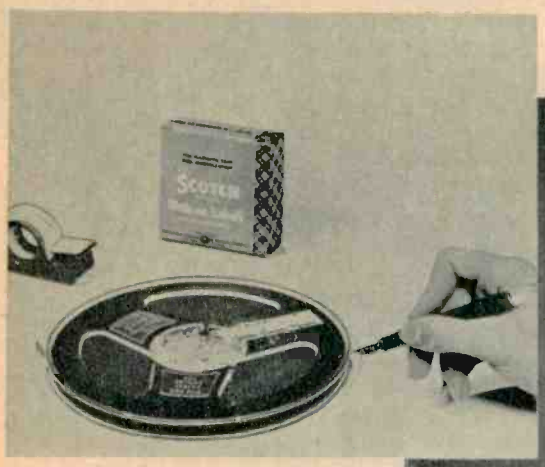
This is not impossible. In fact, it is being done hundreds of times every day by radio broadcast stations throughout the land. In radio stations the operator first sets his sound system so that he can hear the record without it going out on the air. Meanwhile, another record or other program material is being heard by listeners. You won't need this elaboration for your work, but the procedure which the operator then follows will be useful to you.

The next step is to place the pickup in the lead-in groove of the record, then rotate the turntable by hand until the beginning of sound is reached. Then the turntable is ro-

Disc is cued, tape started, turntable turned on, the revolutions counted, volume turned up as the sound is reached.

For a smooth fade-out of a noisy record, announcer Noel uses earphones to monitor his work as the music finishes.

Left and below, written identification of what is on the tape is made on both the tape box and the plastic spool.



These bulk tape erasers will erase even the most powerful signals from a recorded tape in a few moments; these devices clean the entire tape at once.

tated backwards (counter-clockwise) until there is anywhere from one-quarter to three turns of blank grooving ahead of sound. In broadcasting, the pickup is often placed quite close to the beginning of modulation, the record held fast by hand, and the turntable started and permitted to skid under the stationary disc. Then when an announcement is completed, the record is let go to rotate with the table, the volume control is opened up and music begins immediately.

For home use, it's not a good idea to load the turntable with a skidding record, so a longer cue-in of perhaps three turns is to be preferred. Then you can start the table from a dead stop with the switch, count turns, and finally open the volume control just as music starts.

Fading out the end of the record can be almost as tricky as the fade-in, especially if the noise level is high and the music soft. In these cases it is advisable to rehearse the ending and the fadeout a few times, to determine just when it should be made, and how quickly or slowly the control should be rotated. The faded ending may sometimes be made less obtrusive by slowly turning down the treble control on the final soft notes, before the volume control is closed.

Taping your old 78-r.p.m. records will prolong their usefulness, and enable you to program them the way you want. And if sometime later you want to change the sequence, you can do that too. You can also remove ticks and pops, even those caused by a crack in the record. All of this is part of the fascinating art of *tape editing*. But that's another story, to be found elsewhere in this book.

When reusing tape which has been previously recorded, it is often found that the erase oscillator in home machines is not strong enough to silence the tape completely. When going to considerable trouble to provide smooth fade-ins and fade-outs, as well as perfectly silent pauses in your own LP tapes, it is a shame to have the results marred by residual noise and music from previous recordings.

The problem is even greater when tape is used which was originally recorded at excessive levels. Then even the most powerful erase circuits on professional equipment are sometimes unable to obliterate the sounds completely. There are also noises in new tape which are induced in it during manufacture, shipping or storage. Usually the erase circuits in tape machines are adequate for this task, but not always.

All of these problems can be solved through the use of a bulk tape eraser, which will erase even the most powerful signals from a recorded tape in a few moments. These devices clean the entire tape at one time, thus precluding the necessity of running it through a machine at regular playing speed. For anyone who takes his recording work seriously, a bulk eraser is an absolute must. Typical commercial examples are the Amplicorp "Magneraser," Goodell "Noiseraser," and the Stencil-Hoffman Bulk Eraser.

Since laboratory tests have proven that tape recordings are good for thousands upon thousands of playings, transferring a valuable disc library to tape is not only good fun, but good economy as well. And with just a little extra effort, you can have a recorded music library which is truly outstanding. •—*D. H.*

You'll derive more enjoyment from your tapes when the superfluous sound and noise is edited out. Here, CBS announcer Dick Noel listens for improper splicing.

Edit Those Tapes!

It's easy and it costs nothing in materials, since deleted tape can of course be reused. Here is exactly what you must know to do the job right.

HOME-MADE TAPES, like home movies, can be improved immensely by just a little judicious pruning or editing. Still few movie makers ever attempt it, and even fewer tape recordists have ever even considered it.

In the case of the amateur cinematographer there is some justification, for it comes hard to junk even one frame of that little ribbon which was bought with cold, hard cash. But the tape recordist has no such excuse, for every bit of tape he removes by editing can be reused for recording again and again.

It is entirely possible, however, that the recordist would like to try some editing, but the conflicting stories he has heard leave him just plain confused. When he bought his machine, chances are the salesman told him that one of the wondrous advantages of tape is the ability to "just snip out" any mistakes. On the other hand he may have heard that the top tape editors in the country number a mere handful, and if the work is that rough he wants no part of it.

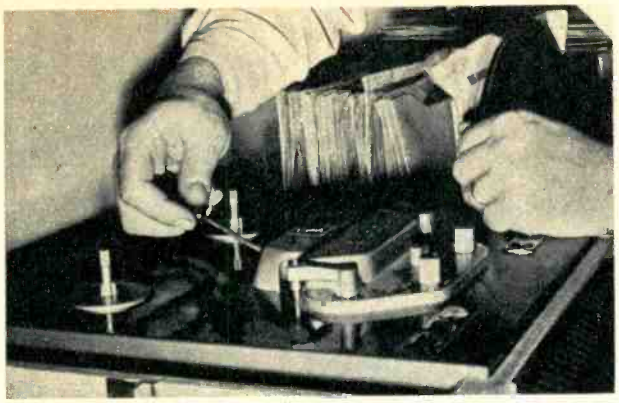
These are the two extremes of the story, and the actual truth of the situation lies somewhere between. Tape editing, while more than just snipping out, is not really very difficult. You can do it too, if you really want to.

Tape editing consists of cutting out unwanted parts of a recording, or arranging parts in a different sequence, or both. To use a photographic analogy, the first type can be likened to cropping a print. You see that by removing parts of the overall picture, the remaining composition becomes more compact, pleasing or forceful. By rearranging various parts of one or more pictures into a montage, you have created something new—you have synthesized a whole from selected parts.

Tape editing works much the same way. You can tighten up a dull performance and eliminate errors by judicious use of the splicer. In the same way you can synthesize something new, something which was never performed that way.

But this is as far as the analogy goes, for while the photographer is working with a visual medium and can see what he's working on, the tape editor cannot see sound. He must rely upon his ears, more than his eyes, to tell his hands what to do. But as long as he understands a few fundamental principles, he can remove that mental roadblock between his ears and his hands.

To begin with, he must remember that recorded tape is really just a series of magnetic impulses, much as a movie film is a series of still picture frames. And the magnetic impulses responsible for each of the sounds he hears have a definite and immobile position on that tape. As long as that tape remains recorded, whenever it passes the reproduce head, the same magnetic impulses will produce the



The shield housing must be removed to enable you to mark the tape; one or two screws are removed to accomplish this.

"Spotting" bad sound is accomplished by manually rocking the tape reels back and forth past the playback head.

same sounds from the same place on the tape every single time.

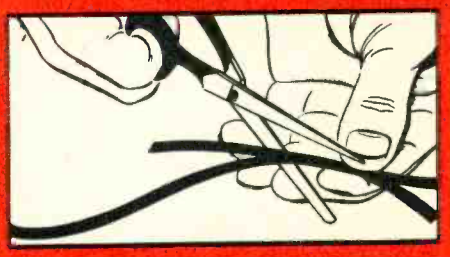
And here we have our first and most important clue: magnetic impulses on a moving tape as it passes a *reproduce head*. It is this reproduce head which will enable us to relate the sound heard on the loudspeaker to the exact position on the tape of the magnetic impulse causing it. Once we have "spotted" the particular sound we're looking for on the tape, the toughest part of the editing job is done.

The reproduce head, as well as the erase and record functions are all to be found in a small housing about midway between the two tape reels. This housing must be removed, as it is essential to be able to see the reproduce head while spotting. Since the tape moves from left to right during normal operation, the reproduce head is the farthest to the right.

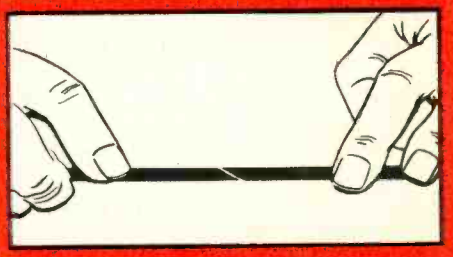
If this same head is also used for recording, it will still be the farthermost to the right. Upon close examination you will see a small vertical line running up through the middle of the head. This is known as the *gap*, since it is as the tape passes this fine hairline that sound is produced. Now it becomes evident just how accurate spotting is possible.

As the tape is played, and it reaches the point where a splice is to be made, the stop button is pressed. Then

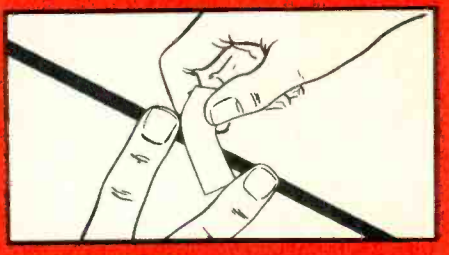
HOW TO SPLICE TAPE



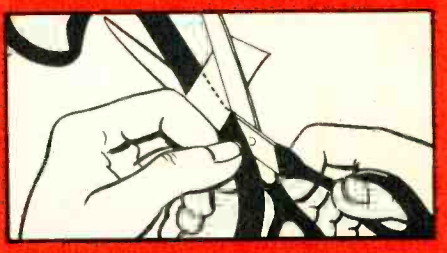
Cut the tape at correct points at 45° angle, with both pieces set parallel.



Align and butt together the tape ends, with the uncoated (shiny) side upward.



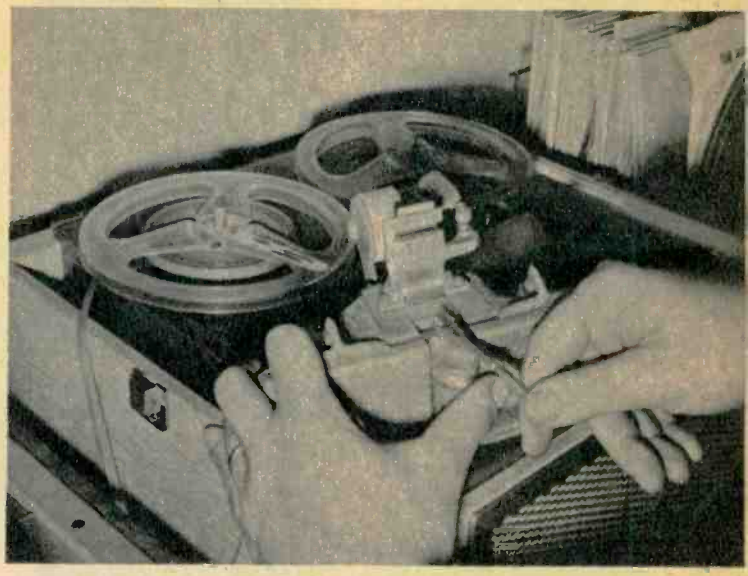
Smooth out the air bubbles after applying cellulose tape; do not use metal.

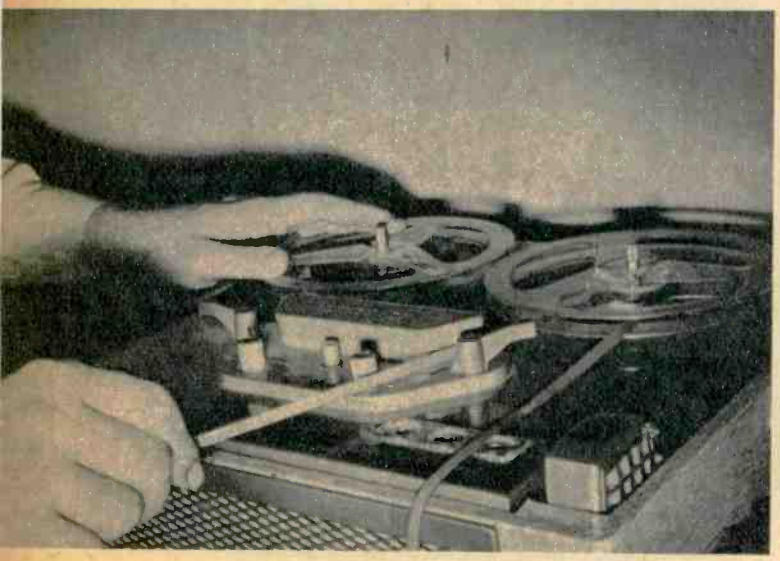


After tape is joined properly, trim and undercut it slightly to avoid sticking.

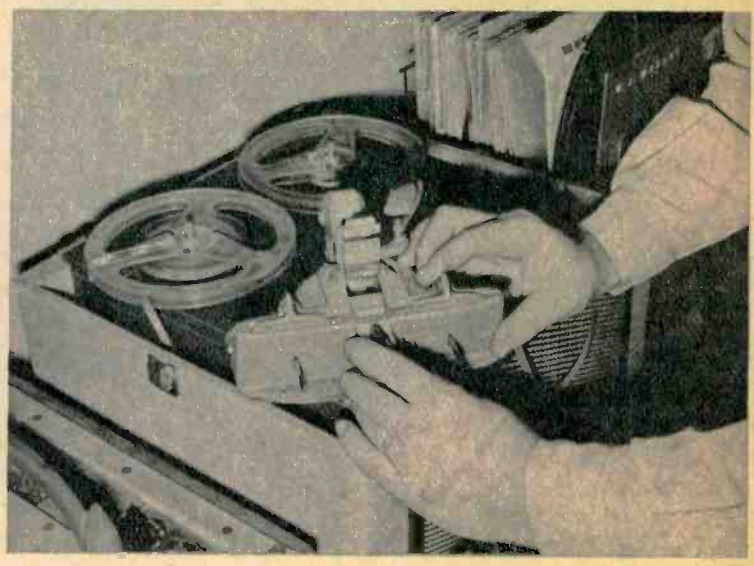
After "spotting" bad sound, tape is marked at the head gap with a china-marking pencil; a crayon can be used.

After marking with pencil, the tape is cut on the mark, using a pair of scissors or an automatic splicer, below.





The cut end of the tape is pulled past the playback head slowly, to spot the next cutting point; work carefully.



Finally, the second cut is made, the removed tape is discarded, and the two remaining ends are spliced together.

HERE IS A TABLE TO HELP YOU DETERMINE HOW LONG YOU CAN RECORD ON A TAPE RECORDER

	SINGLE TRACK			DUAL TRACK	
LENGTH	3¾" per sec.	7½" per sec.	15" per sec.	3¾" per sec.	7½" per sec.
150 ft.	7½ min.	3¾ min.	.....	15 min.	7½ min.
300 ft.	15 min.	7½ min.	3¾ min.	30 min.	15 min.
600 ft.	30 min.	15 min.	7½ min.	60 min.	30 min.
1200 ft.	60 min.	30 min.	15 min.	120 min.	60 min.

the reels are turned back and forth by hand until the exact spot on the tape is found which is producing the sound in question. Then with the tape stopped with the splice point directly over the reproduce head gap, a mark is made on the tape at the gap. A grease pencil (china-marking) is best for this purpose, preferably yellow.

Now let's consider a simple practical problem in tape editing. Suppose that you have a series of tape copies of a number of single phonograph records, which you wish to edit into a pleasing program of continuous music. You may want silent pauses of perhaps 3 to 5 seconds between selections, but as the tape was recorded the pauses are much longer and marred by switching clicks. The problem then is to tighten up pauses and remove the noises.

The first thing to do is play the tape near the end of the first selection. For the few seconds following, listen carefully for any noises. If any are heard, stop the machine and rewind the tape manually by turning the supply (left-hand) reel. As soon as the noise is heard again, stop turning, and with one hand on each reel move the tape rapidly back and forth across the reproduce head. When the noisy section of tape is fairly well centered in the head area, cut off an inch or two either side of this point. It is not necessary to do very precise spotting in this work, as the only objective at the moment is to get several consecutive seconds of clean, quiet tape following the music.

All this can be avoided, of course, by the insertion of tape known to be silent, such as erased magnetic tape or non-magnetic leader tape. The length of the silent tape is then calculated as the time of the pause in seconds multiplied by the operating speed of the machine in inches per second.

So now we have the silent pause of some sort and of the correct length spliced to the end of the preceding selection. The final step is to bring in the next selection right at the end of the pause. This is accomplished by pulling the tape from the supply reel past the playback head until the beginning of the next selection is heard. Then the tape is rocked back and forth across the head until the precise point of the beginning of sound is spotted. It is then marked and cut at that point, and spliced onto the end of the silent pause tape.

Now let's consider a problem in editing speech. Suppose you have a tape of a child reciting, like this:

"Mary had a little lamb, its fleece was Snow White and the—uh—oh, I forget—its—its—fleece was white as snow. And everywhere. . ."

It might very well be that you want that tape just as it is, because it's so cute. But let's assume you're a cold perfectionist.

The first thing to do is *analyze,* know in advance what you want to do. In this simple example the little reader went astray immediately after "was," and got back on the track on the word "fleece." Obviously, then, everything after "was" and before "fleece" must be cut out. But even this won't be sufficient, for we then have a repeat of the words "fleece was."

This is actually an advantage, however, for it means that we can cut at any convenient point in the "fleece was" area. Sibilants are particularly easy to spot on tape, and so we might decide to do our cutting right in the middle of a word. For example, the strong *s-s-s* sound at the end of "fleece" would be ideal. In that case we'd spot and mark the tape at *identical* points, just before the sibilant hiss.

After cutting, we would have from part 1, "Mary had a little lamb, its flee. . .". And from part two we would have ". . .ce was white as snow. And everywhere. . .". Then when the two were spliced together, we'd have "Mary had a little lamb, its flee/ce was white as snow. And everywhere. . .". But if the splicing is done correctly, it won't be discerned at all. Similar splicing of music is often more complex than speech, simply because the sounds themselves are more complex.

And so the fundamentals of tape editing can be boiled down to two simple ideas:

1. *Practice to perfection spotting, marking, and splicing.*
2. *Know in advance exactly the aural effect you want to produce.*

Follow them and you can't go wrong. •—*D. H.*

Splices are pointed to; splices do not distort sound in any way. Knowledge of technique is a must for tape owners.

there are screws to connect an extension speaker. Also on the back, there is a switch to turn music to the extension speaker on or off.

Although we liked the idea of using an intercom in our new house, the fact that the main control station must usually remain in one location didn't appeal to us. We wanted to be able to move it to two or three places, yet be able to speak to four other stations. For this reason we did not want anything to do with the conventional built-in-the-wall squawk box.

At the time of building, I couldn't seem to find either the extension speakers I wanted, or the plug-in receptacle to move the radio-intercom to the two locations, so I decided to build up the units myself.

When our house was being constructed, I roughed in an opening 6x8 inches for a speaker in the kitchen and one at the front door. The bedroom and office used plug-in speakers that could be readily removed or rested on a desk or table.

I wished to move the radio-intercom from one darkroom to the other so standard wall plug openings were roughed in at these two locations. When the building was finished, a junction box cap was used to make a plug-in setup for the four stations. Female phono-plugs were riveted to the metal caps.

The wall speakers were attached to ¼-inch plywood which were covered with Reynolds "Do-It-Yourself" Aluminum.

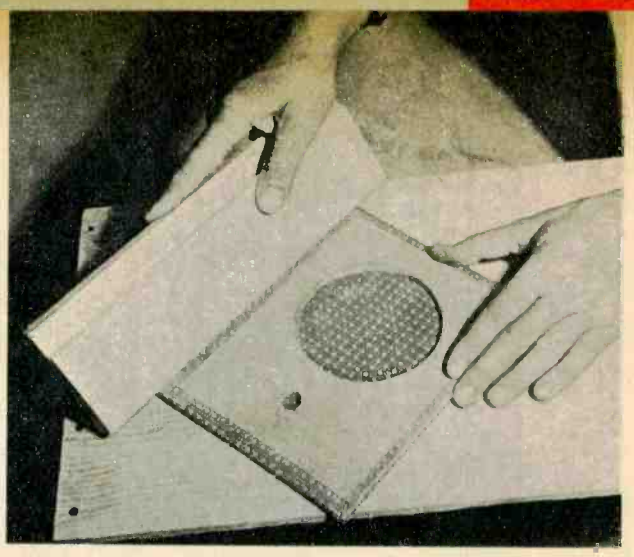
Naturally you can do a smoother job if you are building or remodeling a home because the wires can more easily be concealed. The plug-in speakers are perhaps more easily installed in the already built house because you don't have to cut into the plaster. Wires can be run through the basement with plugs near the baseboard, or through the attic with lead wires partially concealed by the window or door jambs.

We have added another advantage to our homemade intercom system by incorporating a bell system with buttons at the four extension speakers. Power is furnished by the same transformer that works the front door bell. With the bell system your intercom does not have to be turned on to call the main station. The person at the main station can then turn the set on to answer.

This solves the disadvantage of most intercom systems in that the calling must be done by the main station because both TALK and LISTEN are switched from that point only.

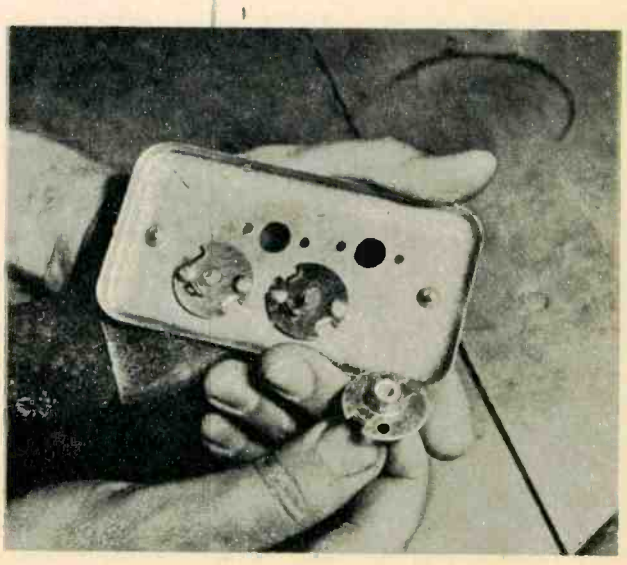
The various stations can be designated by the number of rings. For instance, station one rings once, station two rings twice, etc.

The main advantage of a combined intercom and buzzer system is the fact that the buzzers can be used to call the main station without the system being turned on. Most intercom systems have no way of calling from one station to the other but this method incorporates the use of buzzers at the different stations which work on ordinary bell wire and are hooked to the bell system of the house. It is a very inexpensive project to build since the speakers are only about $1.50 each. Reynolds "Do-It-Yourself" Aluminum can be purchased in sheets at a very small cost. We put this in when the house was being built so that our wires are all inside the walls. However it is possible to put it in at any time, but the difference would be in trying to hide the wires which would, naturally, be on the outside. Our main station is a combination radio and speaker so that music can be played through the system. •—*P. G.*

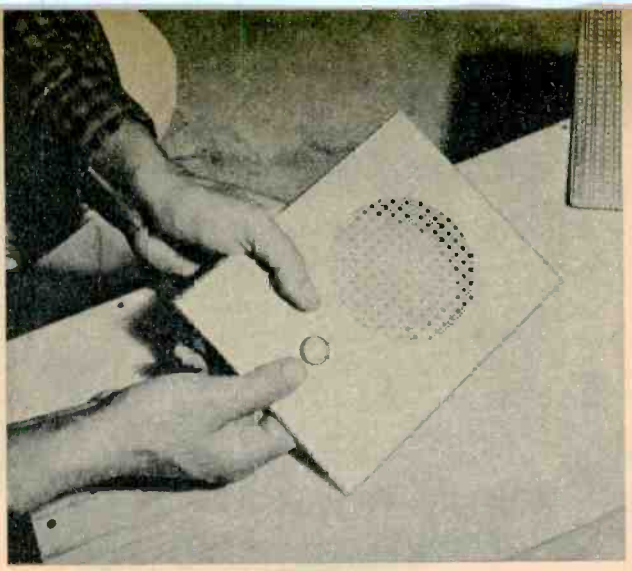


Lay plywood speaker rectangle over cut aluminum and, using a piece of wood, press fold-over so that it's flat, neat.

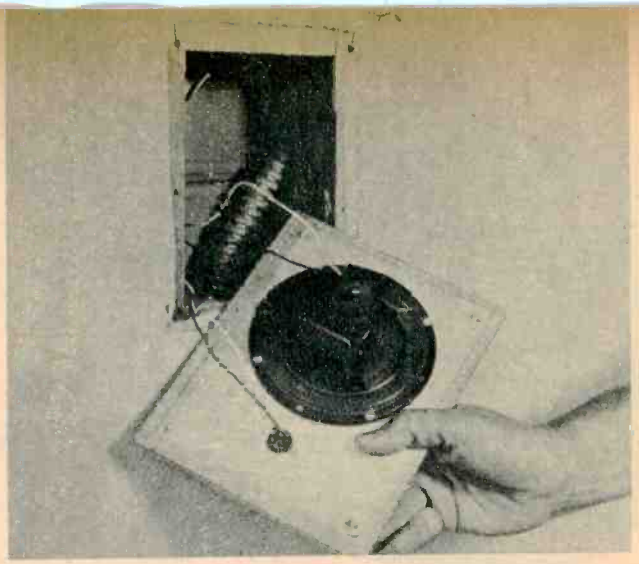
Another station is located next to wall telephone in kitchen and there's no more need for shouting to upstairs or garage.



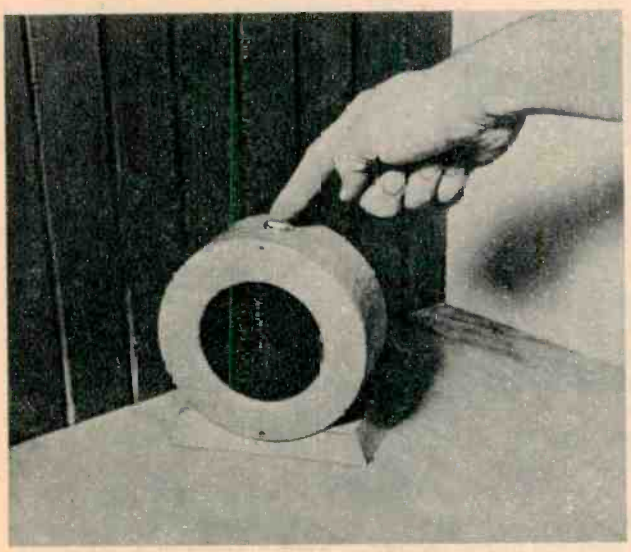
Phonograph jacks are inserted into the four holes and held in place with Reynolds "Do-It-Yourself" Aluminum rivets.



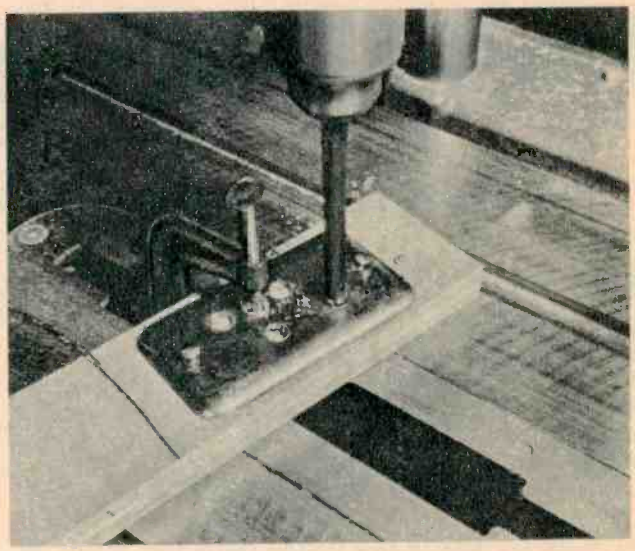
Cut button hole in aluminum over previously drilled hole in plywood. Install button from front as in photograph.



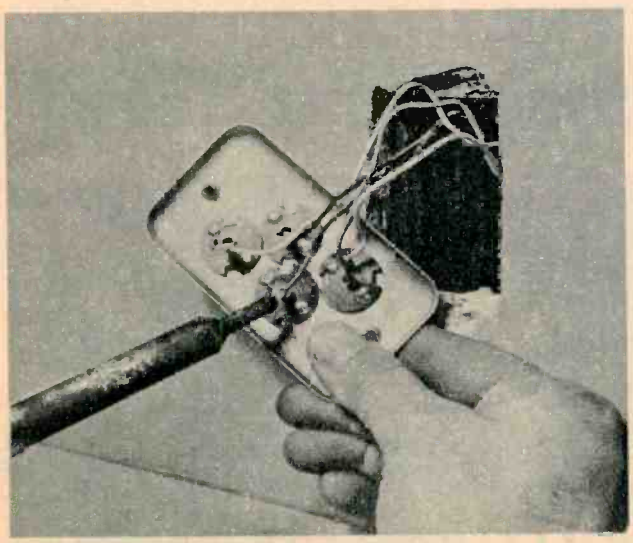
Now attach speaker and buzzer wires. Ideally, you'd have stations wired in when your house is under construction.



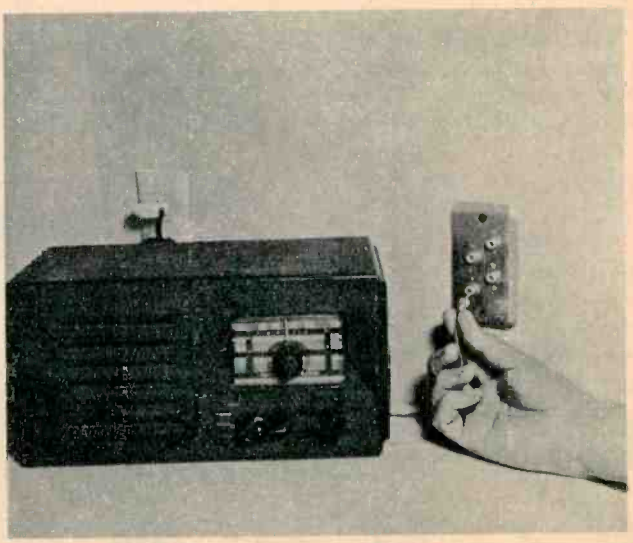
A handsome clock-like speaker is set in the bedroom. When a member of the family is ill, it works better than a bell.



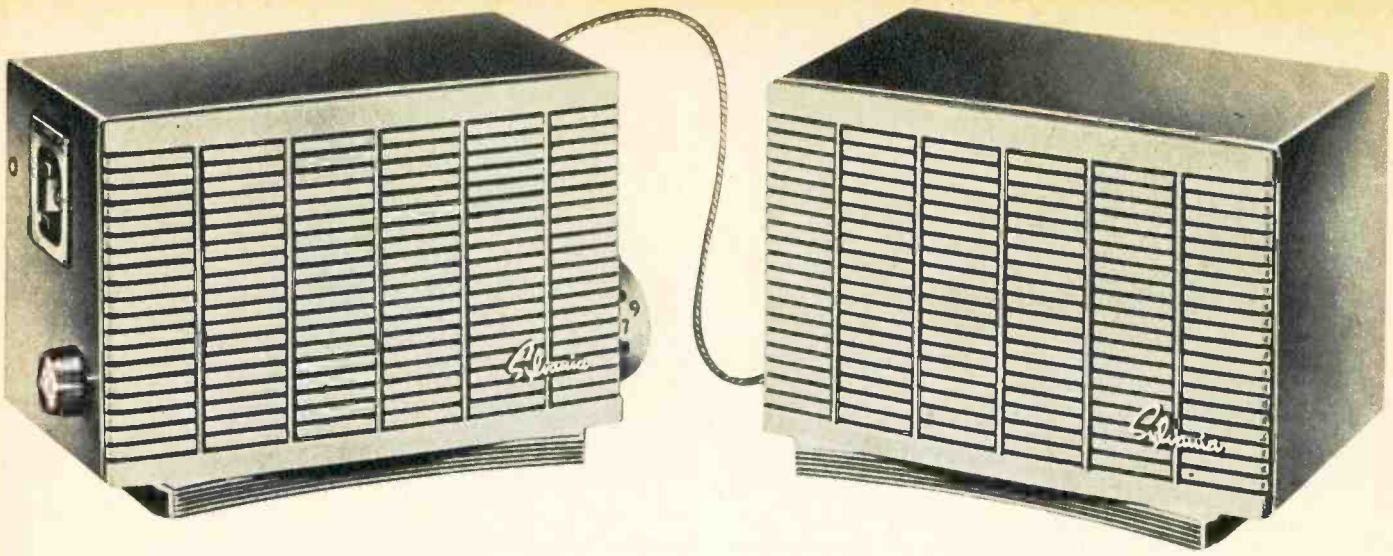
Main station was made by drilling a steel junction-box plate in four places to accommodate the necessary wires.



Wires of various colors to distinguish stations are attached to center unit. One wire serves to ground the entire unit.



Phonograph jack is used to plug into different stations from main intercom. Shown is a combination radio-intercom.



Master unit of "Phone-Radio," left, consists of radio chassis, control switches. "Slave," or remote speaker is at the right.

Radio-Intercom Combo

At the flip of a switch, the "Phone-Radio" is a step-saving two-station intercom.

WHY it hasn't been done before no one knows. That is, build a small radio receiver with an intercommunication feature, so that the single instrument can do double duty in a house or apartment. Every radio set includes a powerful audio amplifying system of two and sometimes more stages, and an "intercom" is merely an amplifier with a loudspeaker at each end also acting as a microphone.

Sylvania Electric now offers such a unit under the name "Phone-Radio." The "master" is a more or less conventional AC-DC radio in an attractive plastic case, measuring about 10½ by 5½ by 6½ inches. It has a tuning knob and a volume control. In addition, on the left side of the cabinet are two switches in a recessed plate. One is marked "Radio-Phone," the other "Listen-Speak." The "slave" or remote speaker, which has no controls, is in a case of similar appearance.

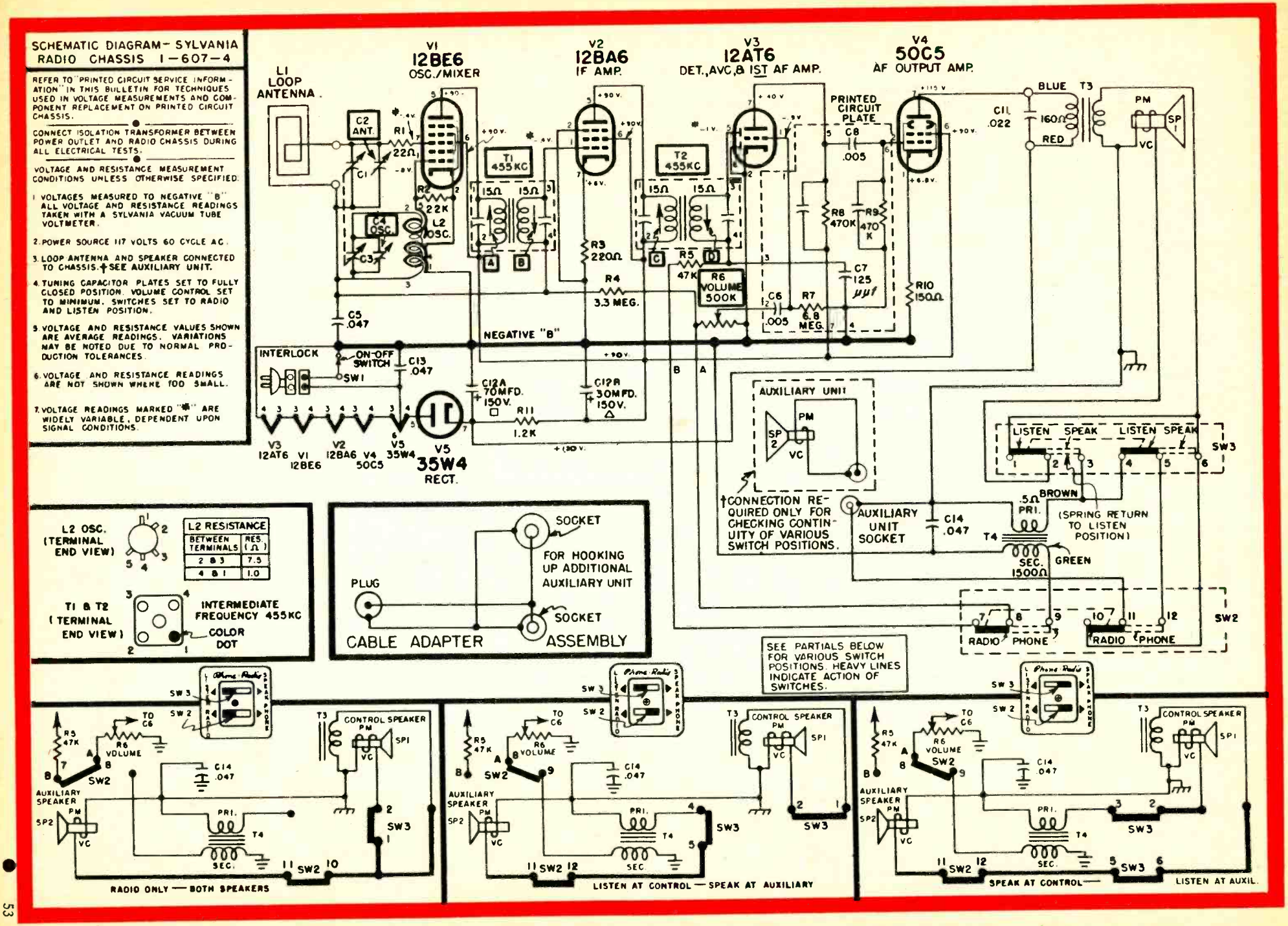
With the first switch at "Radio," the instrument functions as a straightforward radio. Suppose the slave speaker is in a child's room. If mother is in her usual place in the kitchen, she can check on baby at any time by flipping the switch to "Phone." This automatically puts the remote speaker into operation as a microphone and any sound in the baby's room is reproduced in the set in the kitchen. If mother wants to reassure the child with a few words, she presses the "Listen-Speak" switch to "Speak," talks into the kitchen set, and her words come out of the speaker in the bedroom. When she releases this switch, it returns by itself to the "Listen" position.

As a security measure, the intercom speaker at the front door is almost as good as a cop at the curb. Without moving a foot out of the kitchen, a woman alone in a house can dispel unwelcome salesmen and still do business with welcome tradesmen and greet friends.

Of course, the master and remote units are not limited to the home, but are useful in a variety of other applications. They offer a tremendous saving in time, tempers, steps and effort.

As a matter of technical interest, the complete wiring diagram of the "Phone-Radio" is reproduced here, through the courtesy of the manufacturer. The control switches are essentially of the double pole, double throw type. •—*R. H.*

SUGGESTED USES



Complete wiring diagram of the Sylvania Model 1102 "Phone-Radio."

Intercom Kit

You can enjoy the convenience of this neat two-station set for about $15

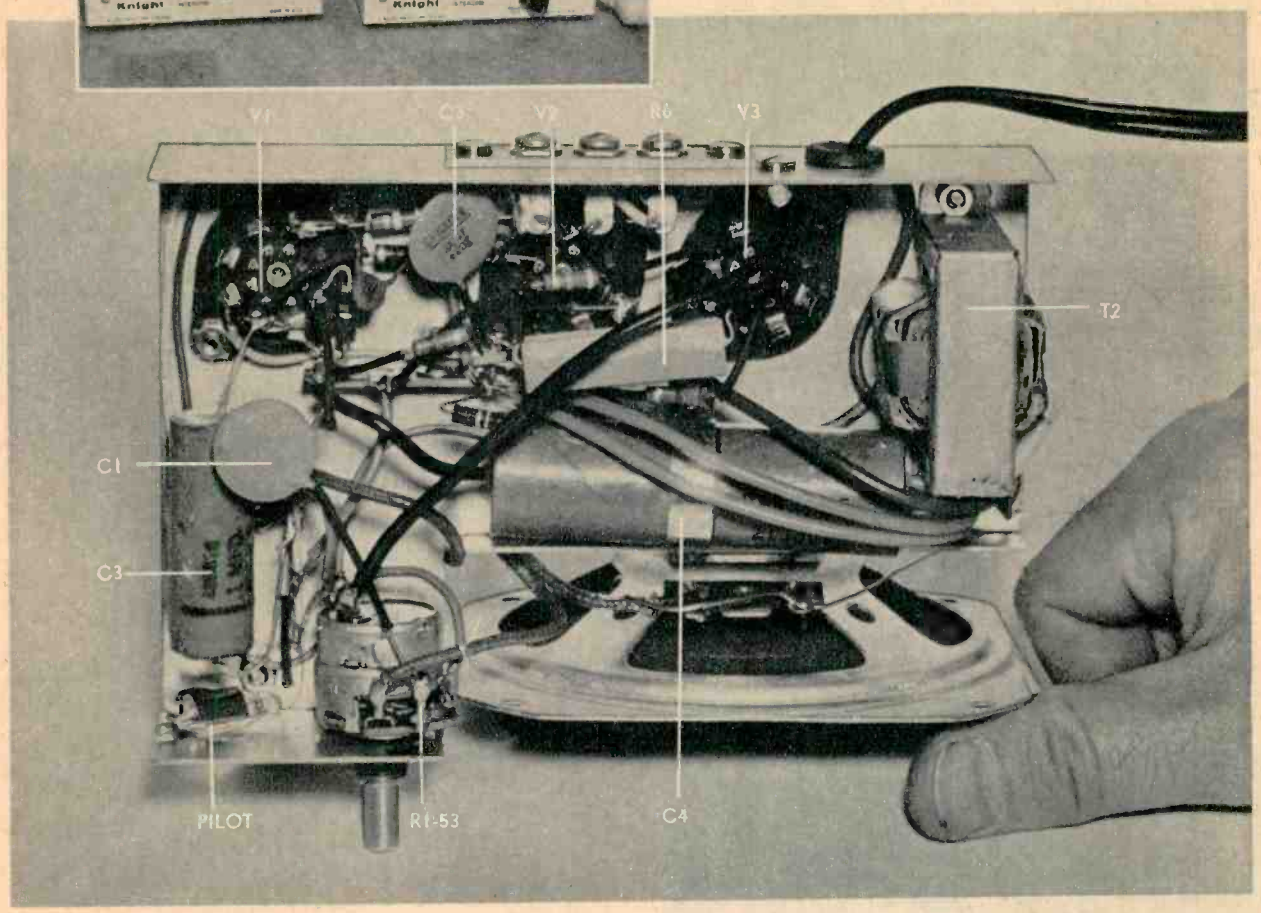
Slick master unit is in author Hertzberg's office; remote speaker in plain perforated case in window on front porch.

A COMPLETE TWO-STATION INTERCOM is now available in kit form for about $15, so there is no longer any reason why you and your family shouldn't enjoy the convenience such an outfit offers. It provides instant private communication, by means of loudspeakers at both ends, at distances up to a couple of hundred feet. The cost of operation is negligible, as only three small tubes are used.

The Knight "Home Intercom," marketed by Allied Radio Corporation of Chicago, is a very well planned kit. Assembly is an easy nut-and-bolt job, and wiring is made virtually foolproof by means of progressive picture diagrams and pre-cut leads. The writer opened a sample kit after lunch on a Saturday afternoon and had it working before supper.

The outfit consists of two units, a "master" and a "remote." The containers are identical and measure only 6½ by 5 inches by 4½ inches deep. They are made of strong sheet iron, finished in plain white, and can easily be sprayed any other color to match the appearance of the surroundings. The master is essentially a two-stage, high-gain audio amplifier, using a 12AV6 and a 50C5 tube, with a 35W4 rectifier in a transformerless power supply. The

Remote unit is on left, master on right of photo at left. Cabinets are identical. Hole beside the volume control on master is pilot light's window.

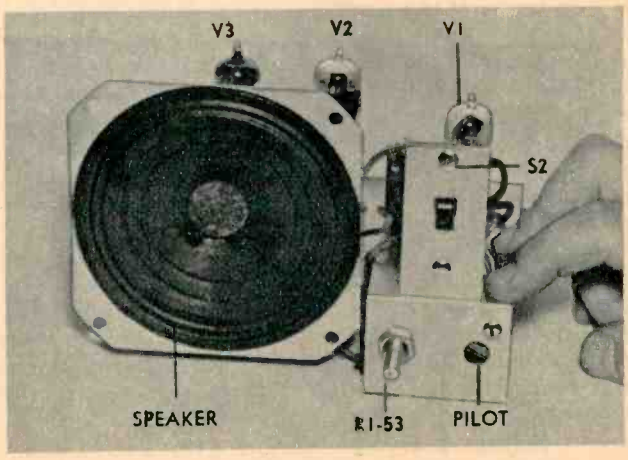


This is the underside of the chassis of the master unit of the Knight "Home Intercom." The parts markings are the same as those of the schematic diagram which appears on the page that follows. Wiring takes roughly two hours.

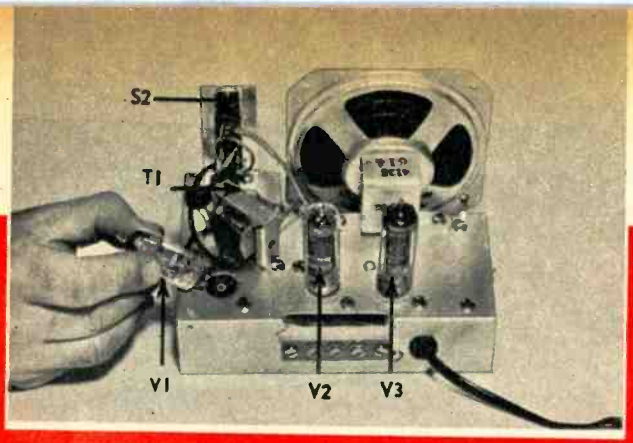
volume control R1 and the line switch S3 (see the schematic diagram) are combined, as in most radio sets. The "pilot light" shown just above the 35W4 is a tiny neon lamp. It shows red only after the rectifier tube has warmed up and has started to deliver its rated voltage to the amplifier circuits. This positive signal, or rather the absence of it, saves you from talking into a dead intercom. The warm-up period runs to about 20 seconds.

The remote is merely a loudspeaker in a box. The switch S1 is optional. It is desirable in some applications, undesirable in others.

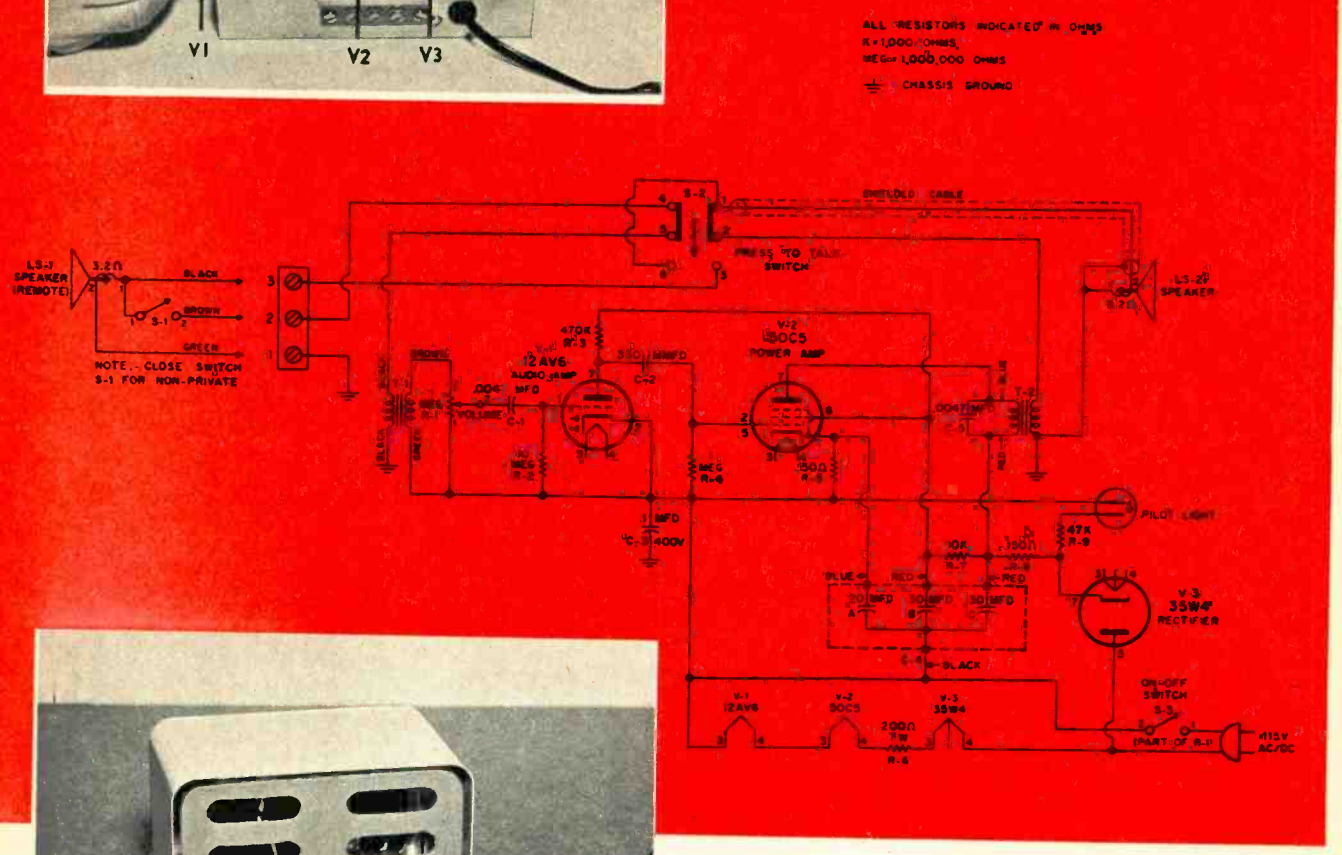
The heart of the master unit is the switch S2. This is a double-pole, double-throw type, with the moving arm contacts spring loaded so that they are normally in the up position as shown in the diagram. This corresponds to the "LISTEN" legend on the front panel. With the circuit in this condition, the loudspeaker of the master is connected to the secondary of the output transformer T2. Let's assume that the master and the remote are connected by a three-wire cable (included with the kit), with the black, brown and green wires from the remote going to posts 3, 2 and 1



Master chassis is little more than a handful. The speaker, switch and volume control mount permanently; entire unit then slides into cabinet and volume control knob is added.



Back view of master chassis. Transformer T1 is angled to minimize magnetic coupling with Transformer T2 below it.



The Knight "Home Intercom" consists of a straightforward two-stage amplifier with a transformerless power supply.

Wires from remote unit go to screw terminals on back of master. Only two wires are needed for non-private hookups.

respectively on the back of the master (left end of schematic diagram). The master unit is turned on. Either party can now originate a call. The master does so by pressing down his "press to talk" switch and talking into his loudspeaker, which now functions as a dynamic microphone. Regardless of the position of switch S1 on the remote, the master's voice comes through the remote's speaker. To answer, remote pushes his switch down to "TALK" and leaves it there. Master must release his switch to hear remote.

With remote's switch left in the "TALK" position and master's switch in the "LISTEN" position, master can hear everything taking place at remote. This, of course, is just what is wanted for baby-sitting, front-door-to-kitchen communication, etc. For these purposes it is better to eliminate the switch, to connect posts 3 and 2 by a jumper, and to hook the black wire to them. A two-wire cable is then all that is needed.

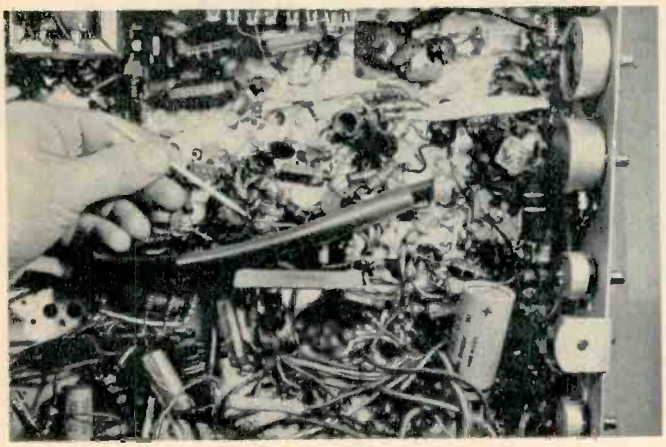
For business purposes, it may be a nuisance to have a constant background of sound from the remote station rumbling out of the master. The system can be made silent, but ready, merely by retaining switch S1 on the remote and leaving it normally in the up or "LISTEN" position. This arrangement is fine between a front office and a rear shop, a kitchen and a garage behind or under the house, etc.

If the remote unit is left permanently in the "TALK" position, the person at the master can keep the circuit alive but silent merely by turning the volume control down all the way to the left, just before it snaps the line switch off. If he wants to talk to the remote, he need only twist the volume knob, then press LISTEN-TALK switch down.

The writer can testify to the pick-up capabilities of this simple intercom. He installed the master in his basement office and the remote at the front door, with about 40 feet of two-wire cable between. With the volume control up full, the system reproduces conversations across the street, a distance of about 60 feet! For ordinary communication with callers, standing three or four feet from the remote speaker, a three o'clock setting of the volume control keeps the sound just below the blasting point.

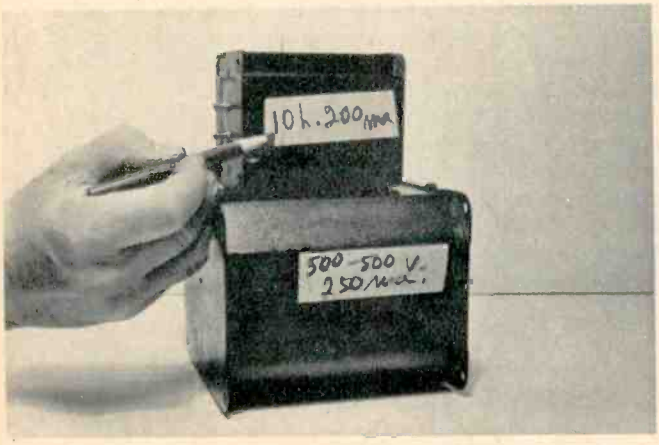
Note that this is a basic two-station intercom. With anything more than a single remote, switching and wiring become progressively more complicated. •—*R. H.*

Handy Kinks



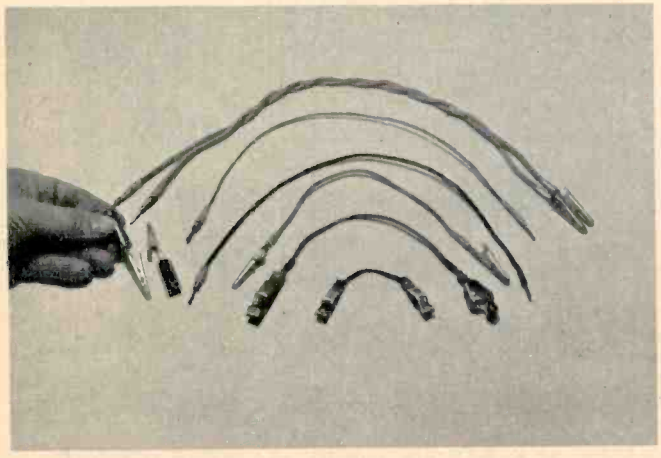
WOOD PICK: When it's necessary to poke into live tangled wiring of a TV set to check wires, use an orange stick or other pointed, stiff piece of wood. Wood insulates, will protect you from shock.

NOISY RECEIVER? If radio receiver is unaccountably noisy when dial is turned, check variable tuning capacitor. Remove from chassis, connect circuit tester, turn shaft, test for short as shown in photo.

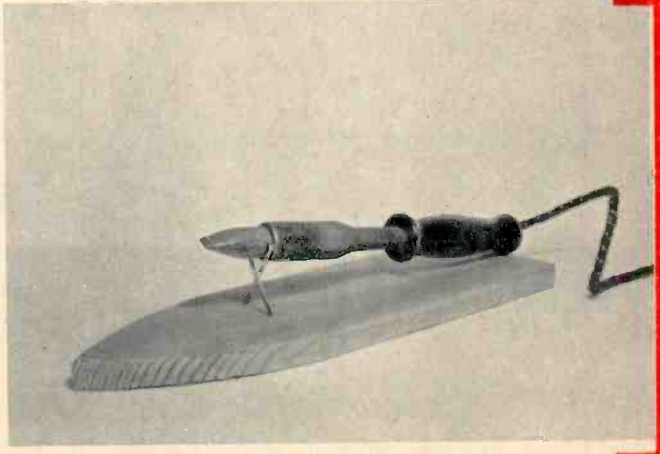


STICK-ON LABELS: Look up technical data for transformers and filter chokes, mark it in grease pencil on masking tape, stick to cases to save bother of consulting dozens of catalogs to identify later on.

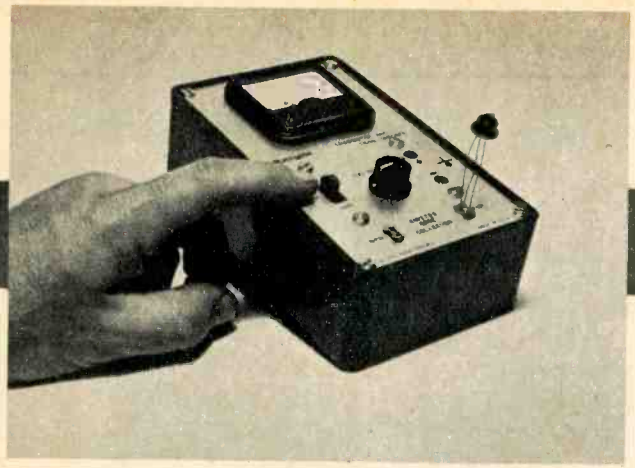
AN ILL WIND: This TV antenna, after being blown down in storm, produced better pictures than before, due to aluminum foil insulation reinforcing signals. Moral: experiment with various positions.



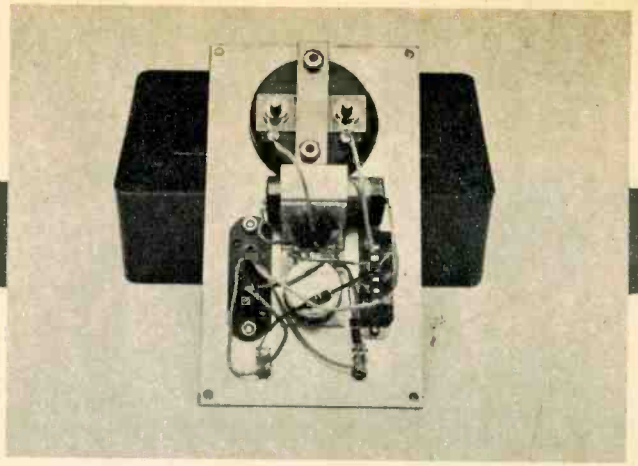
HANDY TEST LEADS: For quick temporary connections, a collection of flexible leads fitted with alligator clips is useful. Use No. 18 lamp cord; fit some wires with phone tips for connection to binding posts.



SOLDERING IRON SUPPORT: When iron is hot and you need both hands free, this stand is made to order. Merely drive two nails into a scrap board to form an "X." Base here is fence picket.



Tiny sockets take the transistor leads directly. Typical transistor is shown here connected to the right-hand receptacle. Finger points to the LEAKAGE-GAIN test switch.



Interior of the Knight Transistor and Diode Checker is seen in this photograph. The checker's power source, a 22½-volt battery, is bracket mounted under the meter.

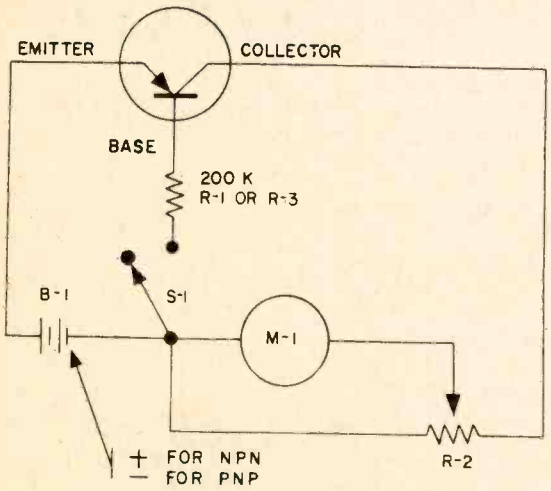
Transistor Checker

With the use of transistors increasing, checkers become increasingly important. This one's inexpensive, easily assembled.

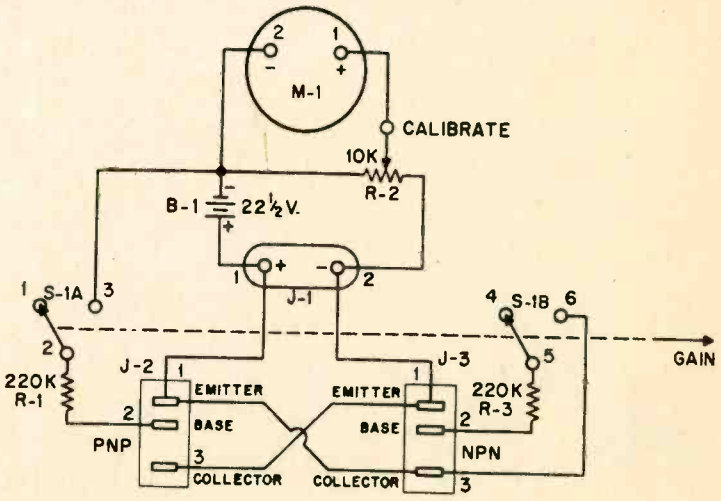
MANY AN ELECTRONIC TECHNICIAN and experimenter finds himself in an embarrassing position these days when he is called on to investigate trouble in radio receivers, hearing aids, amplifiers and similar devices using transistors. He looks over his collection of multimeters, VTVM's, oscilloscopes, signal generators, etc., and realizes sadly that not one of these instruments is of immediate help in testing pea-sized transistors.

Fortunately, it is less than an hour's work to knock together a very good transistor checker from an inexpensive kit. This quickly earns an important place among its more imposing older brothers. The accompanying illustrations show the Knight "Transistor and Diode Checker" assembled by the writer and found to be very effective.

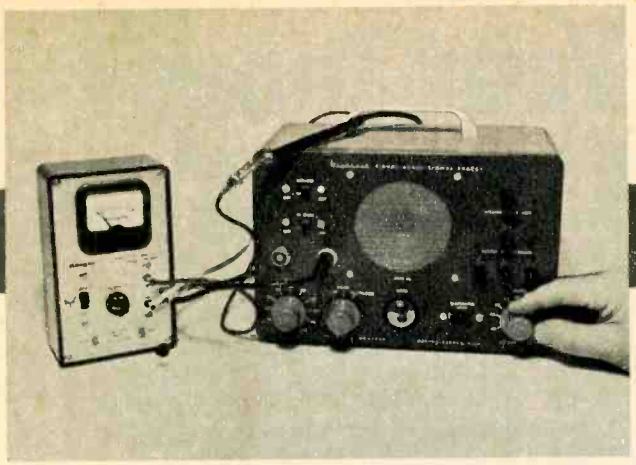
The unit is extremely simple, and consists only of a 0-1



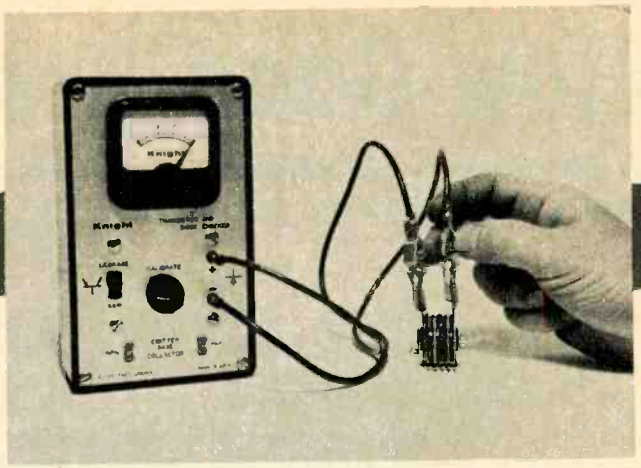
Simplified schematic diagram of the transistor checker.



Switches S-1A, S-1B are actually one: LEAKAGE-GAIN.



With the transistor checker teamed with a signal tracer (essentially a high-gain amplifier with built-in speaker), different transistors' relative noise levels are determined.



As its name indicates, the checker is used for diode rectifiers as well as transistors. Silicon, other types of diode rectifiers, are connected for test with flexible leads.

milliampere meter, a couple of resistors, a 22½-volt battery, a test switch, and connector points for the transistors and rectifiers to be tested. The parts are mounted on an aluminum panel and protected by a molded meter case. As the name indicates, the checker is used for diode rectifiers as well as for transistors.

The most important application of the instrument is the checking of the leakage-to-gain ratio of all types of junction and point contact transistors. Surface-barrier type transistors can be handled as well if a 4½-volt battery is connected in place of the 22½-volt unit. Because the meter readings provide a definite means of comparing transistors, it is easy to match up pairs of transistors, which are required for proper functioning of some amplifier circuits.

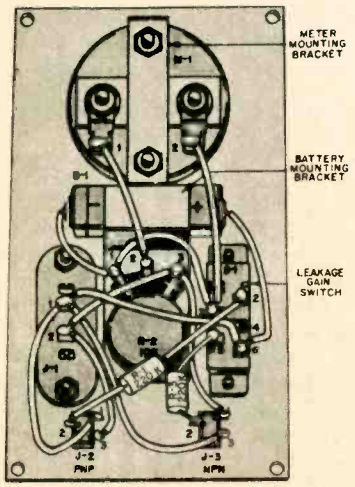
By hooking in a pair of sensitive earphones or better yet a signal tracer, it is also possible to check the noise level of transistors and to select the quietest ones for the most critical circuit positions. At the present time transistors tend to generate internal disturbances which show up in radio and amplifier equipment as a background of rushing or hissing sound.

Germanium and silicon diodes, widely used as detectors in television receivers, and selenium rectifiers, popular for converting AC into DC in all types of receivers, can also be checked readily for reverse current conduction, and for front-to-back conduction ratio.

In the simplified schematic diagram of the checker, the LEAKAGE-GAIN switch S-1 is in the upper or LEAKAGE position. The base lead of the transistor under test is left "floating." The current that flows from the battery B-1 through the emitter and the collector of the transistor, through the meter M-1 and back to the battery, depends on the temperature, the resistance of the germanium comprising the transistor, and the applied voltage. Any contamination on the surface of the germanium, or a short circuit, is indicated by a high reading on the meter.

Closing the switch S-1 to the GAIN position applies voltage to the base of the transistor through the fixed resistor R-1. The collector current of a good transistor will show an increase. The CALIBRATION control R-2 adjusts the amount of collector current through the meter, and is set so that full-scale deflection is obtained with the switch at GAIN. When the switch is released, the leakage current then registers. If this is less than the gain current, the transistor will work properly as an amplifier. The leakage-to-gain ratio is easily figured from the actual meter readings.

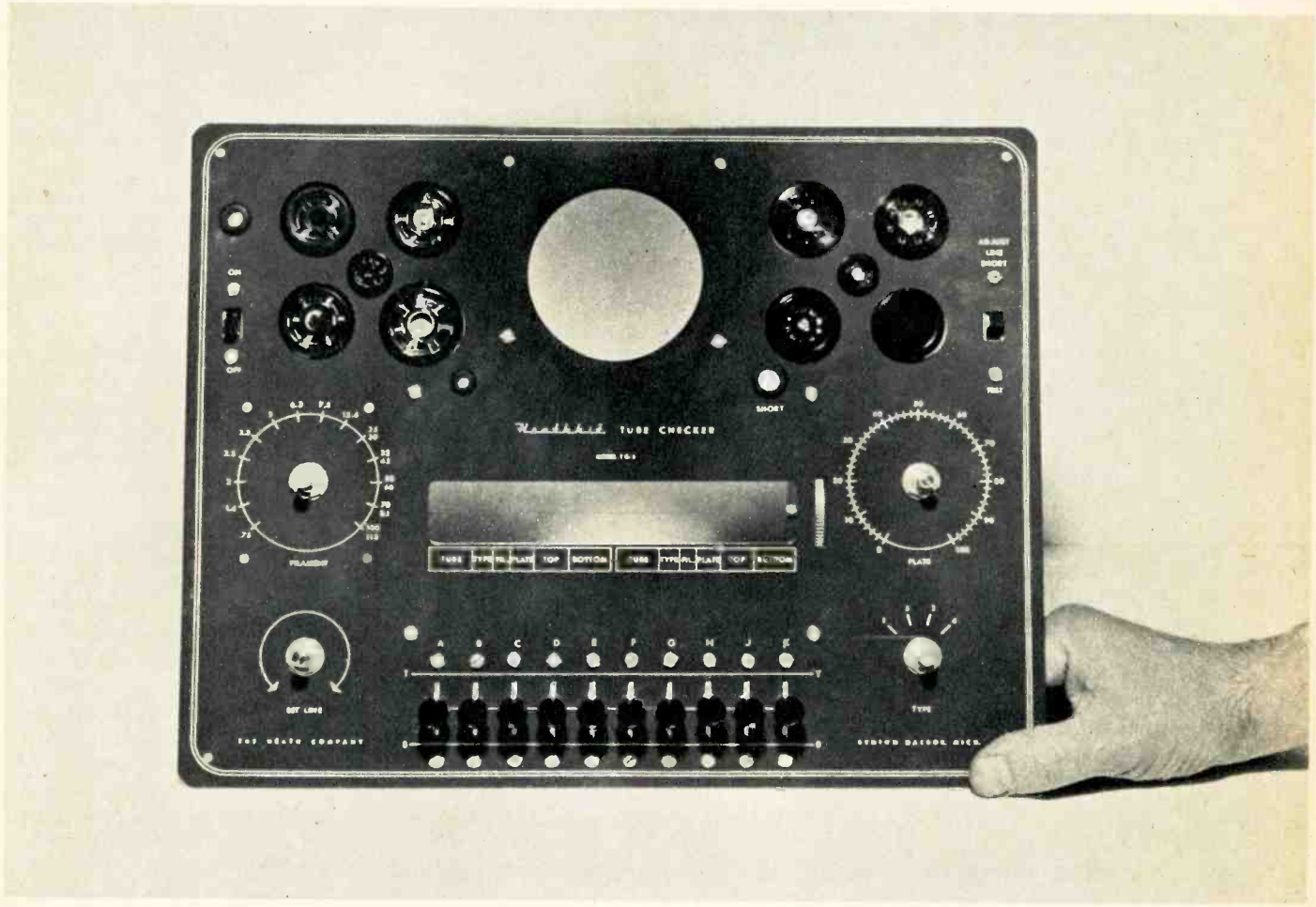
As in the case of tube checking, the *relative* values of the meter readings are more significant than the absolute ones. Experimentation with brand-new as well as defective transistors is necessary to obtain basis for comparison. It is very interesting to put various types of transistors through their paces in this checker, and to observe particularly how agitated they become when heated up. Transistor manufacturers don't like to talk about it, but many types have a very short life when subjected to high temperatures, such as those produced by soldering irons located nearby, for instance. •—*R. H.*



Easily assembled, parts correspond with diagram markings.

How Good Are Your Tubes?

Tube checkers are among the essential tools of most electronic shops. There are a number, of the emission type, that can be purchased reasonably as kits.



Front panel of Heathkit tube checker after assembly of the tube sockets, lever switches, at bottom, and other controls.

IT HAS BEEN ASCERTAINED that fully 90% of all radio and television set "failures" are due only to tube trouble. A tube can be burned out completely, merely weak, or defective. A two-second test with any multimeter or vacuum-tube voltmeter shows if the filament is "open" or not. If it is burned out, the meter needle doesn't budge; if it is still OK, the meter shows a low value of resistance. The best thing to do with a burned-out tube is to destroy it, so that it can't ever get mixed with usable tubes.

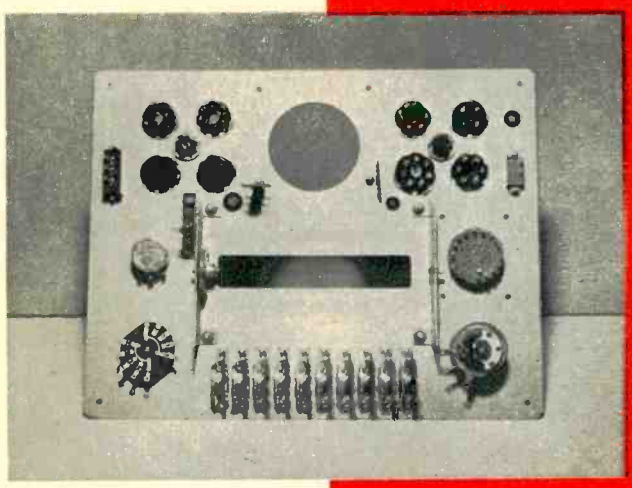
A tube can have a perfectly good filament and still be troublesome. There is a definite difference between the "weak" and "defective" conditions. A weak tube is one that has been used for some time and simply is no longer capable of emitting enough free electrons from its filament-cathode element to satisfy the requirement of the circuit of which it is a part. The latter qualification is important, because a tube that is too pooped to work satisfactorily in one socket or in one receiver might still give years of extra service in another socket or another receiver. For this reason, it is not advisable to throw out "weak" tubes, but to save them for possible future use in other pieces of equipment having less critical characteristics. Put them in a box and mark it "?? Tubes," so that they won't get mixed in with new tubes.

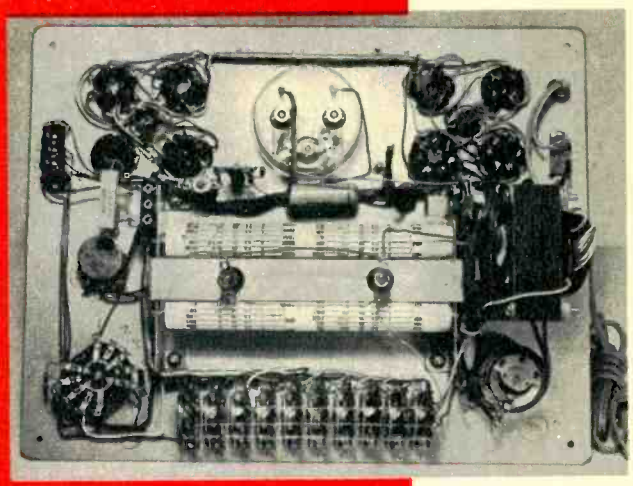
A tube with a good filament and normal electron emission becomes "defective" usually because adjacent elements touch each other; more rarely, they lose their internal connections. Element short-circuiting is almost to be expected with very hot tubes that are mounted horizontally. The elements are very close to begin with, and are bound to sag a little after long periods of operation.

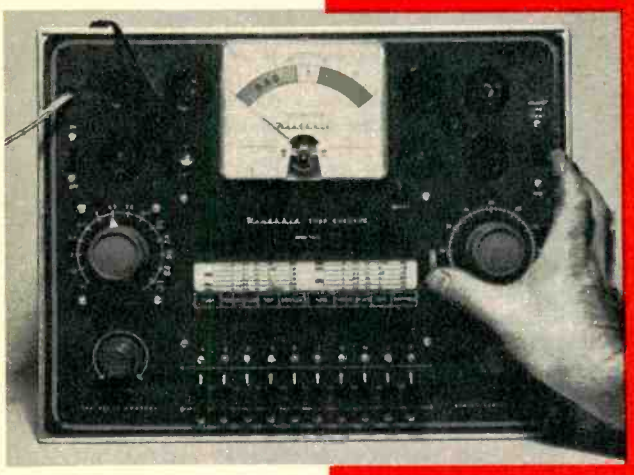
The quickest but not the cheapest way to determine if a suspected tube is good or bad is to pull it out of its socket and to substitute a brand-new one. This is standard practice with many professional service technicians, who appear on the job with large suitcases full of tubes. These are

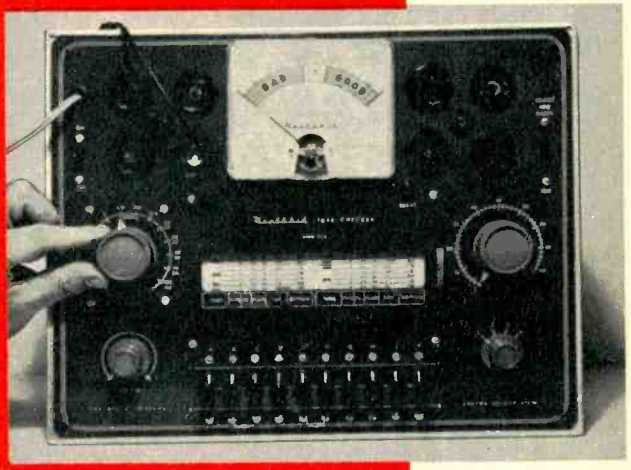
Tube checker's back panel is below, left. Rectangular space is for roll-up chart of control settings for various tubes.

Back view of completed checker, roll-up chart has been installed; a tapped filament transformer is to its right.



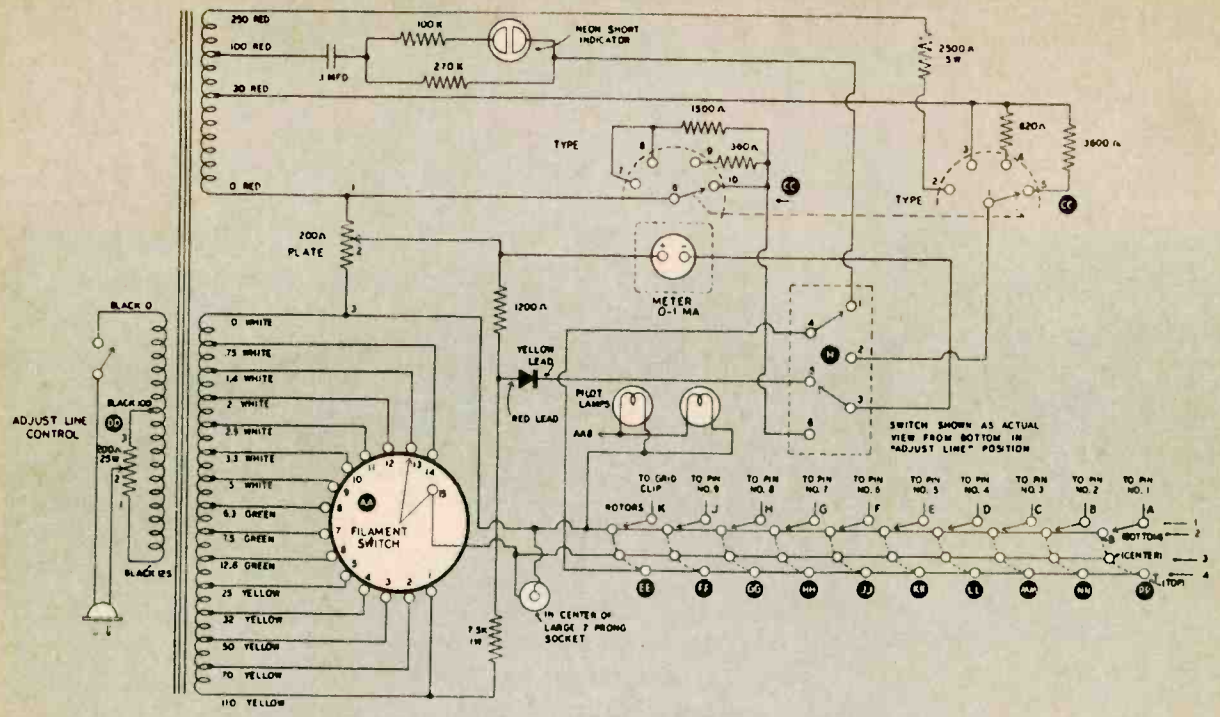






In front panel view, user turns roll chart to find proper tube-type. Note that lever switches, bottom, are centered.

Since chart indicates that tube to be tested calls for a filament voltage of 6.3, FILAMENT knob is set at that value.



Complete schematic diagram of the Heathkit tube checker. The lever switches are marked A through K. The rectifier, marked "Yellow Lead—Red Lead," is used only to make O-1 milliampere DC meter read equivalent of the line voltage.

called "caddies," and contain as many as several hundred tubes of the most popular types. The investment in new tubes is considerable.

The need for a tube checker of some kind becomes pretty obvious to serious electronic experimenters, student engineers, student servicemen, etc., after they have accumulated a boxful of doubtful tubes all having good filaments. In most electronic shops, a checker is the next most useful tool after a VTVM or a high-resistance multimeter. It is doubly valuable in schools because it can be set up to demonstrate certain features of tube operation.

Fortunately, practical tube checkers are available in both kit and manufactured form at prices low enough to make them attractive. They take two major forms: the simple, inexpensive emission type, and the more complex and costly dynamic type. In the first, the plate and the various grids of a tube are connected together to form a single element. This acts as the plate or anode of a basic two-element rectifier, the filament or cathode being the other element. A medium AC voltage from about 25 to 250 is applied, and a meter in series with the test voltage shows the rectified current on a meter scale marked BAD to one side, ? or doubtful in the center, and GOOD to the right. Various controls must be preset so that the meter readings represent reasonable averages for the hundreds of different types of tubes in common use. If the filament or cathode of a tube can no longer deliver a free supply of electrons, the rectified current is low and the meter moves only into the BAD region. If the filament or cathode still has some pep left, the meter reading will be relatively higher. The difference between a new tube and a used one is often startling.

Excellent emission-type tube checkers in kit form cost only about $30 or $35. Ready-made jobs start at about $50.

In the dynamic-type checker, the basic emission test is included, but more important, normal receiver operating conditions can be simulated, and a more significant picture of a tube's capabilities thus is obtained. The circuitry of dynamic checkers is rather complicated, and therefore relatively few people attempt to build them from kits. A good instrument starts at about $125.

Tube checkers all seem to look alike. The central item is a large meter. This is surrounded by nine or more tube sockets, one for each type of tube base. All the No. 1 terminals of the sockets are connected together, all the No. 2's, all the No. 3's, etc., and each group is in turn connected to an individual lever or push-button switch. There is no interference between sockets, as only one tube is tested at a time. Any filament voltage from a fraction of a volt to 115 volts is selected by means of a rotary switch. Various plate and grid voltages are adjustable by means of other controls.

An important part of every tube checker is a chart showing the correct settings of the numerous controls for various tubes. This chart usually is in roll form, with a thumb wheel on the checker panel. New charts or supplements to old ones are issued periodically by the manufacturers.

With each tube element terminating in a switch, it takes only a few seconds to set up combinations of connections for checking element short-circuits, as well as the usual emission and operating tests.

The accompanying photographs show a representative emission-type checker constructed by the writer from a kit.

Mechanical assembly took only about an hour, but the wiring required four evening sessions of about two and a half hours each. The wiring was not difficult; there was merely a lot of it because of the ten lever switches and nine tube sockets. The first time the checker was turned on, it did *not* work. The fault was traced, after about fifteen minutes of poking around with a wooden stick, to a single cold-soldered joint in a strategic connection between the meter and a small slide switch.

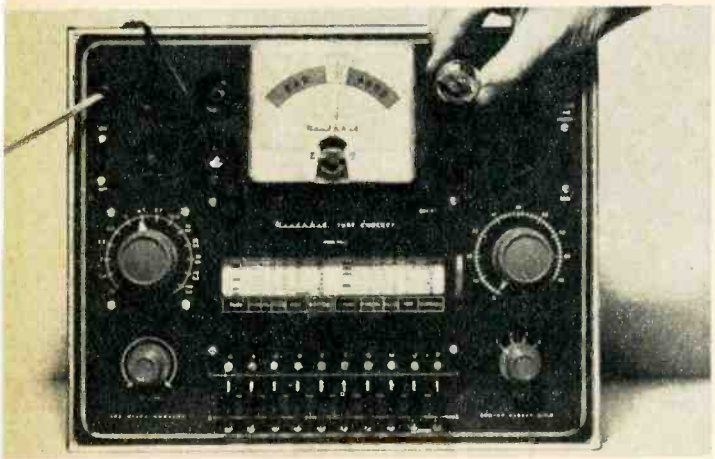
The checker fully paid for itself in a few days by giving definite BAD readings on two hitherto unsuspected tubes in a "tough dog" of a television receiver. This set showed the typical signs of a weak signal: a poor, flat picture, streaked with "snow." The antenna had been beaten up quite a bit in a storm, but replacement by a new and better one had no effect on reception. All the tubes tested OK until the very last two, from the video intermediate-frequency amplifier, a section that rarely causes trouble. These moved the meter needle only about half way into the BAD region of the scale. When they were replaced by new ones, the receiver came brightly to life.

When not required for actual tube testing, the checker is also valuable as a source of AC from .75 to 115 volts for experimental purposes. This is obtained from any of the tube sockets by means of a plug made from a discarded tube base. Only the filament or heater terminals are used, and the desired voltage is selected by means of the FILAMENT control on the checker panel. The output voltages may vary a little from the values marked on the panel. To make sure of them, hook in an AC voltmeter and measure them under load.

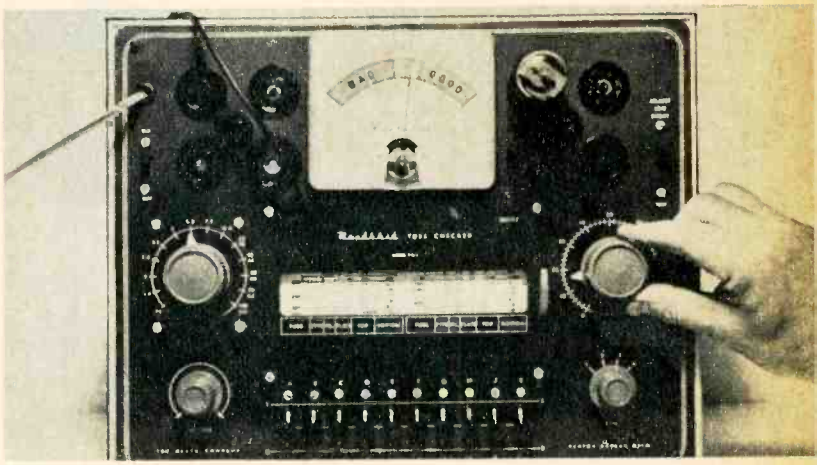
Whenever a new tube is purchased, it is a good idea to try it in the checker and to make a notation of the meter reading it produces. This figure provides a basis of comparison for other tubes of the same type number.

There is no question at all about the usefulness of the tube checker as an electronic tool, but the instrument does have certain limitations. These are described in the RCA "Receiving Tube Manual" as follows:

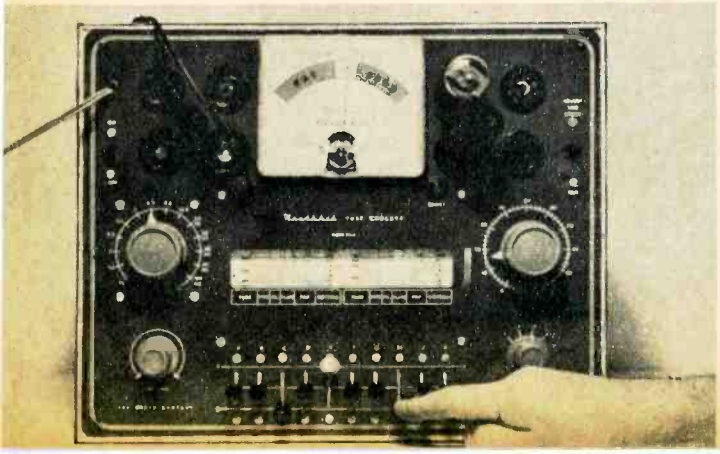
"A tube-testing device can only indicate the difference between a given tube's characteristics and those which are standard for that particular type. Since the operating conditions imposed upon a tube of a given type may vary within wide limits, it is impossible for a tube-testing device to evaluate tubes in terms of performance capabilities for all applications. The tube tester, therefore, cannot be looked upon as a final authority in determining whether or not a tube is always satisfactory. Actual operating test in the equipment in which the tube is to be used will give the best possible indication of a tube's worth." •—*R.H.*



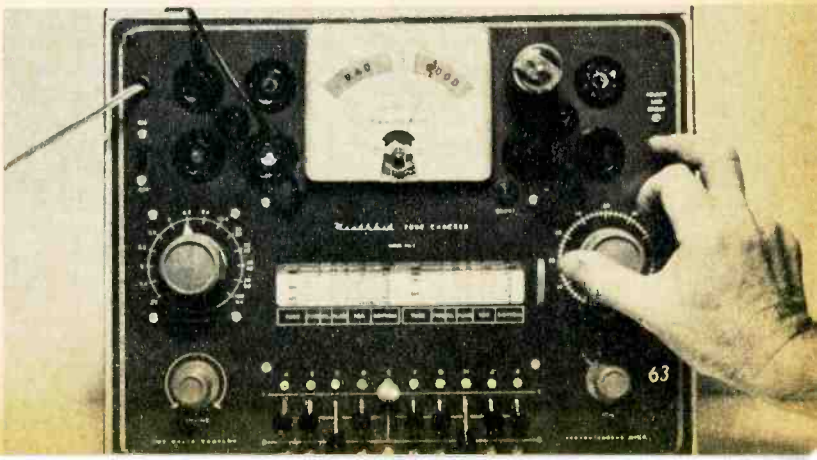
Checker is turned on by switch, upper left, and tube is inserted. SET LINE knob, lower left, is adjusted so meter needle reads in center. This assures right operating voltage.



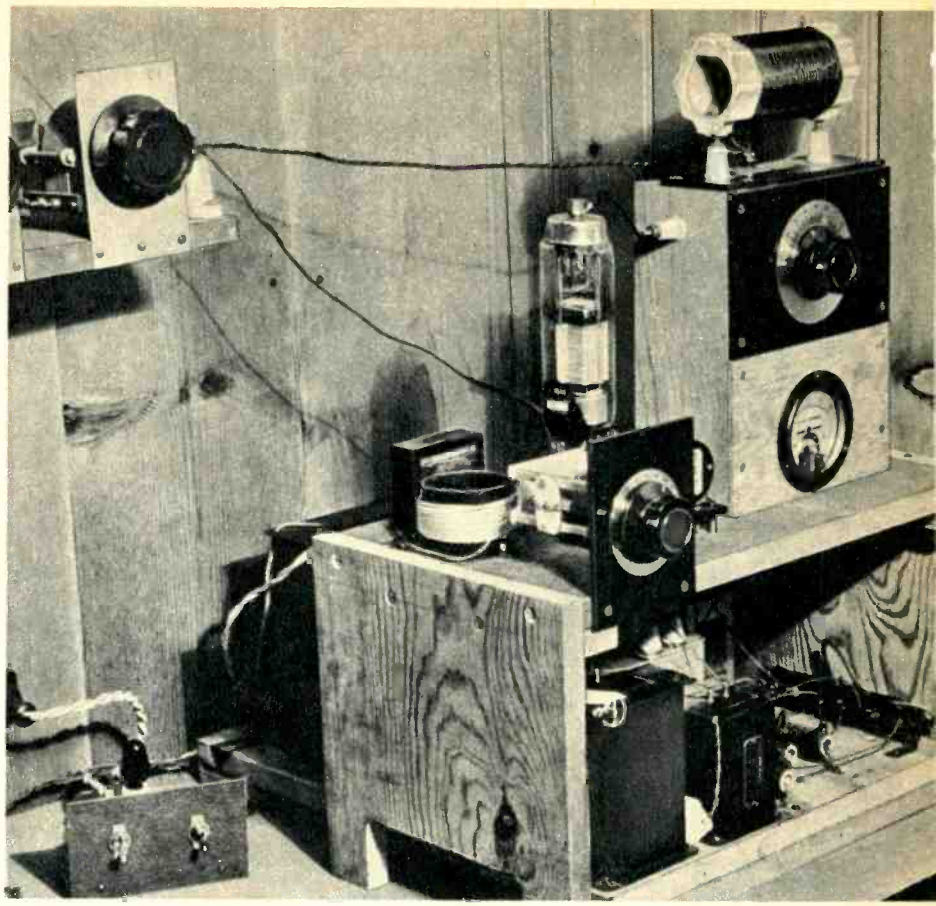
User now adjusts PLATE control to 16, which is the value called for by the roll chart. TYPE knob, which is located beneath it, is set at 3, also as specified by roll chart.



Switches are moved as per chart. Now tube filament is energized, other elements tied together. Internal short circuits will show as SHORT, red signal at meter's lower right.



Meter reading represented line voltage previously, not condition of tube. But now, with TEST switch held down, reading is tube's emission current—well into GOOD region.



Wood, which is cheap, easily worked, a good insulator, is fine for experimental set-ups. This low-powered transmitter in extended breadboard form has all parts readily accessible. It worked so well (possibly due to short, direct connections) it was left this way for months before being dolled up with a decorative cabinet.

Keep The Ham Shack Neat

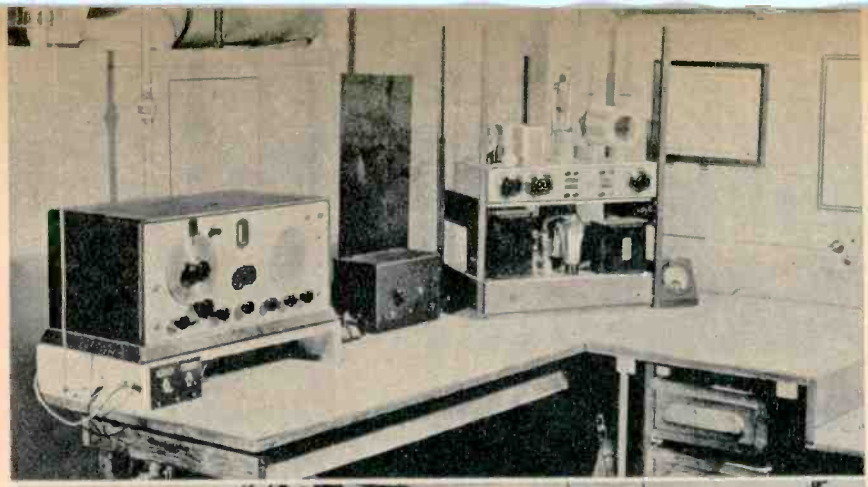
And not only for the sake of appearances either. You will find you're a much more efficient radio operator if your station is orderly and organized.

ONCE A PERSON gets into ham radio, he accumulates equipment at a rapid rate. In a short time, his "shack" is likely to resemble a high-grade junk shop. Disorder is not merely unattractive; it can also be unsafe. Transmitters all run on high voltage, and this sometimes leaks off in the wrong direction if various wires behind the table become jumbled.

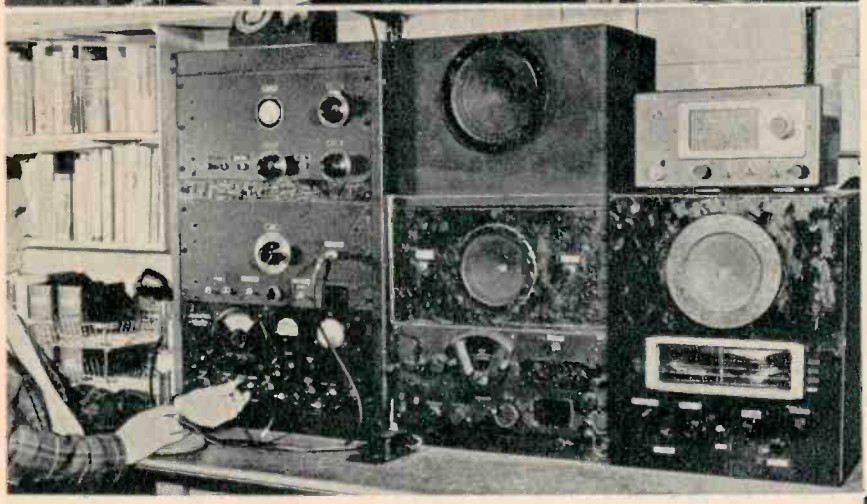
Communications receivers and even small transmitters contain a lot of iron and are very heavy. They should be mounted on sturdy, well-reinforced tables, with hard tops that resist scratching. Recommended for the purpose are plastic laminates commonly used on kitchen tables.

It is a very wise idea to fit the radio table with casters, so that it can be moved readily when changes in the back wiring must be made. Allow enough slack in the power and antenna leads so that the table can be swung out and the equipment left in operation for possible rear-area adjustments.

Presented on these pages are photos of some actual installations ranging from the simple to the elaborate. They contain ideas that can be adapted to ham shacks in basements, attics or dens. •—*R. H.*

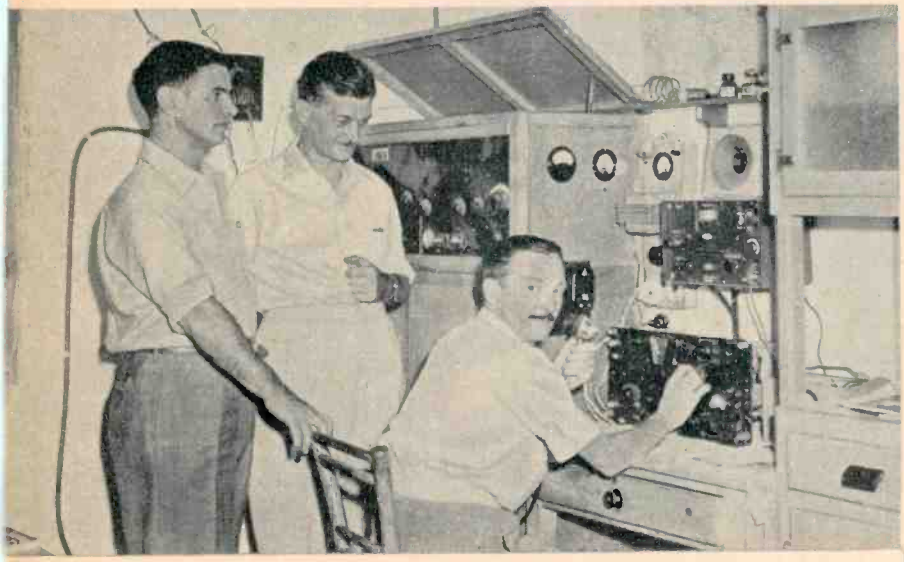


Receiver of this snug, modest ham shack is raised 3 inches above table, and the space beneath it provides convenient storage. Switches on dark panel, lower left, control transmitter. Latter, at right, is built up of uniform-sized aluminum chassis, supported on an open frame of angle iron. Parts are readily accessible.



"Relay rack" construction is employed for unit at left of this impressive 3-receiver, 2-transmitter collection. In lower center is revamped Air Force BC-348 receiver; above it, speakers for it and other next to it on the left. Though combination is extremely heavy, weighing several hundred pounds, it's easily movable on casters.

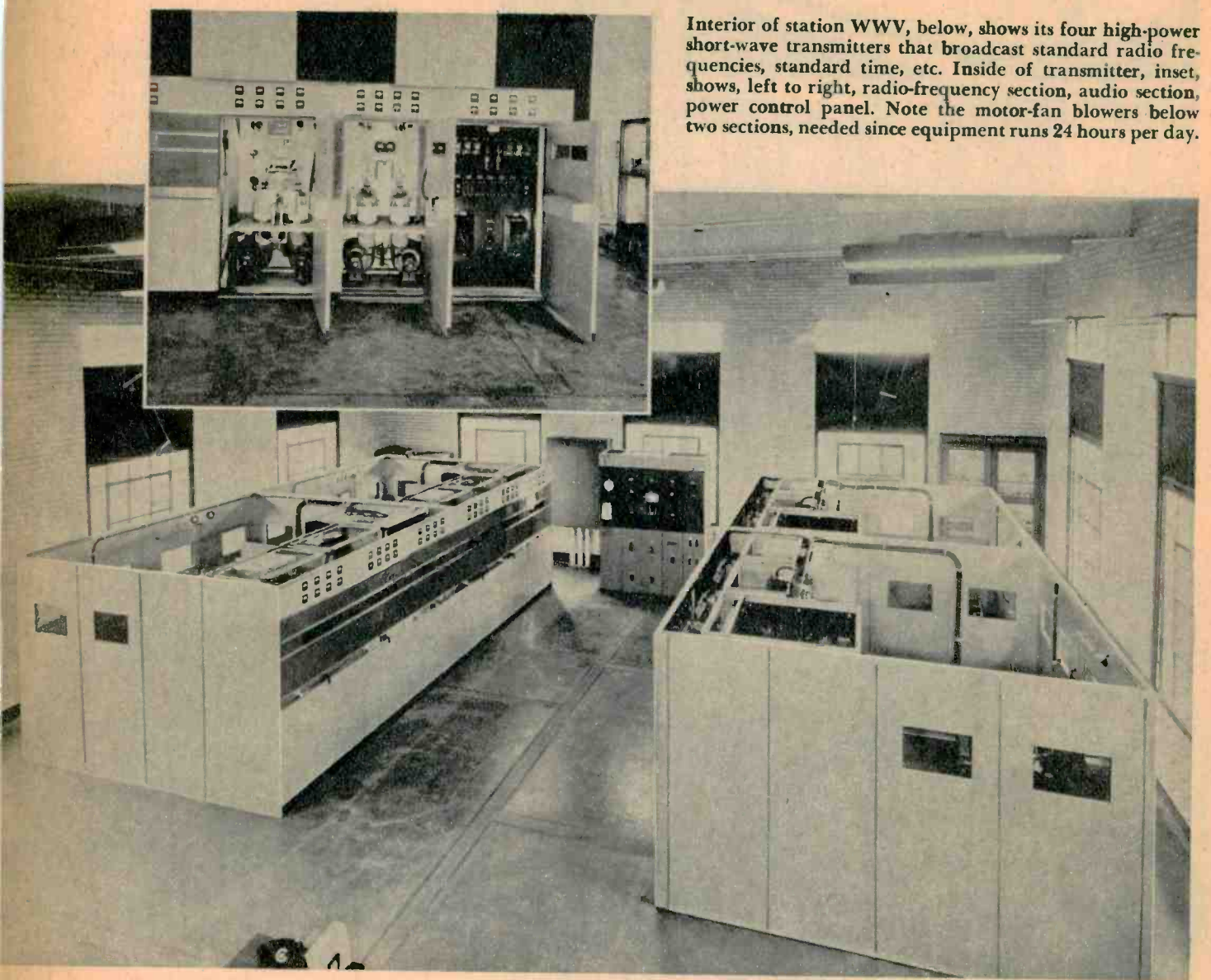
Below, Albert Kahn, W8DUS, of Buchanan, Michigan, peruses some of acknowledgement cards he has received from foreign hams. Large unit, center, is a Collins receiver. Clock-like device indicates position of directional antenna on roof. Transmitter is behind Kahn. Receiver alone in this set-up cost more than $600.



Only one can sit in Dominico Carbone's kitchen-corner shack in Alassio, Italy. Receiver fills operating table; transmitter occupies cupboard at left. Equipment is for the most part World War Two GI salvage. Carbone communicates regularly with North and South America. Call letters are I1KV.

The transmitter is part of the desk in this unusual set-up. It consists of two parts: the "exciter" unit, top left of photo, and "power amplifier," which fills pedestal. This is the Johnson Viking Kilowatt, with top power permitted amateur operation. Note receiver, mike, key on the desk top.

Is Your Short-Wave Receiver Accurate?



Interior of station WWV, below, shows its four high-power short-wave transmitters that broadcast standard radio frequencies, standard time, etc. Inside of transmitter, inset, shows, left to right, radio-frequency section, audio section, power control panel. Note the motor-fan blowers below two sections, needed since equipment runs 24 hours per day.

OWNERS OF SHORT-WAVE RECEIVERS can readily check the accuracy of their dial calibrations by tuning in the standard frequency signals transmitted around the clock by station WWV, near Washington, D.C., and station WWVH, Maui, Territory of Hawaii. These stations are operated by the National Bureau of Standards, an agency of the United States Department of Commerce.

WWV broadcasts continuously on six different frequencies: 2.5, 5, 10, 15, 20 and 25 megacycles. WWVH transmits only on 5, 10 and 15 megacycles, and is silent for four minutes following each hour and half hour and for a period of 34 minutes every day beginning at 1900 hours UT (Universal Time, which is the same as Greenwich Civil Time).

The carrier signals of both stations are modulated by two standard audio frequencies, 440 and 600 cycles. These are transmitted alternately, starting with 600 cycles on the hour for four minutes, interrupted for one minute, followed by 440 cycles for four minutes, interrupted for one minute, etc. The 440-cycle tone is the standard musical pitch.

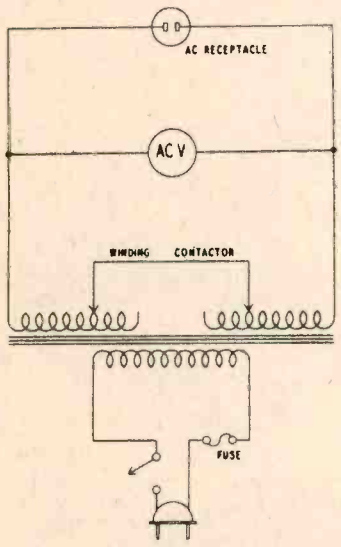
During the one-minute periods between the alternating tone signals, Universal Time is announced in telegraphic code by both stations. In addition, WWV makes voice announcements of Eastern Standard Time only; these precede and follow the code transmissions. These time signals are checked by the U.S. Naval Observatory and are the most accurate available anywhere. If you set and recheck your clocks against them, you have *the* right time.•—*R. H.*

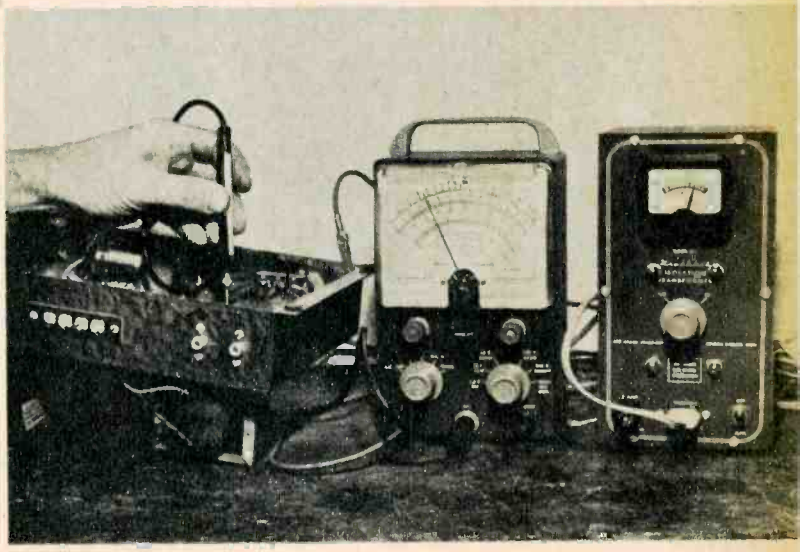
Isolation Transformer

Add one to your basic test equipment. They take "bite" out of AC-DC chassis.

Knob in center of isolation transformer adjusts the output voltage, available at outlet at bottom. Line fuse, lower left, protects power line if short develops in the appliance plugged into isolation transformer.

In test set-up isolation transformer is connected between power line, receiver chassis. Circuit diagram is at lower left. "Dwindling contactor" on secondary, coupled to LO-HI knob, varies voltage at AC receptacle.





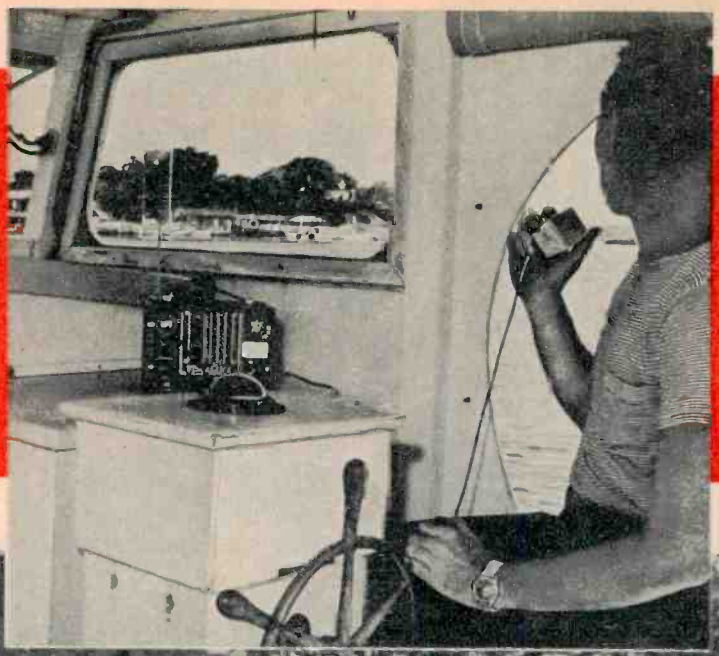
YOU HAVE the small AC-DC radio set from the kitchen on your workbench and you're shooting trouble in it. From past experience you know it's nothing more serious than a shorted filter capacitor or a burned-out tube. It's plugged in but not turned on, and as you touch the chassis you are rocked back by the unmistakable stab of the 115-volt line.

"What the . . ." you exclaim. Then you realize that you're standing on a concrete basement floor and that you've inadvertently gotten between a "hot" chassis and ground. Everyone who plays with transformerless electronic equipment goes through this initiation.

Because 115-volt shocks are definitely not pleasant, and often are fatal, it is extremely wise to add an isolation transformer to your basic test equipment. Various sizes and both fixed and adjustable types are available. The one shown was designed specifically for the small shop. The writer put it together from a kit in half an hour.

This protective device does what its name implies: it separates the grounded power line from the equipment under test. The secondary voltage is adjustable from about 90 to 130 volts, and is indicated on a front-panel meter. This feature makes the transformer immensely useful for numerous purposes. For example, a common fault in many receivers is intermittent operation, due usually to a worn out component that isn't quite ready to die altogether. Jacking up the line voltage very often hastens its demise; once the set goes quiet it is fairly easy to trace out the circuit and to spot the defective part. This treatment is not a cure-all, but it does prove helpful in a great many cases.

The unit is intended for radio sets, small appliances, motors, lights, etc., not exceeding about 100 watts. Short-time operation up to 200 watts is allowable, but will lead to overheating if it is stretched out for too long a period of time. •—*R. H.*



"Vocaline" transceiver, operating on 465 megacycles, sits within easy reach of owner of small boat, shown inset, talking to shore.

From kitchen of lake cottage, wife responds. Entire antenna is 6-inch rod sticking up out of Vocaline transceiver case beside her hand.

Personal Two-Way Radio

These compact, portable units offer a wonderfully convenient two-way voice communication facility. Besides, you are not required to take an examination or obtain an amateur operator's license to use them.

"HELLO, MARGE, this is Jack. We've caught a nice batch of fish and we're heading home. Should be at the dock in about an hour. Will you please bring the car around? Over."

You release the microphone button, and in an instant your wife's voice crackles from the loudspeaker of a radio not much larger than a cigar box.

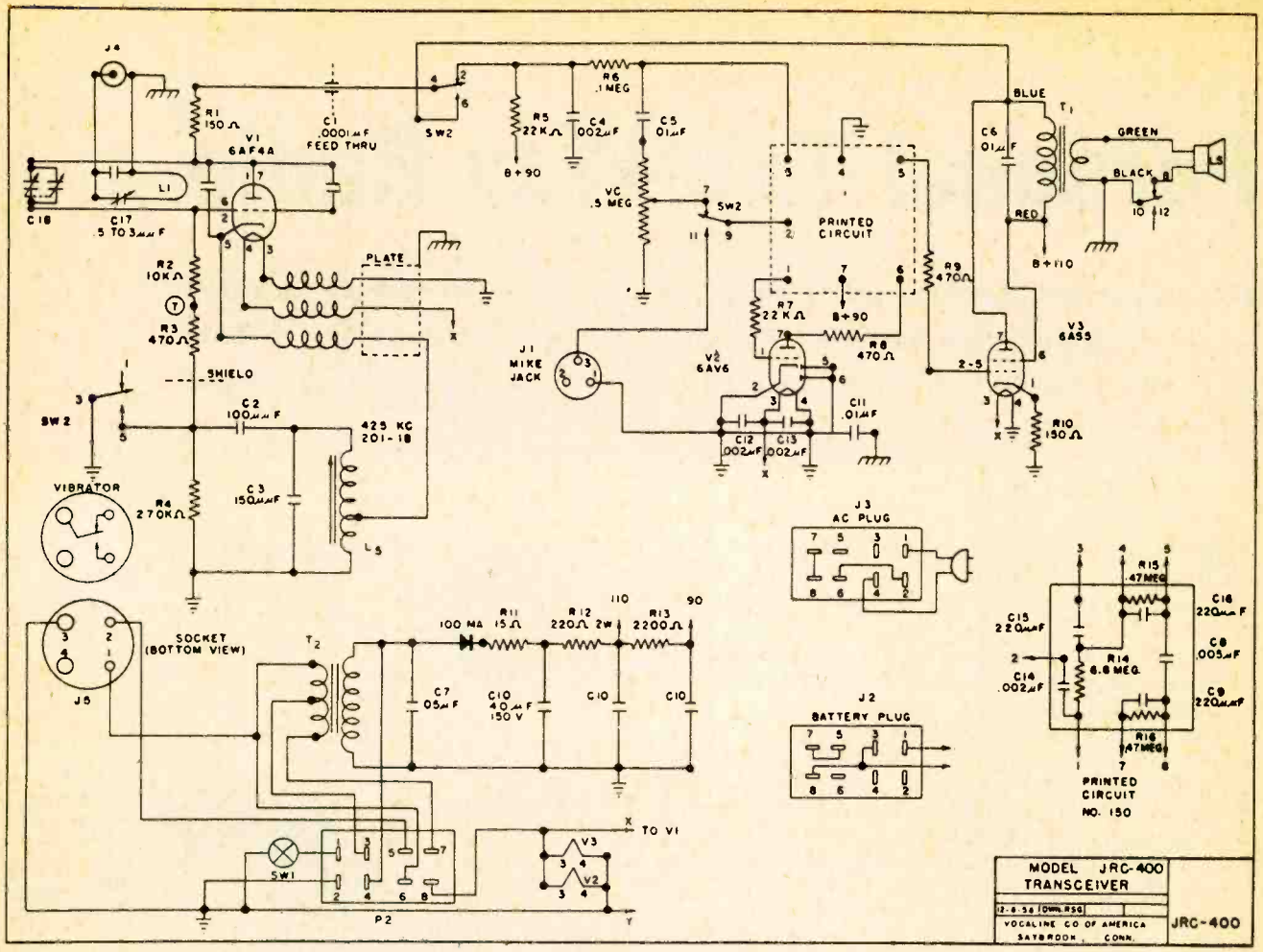
"Okay, honey, will be waiting for you."

Wouldn't it be great if you could enjoy personal two-way voice radio like this, without having to bother with an amateur operator's license and the expensive, complicated equipment that hams like to use? It isn't generally known, but this communication facility is available *right now* in the form of the "Citizen's Radio Service." You can buy portable units that don't even have any tuning knobs on them; just connect them to a battery or the house power line and you're on the air. You do need a license from the Federal Communications Commission, but this is issued free for the asking to any U.S. citizen 18 years old or older, and does not require an examination of any kind.

There are two little "catches" in this seemingly ideal set-up, neither serious enough to affect the great value of the service to fishermen, hunters, farmers, ranchers, construction teams, surveyors, etc. The first is that all stations operate on the same frequency of 465 megacycles, which means that interference between several stations in the same area must be expected. The service is like a party-line telephone, with no privacy for any of the talking parties. The second restriction is on the power that can be

Operating well away from the regular aeronautical radio channels, Citizens' Band transceiver offers plane-ground contact. Ground station's power source is battery of the car, with set connected through the cigarette lighter plug.

Ideal for use on large farms and ranches, the transceiver (Vocaline Model JRC-400) keeps the field workers in touch with office, saves time and gas usually spent going back and forth. Contact across open fields is easy, reliable.



Complete wiring diagram of the Vocaline Model JRC-400 transceiver.

used: 10 watts. Actually, this helps to keep the transmission range down, and thus limits interference too.

Radio signals at the high frequency of 465 megacycles act very much like light waves. If there is a more or less direct line of sight between two stations, good communication can be had over distances of ten miles or more. Intervening hills, bodies of trees, large buildings, etc., often act as deflectors and either block contact altogether or reduce the effective range. The only way of determining how stations will work in any particular area is to try them.

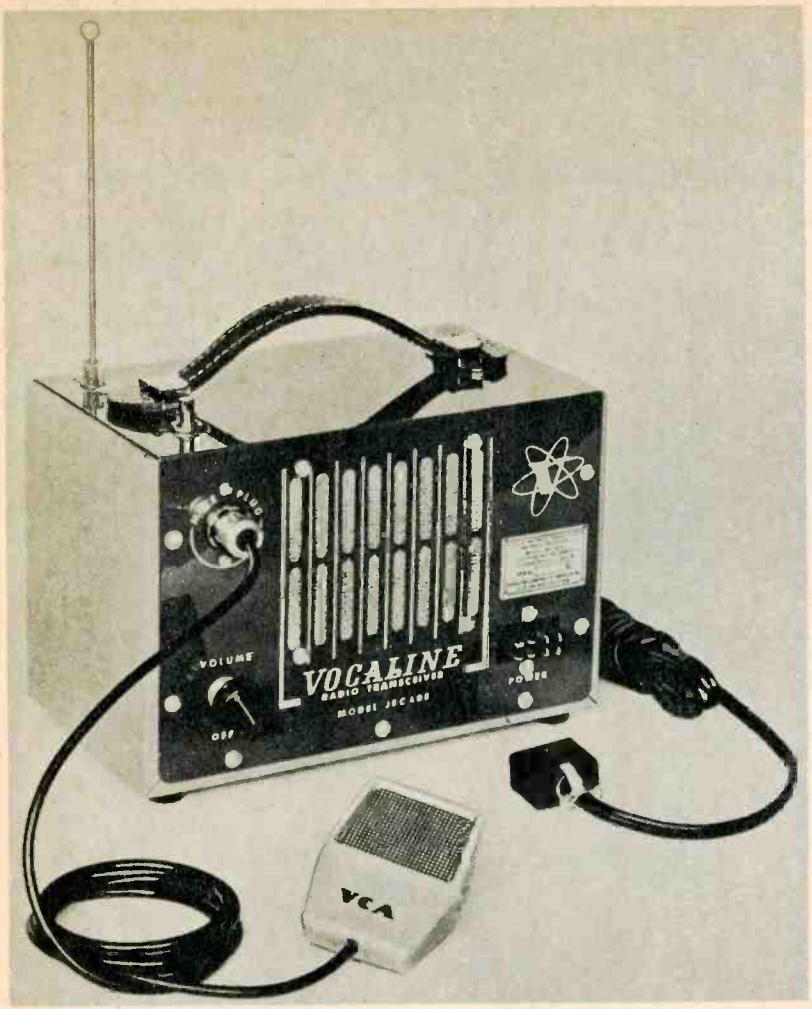
As might be expected from the direct-ray action of 465-megacycle signals, communication is usually very good over open stretches of water and between airplanes and the ground.

Because most of materials used in home construction are inert to radio energy, a self-contained station inside a house often works as well as it does outdoors. It is necessary, however, to avoid window screens, metal doors and walls built up of wire lath, all of which act as shields and may prevent signals from getting either in or out. Moving the equipment only a few feet from one spot to another often makes a big difference.

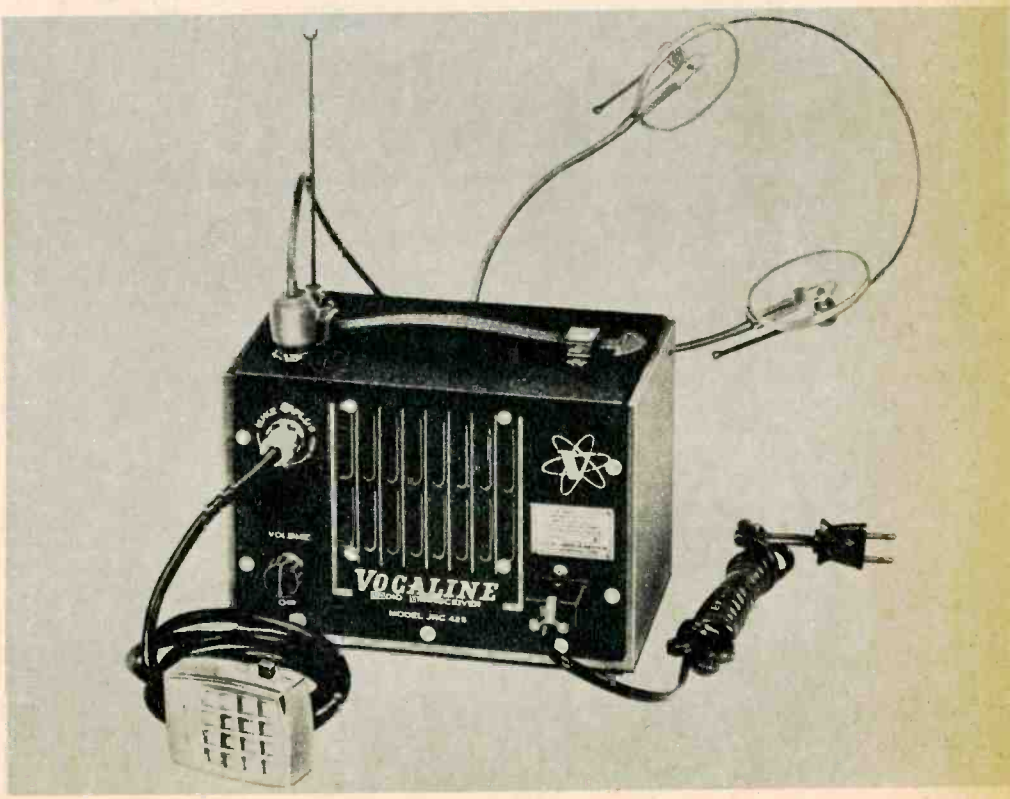
The citizen's band is sandwiched between the ultra-high-frequency television channels and certain others used for radio aids to navigation. For this reason, the Federal Communications Commission requires extremely accurate control of 465-megacycle transmitters. In fact, it requires manufacturers to submit samples of their units for FCC laboratory test, prior to issuance of "type approval" for them. There are no citizen's band set kits. Anyone with sufficient technical background to make a transmitter to the FCC requirements wouldn't be bothering with 465 megacycles in the first place.

There are actually three types of citizen's band stations. The fixed-frequency 465-megacycle equipment is known as Class B. Class A stations may operate on any frequency between 460 and 470, and thus have a slightly better chance of avoiding interference. However, only Class B equipment is available to the public on the open market, from the established electronic supply firms. Class C stations operate on a frequency of 27.255 megacycles and can be used *only* for radio control of "objects and devices," and not for voice communication at all. Class C equipment is relatively easy to make (see ELECTRONICS HANDBOOK, Fawcett Book No. 319, page 116).

The accompanying pictures show some actual applications of the Vocaline transceiver (*trans*mitter-re*ceiver*), a popular Class B unit that is proving highly successful. Measuring only 9 by 6 by 5 inches overall and weighing only 4 pounds, it is readily transportable. Identical models are available for operation on 6 volts DC—115 volts AC and 12 volts DC—115 volts AC. For field service, the obvious source of energy is the storage battery of a car, a tractor, a boat, an airplane, etc. The current load is only three amperes, which imposes no strain on the vehicle's electrical system. •—*R. H.*



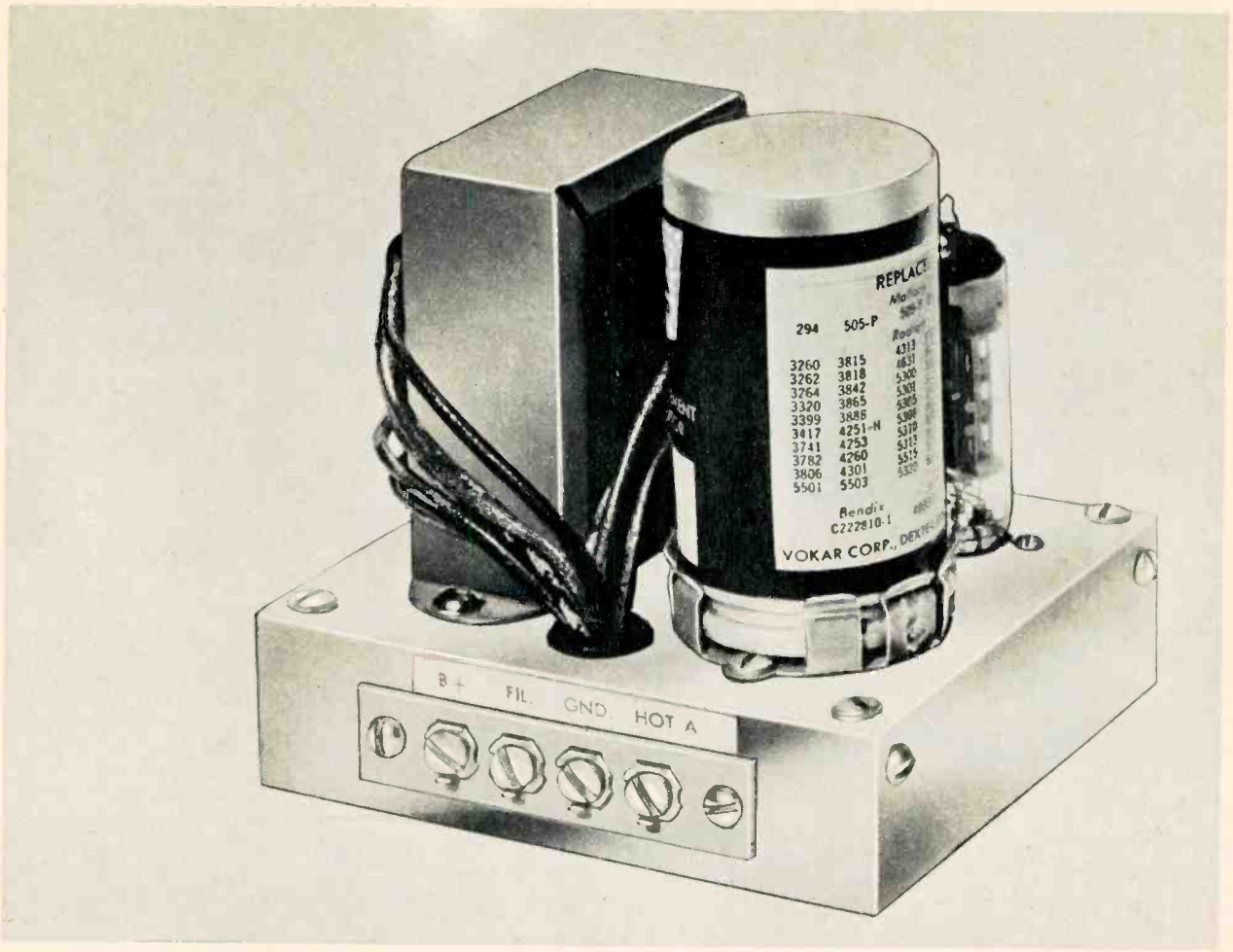
There are no external tuning controls on Vocaline JRC-400. To talk, operator presses the button in top of cabinet. To listen, he releases it. Price is $69.75.



Push-to-talk switch is on mike of Vocaline JRC-425 and provision is made for earphones for weak signals and use in noisy locations. Price is $99.75 per unit.

Vibrator Power Supply

Hi-fi in your car is but one of the many luxuries it places within easy reach.



Vibrator power supply permits mobile operation of standard AC equipment. Connection is by terminal strip on chassis.

DO YOU have an old table model radio lying around the house that you would like to use in an equally old jalopy? Do you have a communications receiver which would be just dandy on your outboard cruiser, if you only had a source of power? Have you a spare FM tuner which could bring you hi-fi along the highway, except that its operation requires a 110-volt power line?

These and many other similar problems can now be solved by anyone, through the use of a vibrator power supply, now available in kit form. The circuitry and construction of these units is straightforward and exceedingly simple, making them ideal as starter projects for novices to the world of electronics.

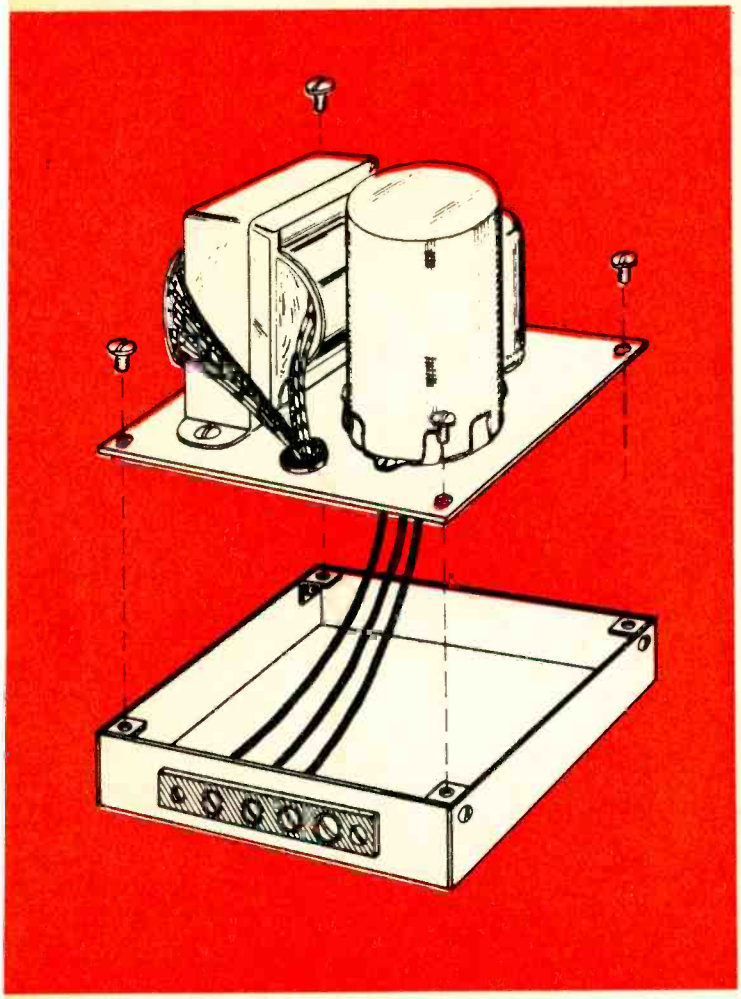
The heart of a vibrator power supply, the vibrator itself, is really a voltage converter which changes direct current into alternating current. Its operation resembles that of an electric doorbell, with a vibrating arm swinging back and forth between two gongs. The vibrator arm, however, also acts as a conductor of current; and instead of a clapper at the end of it there is a contact swinging back and forth between two other contacts. There is then a flow of current from the swinging arm to whichever contact the arm happens to be touching at any instant.

These bursts of current, first through one circuit and then the other, can be combined in a common output circuit in such a way that their polarities, or directions of flow are directly opposite. The result of these two opposing flows then is a rather unique form of alternating current known as a *square* wave. Since this waveform is more complex than the simple *sine* wave usually found in commercial power mains, it requires additional care and treatment, as we shall see. The main thing, however, is that we now have converted DC voltage from a battery into AC.

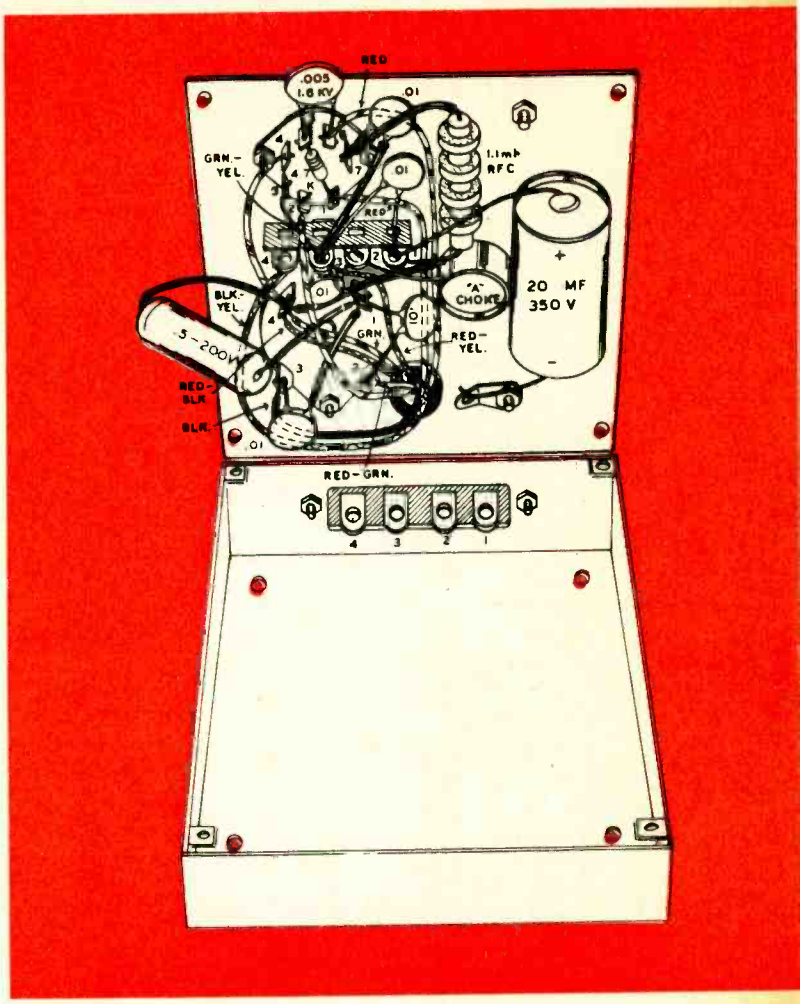
"But just a minute!", you say. "Isn't it true that the voltages I need to operate my equipment are DC, not AC? Then how come this fol-de-rol of converting to AC, when DC is the final supply I need anyway?"

The process seems rather roundabout, admittedly, but it is done to utilize the basic electrical phenomenon of *transformer action*. For while the operating voltages your equipment requires are all preferably DC, they range up to perhaps 250 volts, while the battery voltage for your en-

Chassis of the vibrator power supply unit mounts in case by four screws, permitting easy access for maintenance.



All components of kit mount to underside or top (opposite) of chassis plate, making compact unit installation.



gine's ignition system is only 6 or 12. The simplest way known to boost a voltage is by means of a transformer. *But* a transformer works only with AC.

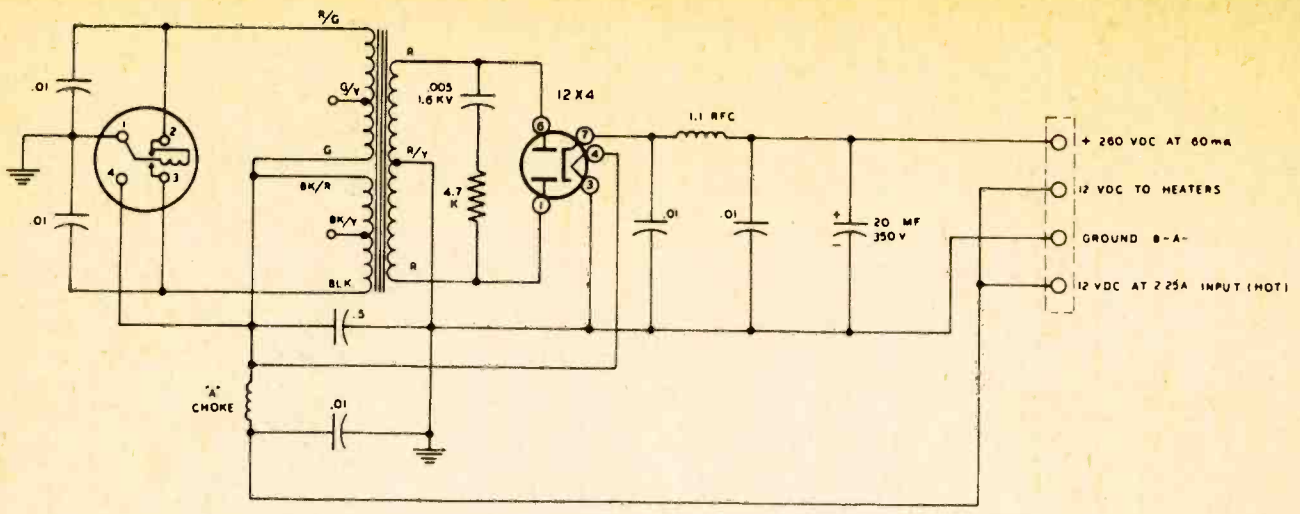
Thus our entire purpose in converting to AC is to boost the voltage by 25 or 50 times. As soon as this is accomplished we immediately convert back to DC. This change occurs in the *rectifier* tube. The three most important steps in the operation of our vibrator power supply, then, are as follows:

1. The vibrator converts low voltage DC from the battery to low voltage AC.
2. The transformer steps up the low voltage AC to high voltage AC.
3. The rectifier converts the high voltage AC to high voltage DC.

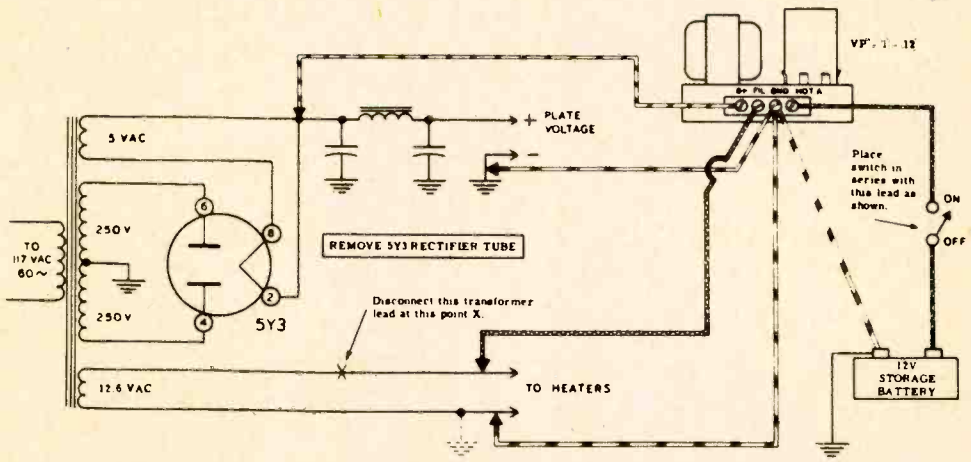
Now let's have a little closer look at the circuit of this Heathkit vibrator power supply. Reading from left to right, the first thing we see is the vibrator. Its output is connected across the primary winding of the transformer. Across the transformer secondary, between the transformer and the tube, you will note a resistor and condenser in series. This combination forms a *tuned* circuit with the transformer and increases its step-up effectiveness by "resonating" the transformer to the frequency of the AC output from the vibrator. In this unit that frequency is about 115 c.p.s.

The first three components immediately following the rectifier are two small (0.01) condensers and a radio-frequency choke coil. This connection is known as a *pi-section* filter, and in this instance is being used as a "hash" filter. Since the square-wave AC appearing in this unit is mathematically a combination of a fundamental frequency and an infinite number of odd harmonics, it is obvious that there are present many high frequencies in addition to the 115-c.p.s. fundamental. This hash can cause a loud "frying" noise in the audio output, and so it must be filtered out before it gets that far.

Finally, across the output there is a large (20 microfarad) condenser, which partially filters out the "ripple" or hum frequencies. Since the unit is designed primarily to work in place of the conventional 110-volt AC power supply in the equipment to be mobilized, most of the ripple filtering will be provided by the equipment itself. This avoids needless duplication of components.



Circuitry of vibrator power supply is straightforward. It includes vibrator, transformer, rectifier and partial filtering.



Typical installation involves removal of set's rectifier, breaking side of transformer filament winding. Filter lessens hum.

This Heathkit is designed for powering a variety of small electronic devices in situations remote from 110-volt AC power lines. There are a couple of precautions to be observed, however. First, the filament voltage requirements of the equipment must be equal to that supplied by the storage battery, and the vibrator supply must have the same rating as well. For example, if your storage battery is 6 volts, you can only use equipment having 6-volt filaments, and your power pack must be the Heathkit model VP-1-6. If on the other hand your equipment has 12-volt filaments, then a 12-volt battery is required, along with the Heathkit VP-1-12.

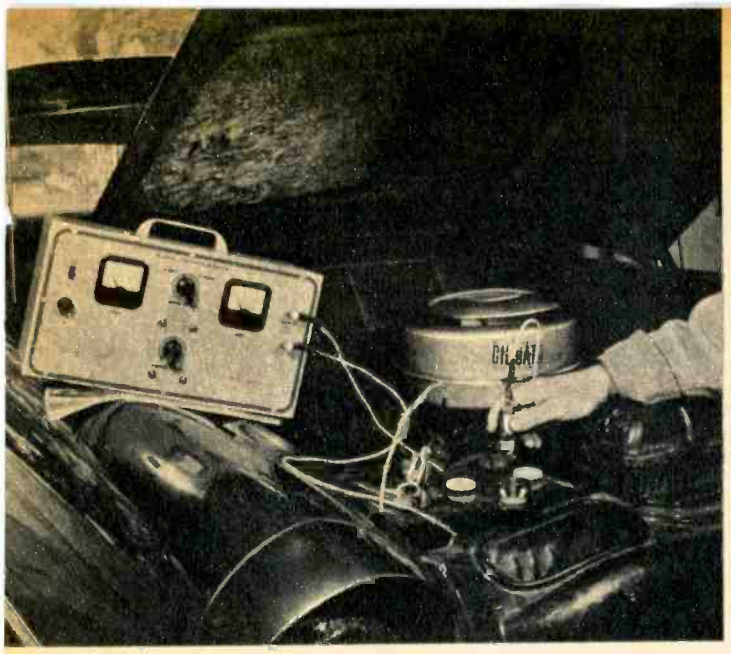
The other consideration is the high voltage requirement of the equipment, which is somewhat less critical than the filament voltage. Both of these Heathkits deliver 0.06 amperes at 260 volts, a figure which satisfies the demands of most light electronic equipment.

Unless the equipment is wired with an emergency power socket, however, its own internal power supply must be disconnected. This is done simply by removing its rectifier tube and disconnecting one of the leads from the transformer filament winding. This connection must be broken, or the battery voltage from the internal power supply will quickly burn this winding out. With these two items taken care of, it is now possible to connect in the external vibrator power supply.

Connection is extremely simple, involving at the most three pairs of wires. One pair goes to the leads which had been connected to the transformer filament winding. Another pair ties between ground and the input of the filter circuit. The last pair, with a switch inserted in one leg, goes to the battery.

Mounting of the unit is by means of four screw holes in the bottom of the chassis, through which the unit may be secured directly to a floor, firewall or bulkhead. It is not important whether the mounting be on metal, wood, plastic, or any other solid material, and shock mounting is unnecessary. It is advisable, however, that the surface be horizontal to insure longest life for vibrator and tube.

Now let's see how much of your electronic gear can get a new lease on life and provide many more hours of enjoyment when you mobilize it! •—*D. H.*



New Cars Need New Battery Chargers

A heavy-duty charger, like this Heath dual-voltage unit, is battery insurance. Existing cables to the battery are not disturbed; charger's leads clip directly to terminals.

WITH THE ALMOST universal adoption of the six-cell, "twelve-volt" storage battery in new cars, vast numbers of old six-volt chargers are starting to go rusty on garage shelves.

There's no easy way of increasing the voltage of a six-volt job, short of rebuilding it. It's much simpler to make an entirely new charger, from any of several excellent kits sold by radio firms. All of them handle six- as well as twelve-volt batteries, making them doubly useful.

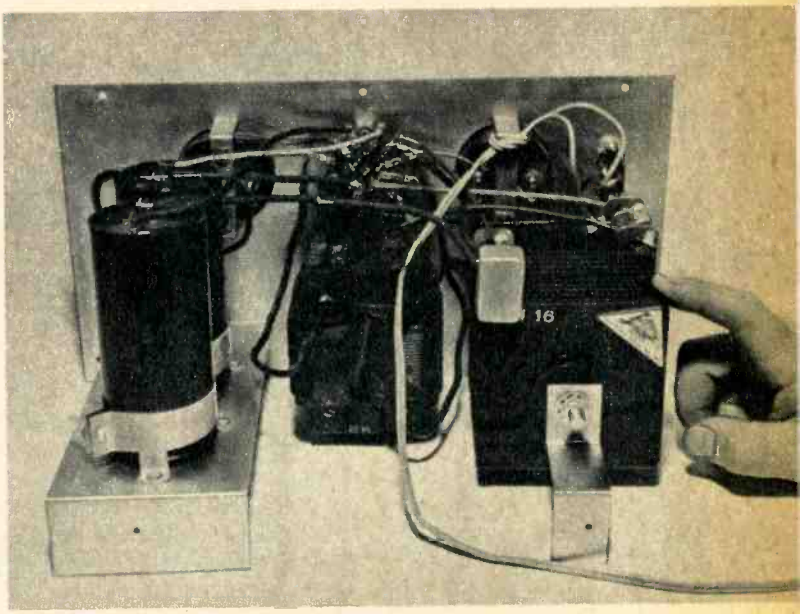
Some manufacturers list their products as "battery eliminators" rather than as "chargers," because they can be used directly as sources of low-voltage, high-current DC for bench testing of auto sets, for home electro-plating of babies' shoes, etc.

The newer battery eliminators follow a more or less standard pattern: A heavy transformer reduces the 115-volt energy from the AC line to the lower voltages. Still AC, these are turned into pulsating DC by dry-disc rectifiers. The rather rough DC is smoothed out by a filter consisting of one or two fixed capacitors of enormous electrical size, usually in the neighborhood of 10,000 microfarads. Their physical dimensions can be kept reasonable because the operating voltage is only 15 or 18, as compared with the several hundred and often several thousand volts encountered in radio and television receivers.

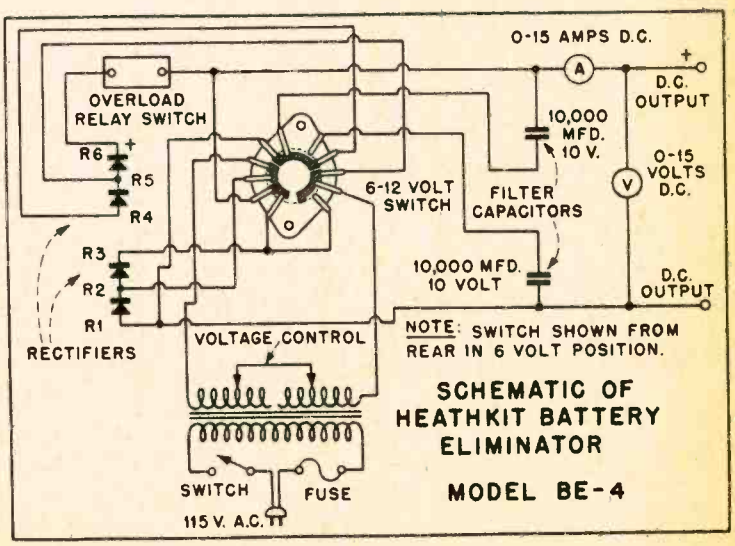
Provision is usually made for adjusting the secondary output. The control takes the form of a sliding contact on the secondary winding. The better eliminators include two small meters: one for indicating the DC output in volts, and the other the output current in amperes. These are very useful, especially for radio testing, but no less so for setting the charging rate of batteries.

The technique in using a charger is *not* to wait until the battery poops out completely some frosty winter morning, but to keep it full of pep by means of occasional overnight charges at a rather low rate of about three amperes for a six-volt battery and 1 or 1½ for a twelve-volt one. This is called "trickle" charging. Test the battery frequently during the winter with a hydrometer and try to keep the float definitely above the "half-charge" level.

In the first sentence of this article, quotation marks are included around the expression "twelve-volt." The reason is that the new six-cell batteries read well above thirteen volts, and actually 13.2 when well charged. A "six-volt" battery measures about 6.6 volts. In other words, the voltage per cell runs to 2.2. Automobile bulbs are usually marked "6-8v" or "12-16v." •—*R. H.*

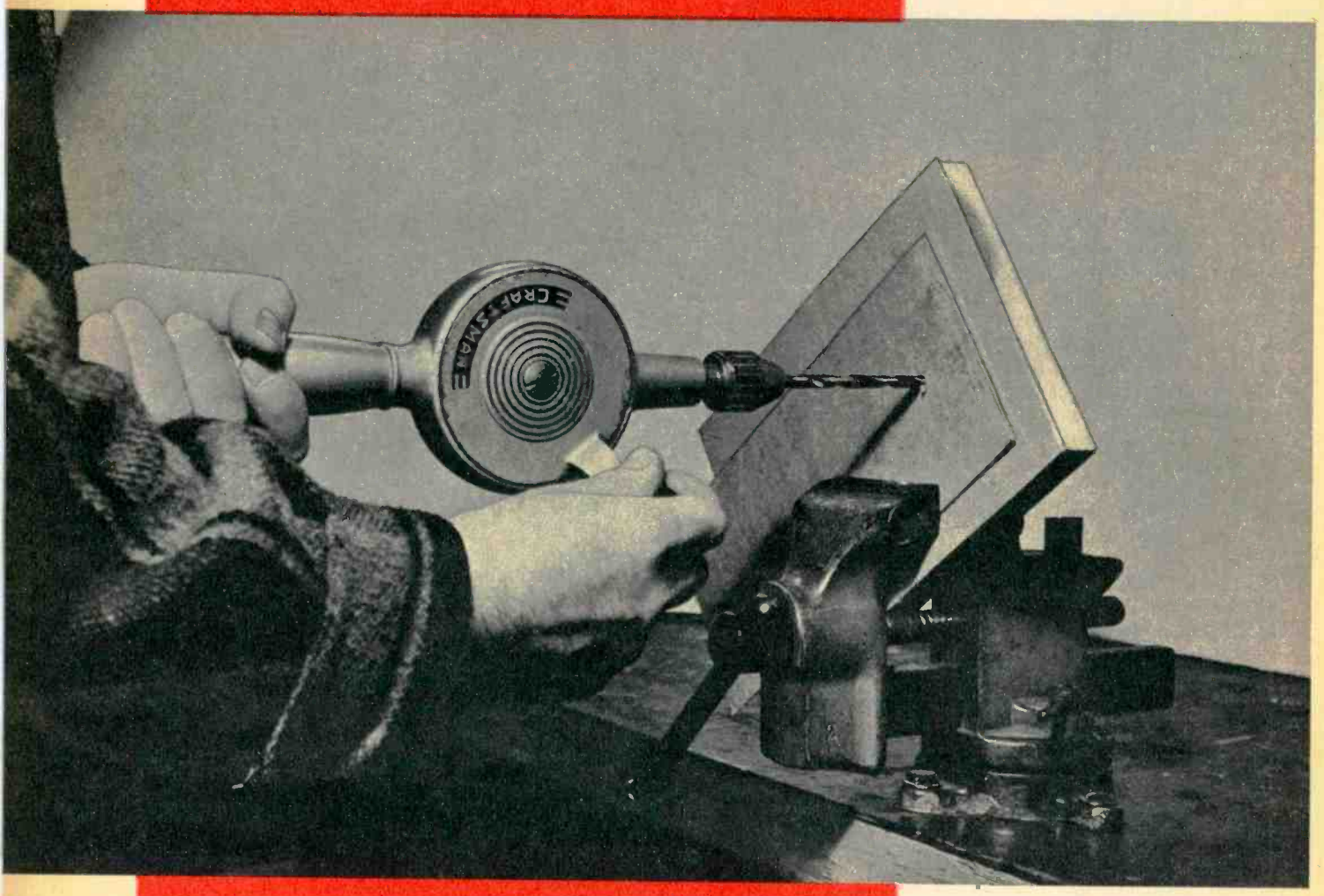


Finger is on dry disc rectifiers that turn AC into rough DC in Heath battery eliminator. Step-down transformer is in center; two 10,000-mfd. filter capacitors are at left.



Making Big Ones from Little Ones

It's easy to enlarge chassis holes for electronic parts when you use the right tools and techniques.



When making initial holes with a hand drill, support panel with wood and run the drill into latter. Clamp work in a vise, and force the drill through slowly.

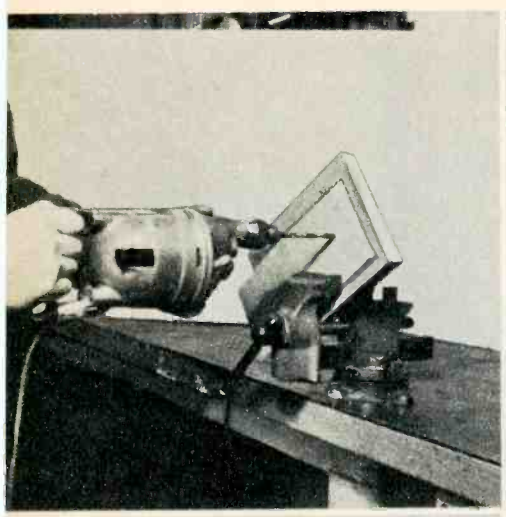
MAKING LARGE HOLES in aluminum and steel panels and chassis for numerous electronic components is a constantly recurring problem for experimenters and constructors, amateur and professional alike. Round holes from about 7/16 inch through 1½ inches are needed for switches, jacks, volume controls, etc.; square or rectangular openings are needed for transformers, choke coils, etc.

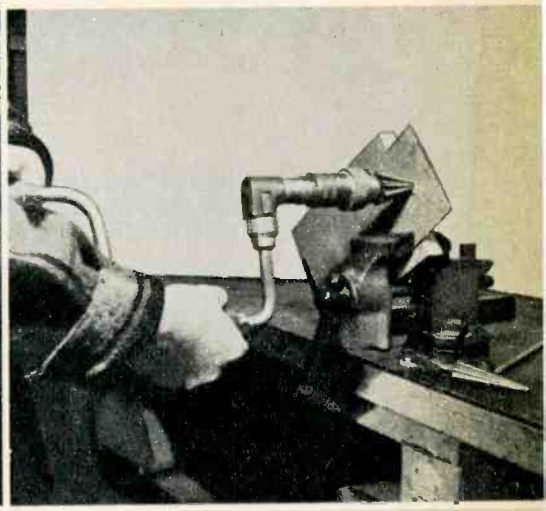
Enlarging a ¼-inch starting hole to about ½ inch is a relatively quick and easy job with tapered reamers, which are available in many sizes and styles. For socket holes, by far the best tools are radio chassis punches. In spite of their names, these do not require "punching" or hammering at all, but are operated with wrenches. Similar punches that make square holes are ideal for transformer cutouts. For the occasional or odd-size job, there is the old-fashioned, time-consuming but still effective method of drilling a circle or square of small holes, chiseling out the center, and hand-filing the edges. All of these techniques are illustrated on these pages. •—*R. H.*

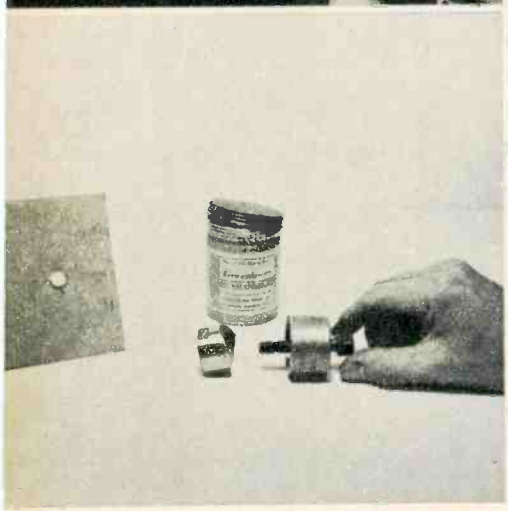
Same technique is used with a portable power drill. Keep one hand near chuck end, to support tool in horizontal position. Drill used is ¼ inch.

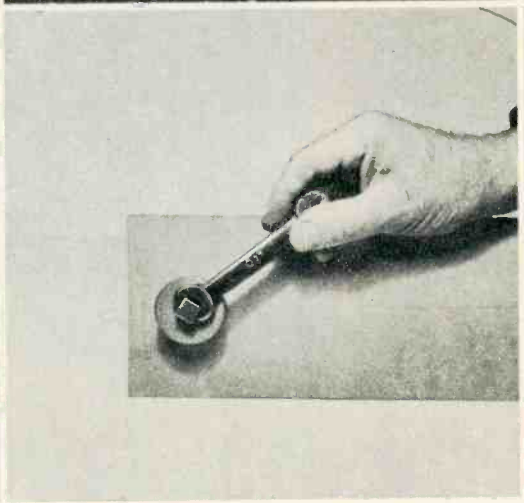
To enlarge hole, use hand reamer with ⅛-inch point and ½-inch-maximum diameter. Turn reamer with half-twisting motion, remove shavings often.

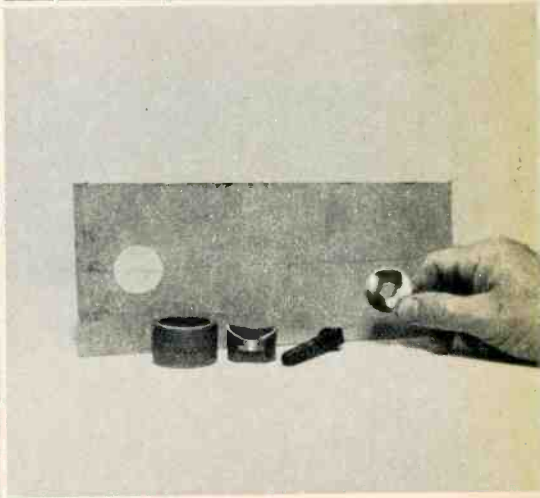
For holes larger than ½ inch, use carpenter's brace. Tapered reamer is enlarging ¼-inch hole to 1¼ inches. Nearing finish, turn panel, cut from back.







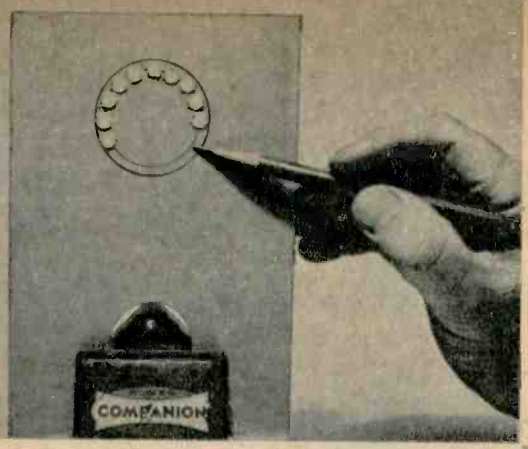




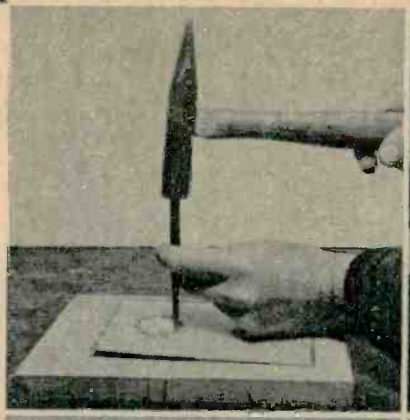
Fastest, cleanest job is done by hardened steel chassis punches like this. Center screw draws cutting section through panel, into hollow body of die.

For this method, pilot hole is needed. Parts of punch are placed on draw screw, tightened with fingers only. Wrench then draws punch parts together.

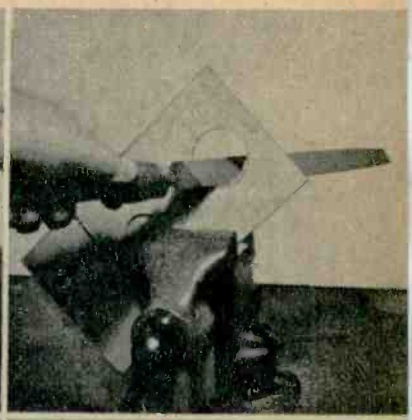
With about half a dozen turns of the draw screw, the punch cuts a perfectly round, burr-free hole. Piece of aluminum removed is in hand. (Turn page.)



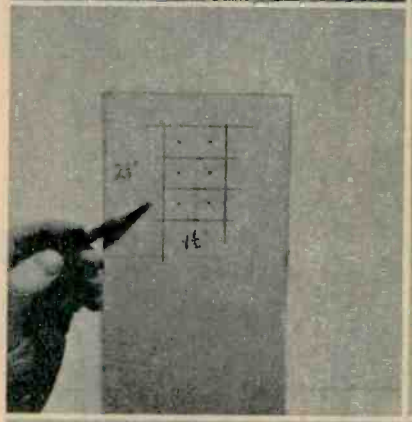
Lacking reamers and chassis punches, you can still cut large holes by starting with a series of small ones. Here the heavy outer circle represents the diameter of desired hole and the inner circle is the guide for the ¼-inch cutting-out holes. Be sure to allow room for final filing.



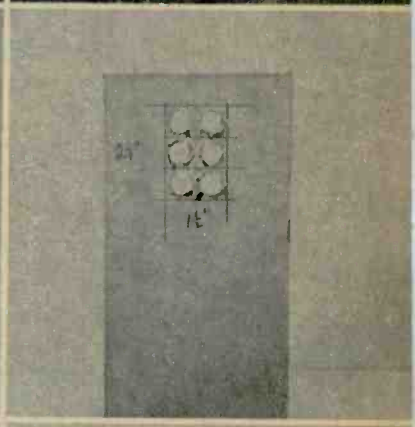
After full circle of holes has been drilled, cut through them with small chisel and remove center. Place wood scrap below to protect work surface.



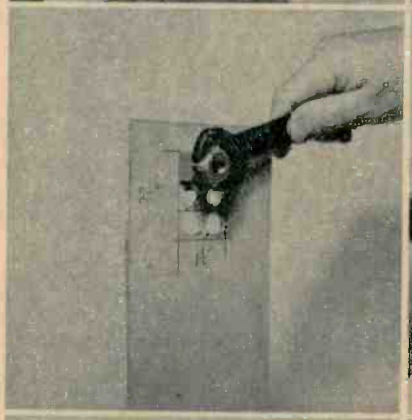
With panel supported in vise against back board, finish off hole with half-round file as shown. If you use rolling motion, you can do a fine job.



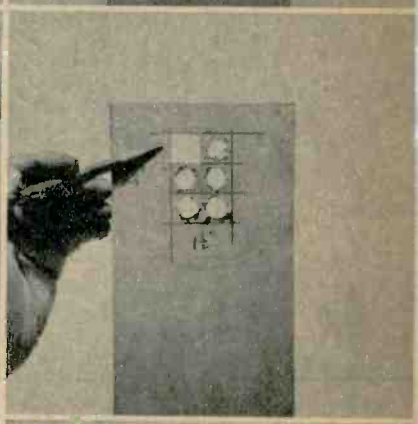
Typical construction requirement is a rectangular opening 1½x2¼ inches for a transformer. The area has been covered with wrapping paper.



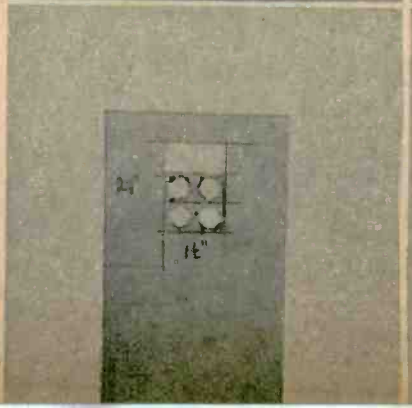
Rule off wrapping paper into ¾-inch squares and punch centers for drilling. The next step is to drill out punch center holes to ½ inch.



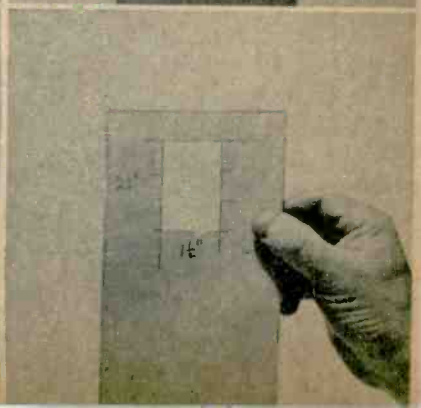
Chassis punch that makes ¾-inch square hole is started in first hole. Wrench turns large nut that draws two sections of punch together.



Square punches work just like the round versions. First hole makes neat, perfectly straight line. Punch is now shifted over to the second corner.

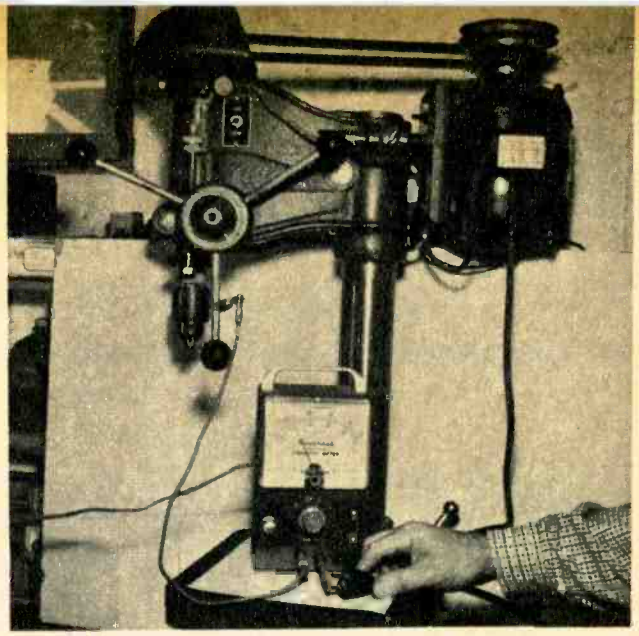


Shifted to second corner, punch trims off the opening right to the line. Overlap cuts if openings are not even multiples of punch size.



Here is finished transformer opening. A few strokes of fine file will remove metal shreds. They will crop up where cuts do not quite overlap.

How to Plug Electronic Leaks



Test on drill press with capacitance meter reveals capacitance of .02 mfd. between motor winding, metal framework which accounts for known leakage effect. Grounding wire from motor's frame to BX or water pipe, if power wiring is of open type, is protection against internal "grounds."

IT IS ENTIRELY POSSIBLE for an electrical appliance or a piece of electronic equipment to "leak" electricity, even though it is in perfect operating order. The effect is highly puzzling until you analyze the internal construction of the leaky devices and then remind yourself of the grounding arrangement of power lines.

The leakage makes itself evident in two common ways: 1) In shops having bare concrete floors, you feel a mild tingle when you touch the metal frame of a lathe, a drill press, a saw, etc., *even though the line switch is off.* 2) With electronic gear incorporating power transformers, touching a ground wire to the chassis produces a small but unmistakable spark. What makes the leakage even more mysterious is the fact that it occurs or does not occur at different times under apparently identical conditions.

The basic cause of the trouble is the capacitance effect between the large amount of copper wire in a motor or transformer and the heavy iron core on which it is wound. We commonly think of "capacitance" as the characteristic of "capacitors" or "condensers," which consist of close aluminum plates insulated and separated from each other by air, by paper or mica, or by very thin chemically-formed oxide films. Actually, there is capacitance between any adjacent but unconnected metal surfaces, the amount depending on their area and proximity. The wire in motors and transformers forms one plate of a perfectly good capacitor, the core or frame the other. The effect is completely independent of the device's normal functioning.

Quick tests made on common machines reveal some surprising figures. As illustrated in an accompanying photograph, a direct-reading capacitance meter showed a value of .02 mfd. between the frame of a drill press motor and one end of the internal winding. This is a very considerable reading.

The current passed through a circuit by a capacitor goes up with its capacitance, the line voltage, and the frequency of the latter. A .02 mfd. capacitor at 115 volts, 60 cycles, lets through an appreciable current.

"Let's through where and how?" you're probably asking. Figure 1 has the answer. If the line plug happens to be in the wall outlet with the switch side to the grounded leg of the power line and the free end of the motor winding to the "hot" leg, and if you place your body between the motor frame and a grounded floor, you can readily trace a complete circuit as follows: From the hot leg of the line, to the mass of wire in the motor, *through the capacitor formed by the wire and the motor frame,* through your body, through the grounded floor, and back through the grounded side of the line. The equivalent wiring diagram is shown as Figure 2.

If R is a piece of grounding wire from the frame, instead of the human body, the circuit is even more complete in that the total resistance is lower than before, and a small spark appears when the connection is made or broken.

While the leakage current is "appreciable," it is not, fortunately, large enough to be dangerous. That's why you feel only a mild muscle contraction, and not a real shock. If the bottom end of the motor winding makes actual contact with the frame, the current-limiting action of the capacitance effect is removed, and then you can get knocked off your feet by the 115-volt line.

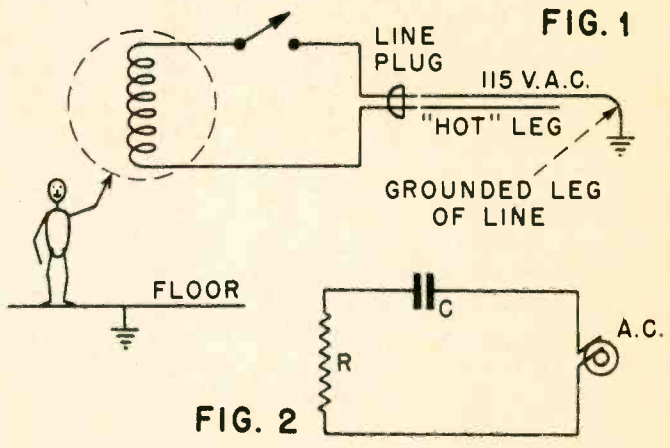


Fig. 1: Body placed between motor frame and ground forms completed circuit, through motor capacitance. Fig. 2: C is motor capacitance, while R reflects body resistance.

The fact that an ordinary two-prong attachment plug can be inserted either way into an ordinary outlet explains why leakage is observed some times but not others. If the line plug of Figure 1 is flopped around, the bottom end of the motor winding now goes to ground through the ground leg of the line, and the capacitance effect within the motor is effectively short-circuited. Obviously, it's a good idea to mark the plug some way so that you can reinsert it correctly each time. For complete protection against the possibility of dangerous internal grounding, as well as against leakage, it's an even better idea to ground the framework by a separate wire. This protection is now built into practically all new motor-operated tools and household machines such as clothes washers, dish washers, etc. Their line cords contain three wires and are fitted with special three-prong plugs which can be inserted only one way; the third wire is the grounding lead. •—*R. H.*

Radio Kits

Without a single tool, Junior (or his inquisitive Dad) can now build a radio and other units in a few minutes.

At left is a small tool-less radio kit, intended for persons entirely without previous knowledge of electronics. Some parts are already in position on the template over the baseboard. The larger kit, shown below, contains a tube, can be assembled into 15 different electronic units.

ASSEMBLE AND WIRE a complete one-tube radio receiver that really works . . . in ten minutes. A code-practice oscillator or half a dozen other practical electronic units . . . in four to seven minutes. And all without tools, absolutely none, not even a screwdriver.

Sound impossible? That's what I thought when I read the press release announcing a new line of do-it-yourself kits called "ErecTronic," put out by Science Electronics, Inc., of Cambridge, Mass. So I sent for a couple of them, fully expecting to receive only some boxes of surplus parts. I must say that I was most pleasantly surprised when I opened the large packages that arrived shortly. Far from being toys or junk, as I had made up my mind they must be, these kits turned out to be high-grade merchandise of very clever and practical design. Although they are aimed obviously at the juvenile market, they will undoubtedly receive a great deal of attention also from the fond fathers who will buy them, ostensibly, for their sons.

The foundation of the ErecTronic kits is a foot-square pressed peg board, with the holes a half-inch apart. Individual electronic components such as resistors, capacitors, tuning coils, transistors, tube sockets, battery holders, etc., are mounted on specially-molded plastic bases that have 3/16-inch buttons or pegs on their undersides. These buttons are spaced one inch or other multiples of a half-inch apart. To mount any part, you simply press it into the peg board; to dismount it, pry it out with a thumb nail.

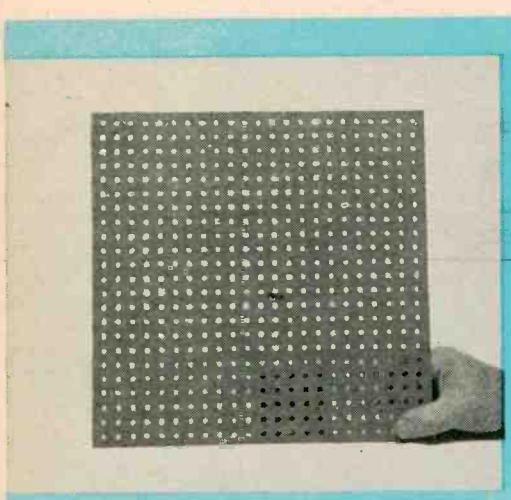
The terminals of the components are nickel-plated brass studs 3/8 inch high, firmly anchored in the plastic bases. All connections to these terminals are made with "jiffy connectors," which are pieces of flexible wire of various lengths fitted with spring-action, fork-shaped ends. As many as five connectors can be piled on a single stud, at the rate of one per second. The connections are tight, *and no soldering is required.* It takes even less time to pull the connectors off if you want to change the hook-up.

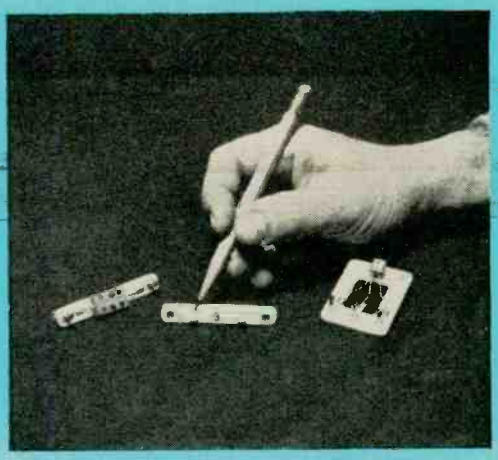
It is practically impossible even for the rankest beginner to make a mistake in assembly and wiring, because a punched and self-aligning template is included for each of the various electronic units that can be put together out of the assortment of parts. The template is the size of the peg board, and is printed with outlines of the components, their identifying numbers, and their correct schematic symbols. Thus, the first time a user handles a part, he learns

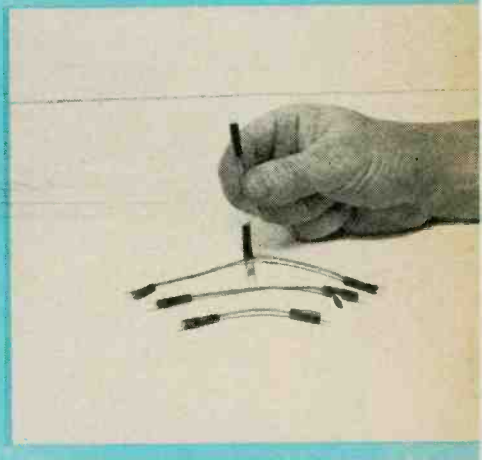
Foundation of the ErecTronic kits is this simple pegboard, about a foot square. It comes with holes punched at intervals of half inch.

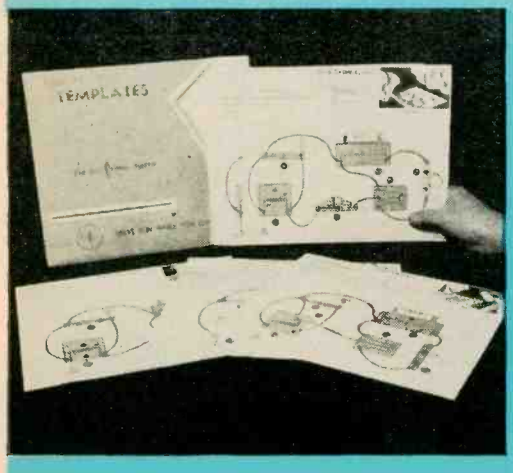
Individual parts come mounted on plastic bases. Pencil points to underside stud. At left is mica fixed capacitor; right, transistor.

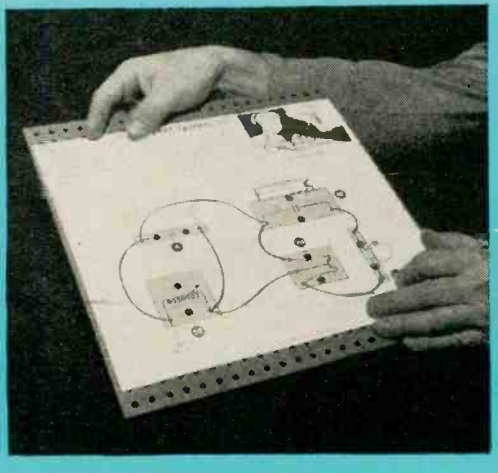
"Jiffy connectors" have spring-action forked ends, which fit upright terminals of components. Kit includes leads like these in assorted lengths.

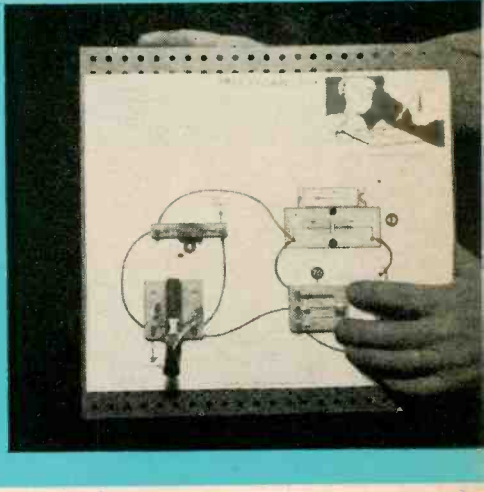












These are some of the full-size templates furnished with the kits. The heavy lines on each template show connections between the elements.

Holes punched in template line up with holes in peg board. Note how required parts are identified by symbols, numbers stamped on bases.

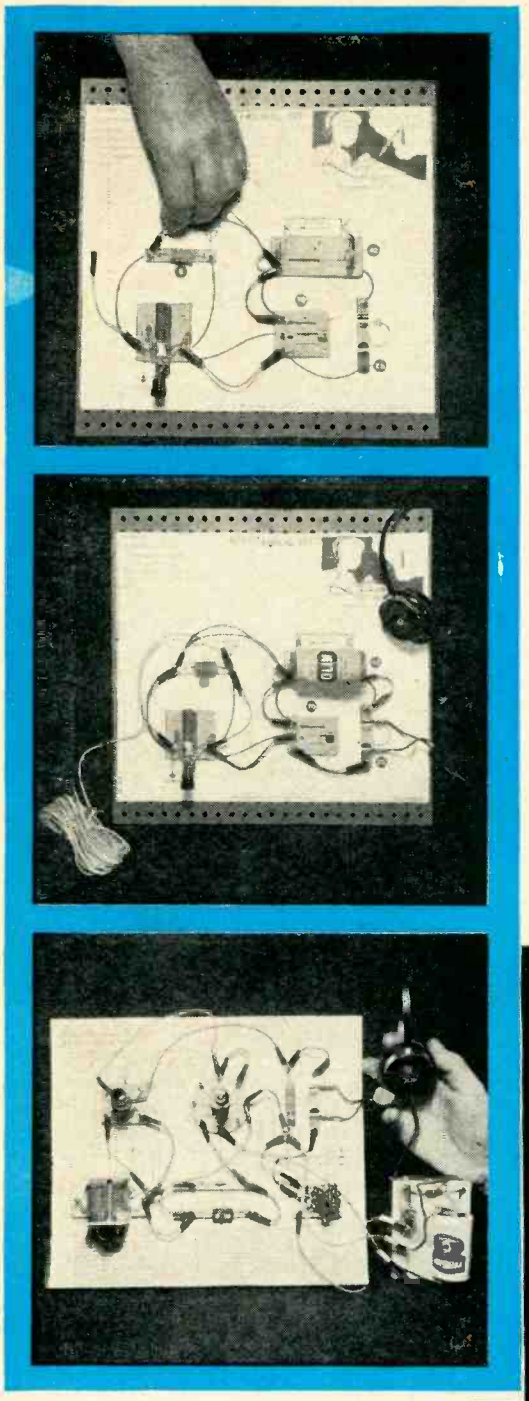
Fixed capacitor (4) and tuning coil (beneath) for basic transistor radio are mounted. Transistor (70) is being pressed down with the fingers.

its name, what it looks like, and how it is represented in the diagrams used universally in electronic practice. In this respect it can be said that the kits are highly educational, and in a completely painless way.

Heavy lines on the templates show the connections between elements. The equivalent schematic diagrams are printed on the top.

Two kits are available. The Model T-150 is the basic job, with enough parts for nine different units. A crystal detector and a transistor are included, but no tubes. The Model T-200 is a little more advanced, and has material for fifteen assemblies. It includes a 1T4 battery-type tube. Additional components can be purchased separately, and of course peg boards can be placed side by side to accommodate them.

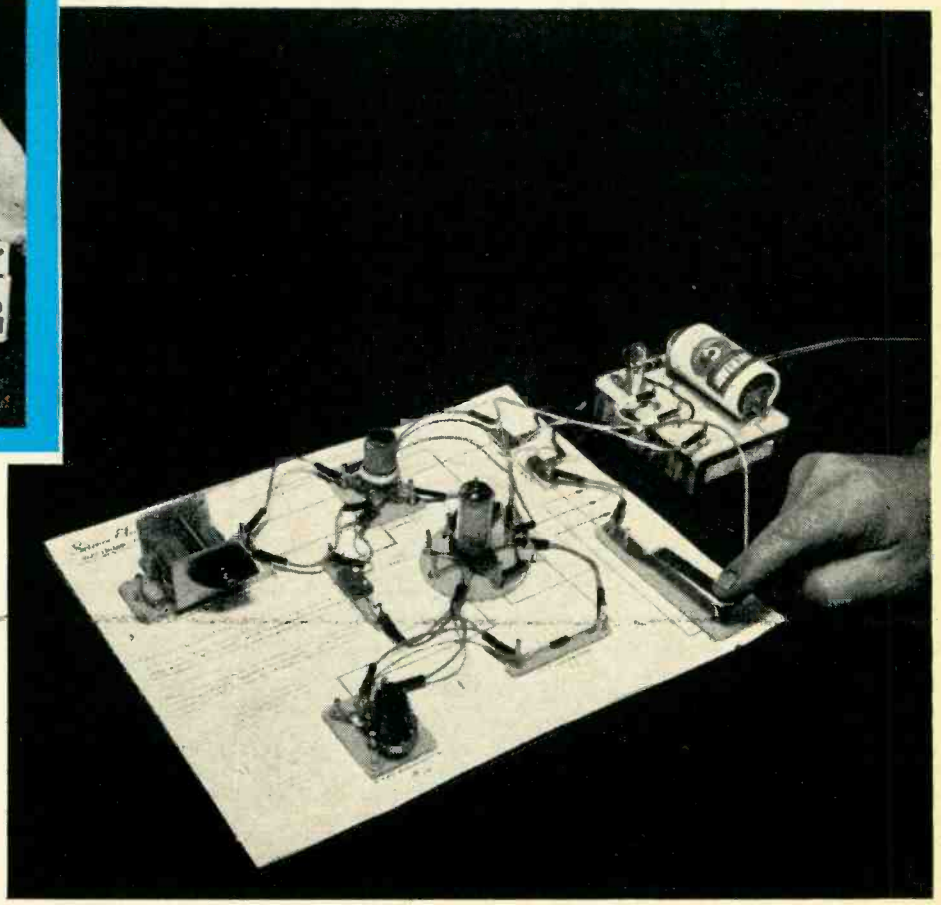
Although intended primarily for self-instruction, these kits are also terrific for classroom use. A friend of mine who teaches electricity and radio in a New York City school "borrowed" the T-200 and reports that it is one of his most effective teaching aids. •—*R. H.*



With battery holder (42) and earphone clips (25) in place, wiring can be clipped to connectors (no soldering needed.)

Coil of wire in lower left corner is antenna "hank." A single earphone gives good signals from local broadcasters.

Here is a one-tube receiver, with battery pack in lower right corner. Template covers the peg board completely.

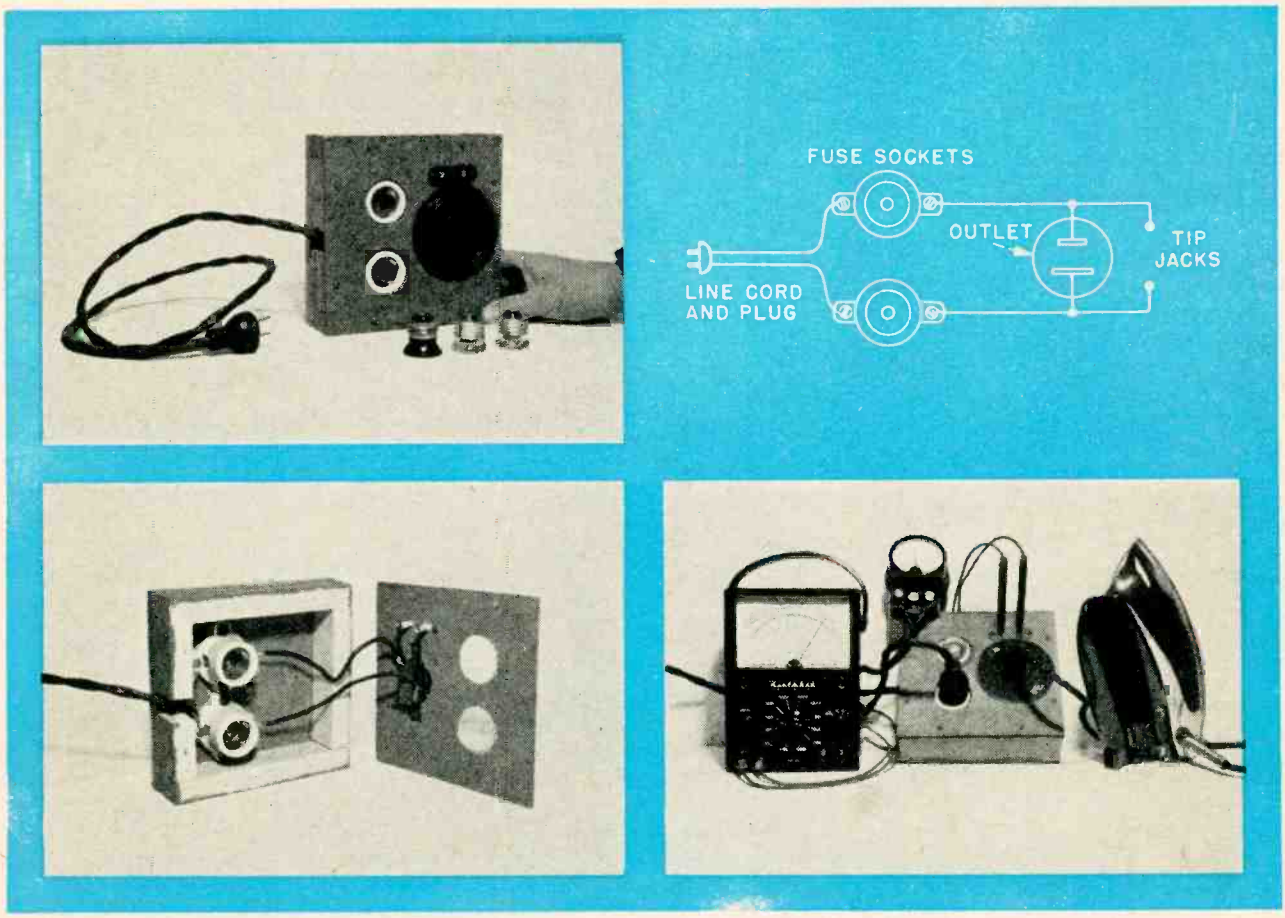


This is same peg board shown in preceding photograph, but parts are arranged to form a code practice oscillator. Template is included in kit.

Keep Those Lights Burning!

Complete fuse box is shown here. White fuse sockets are on left; voltmeter tip jacks, convenience outlet on the right.

Wiring is simple. Actually, one fuse would be enough, but second provides convenient connection point for ammeter.



Interior view. Note that fuse sockets are fastened to the bottom of box. Holes in panel are oversize to clear them.

In voltage, current check on iron, voltmeter connects to tip jacks by prods; ammeter plugs into lower fuse socket.

YOU'RE struggling with a balky radio set on your workbench, and you're wondering why it doesn't work. Suddenly, it makes a soft sound like "plft," and the basement lights all go out. You realize, somewhat sheepishly, that you've blown a branch fuse. No serious damage, but it's annoying to be plunged into darkness this way.

After one such experience, you'll appreciate the value of an intermediate fuse box of some kind connected between a suspected appliance and the power outlet on the bench. You can make one out of odd parts: two Edison base lamp sockets, a single convenience outlet on a round or rectangular plate, a three- or four-foot length of lamp cord with a plug on one end, a pair of phone tip jacks, a piece of plywood or pressed board about seven inches square, and some scrap wood to form a shallow box.

The fuses in this box should be of lower rating than the one in the branch circuit, so that they will blow before the latter. The appropriate size depends on the device undergoing examination. A radio receiver or a hi-fi amplifier runs on a couple of amperes or less, so five-amp fuses for the box would be fine. An iron might take eight or nine amperes, so start with ten-amp fuses.

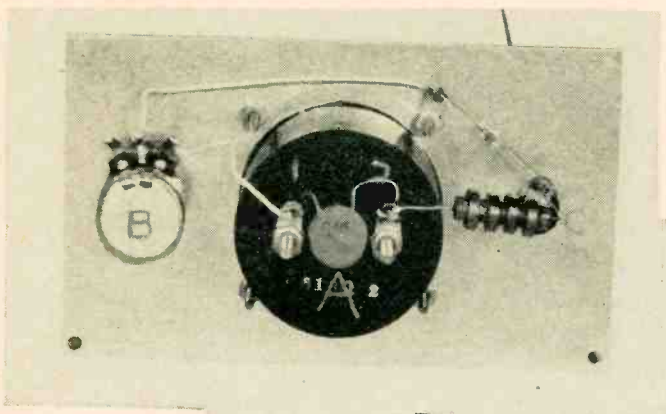
The set-up for a test is simple. Plug the cord of the fuse box into the bench outlet, and the cord of the appliance into the box outlet. The tip jacks permit quick connection of a voltmeter to measure the line voltage.

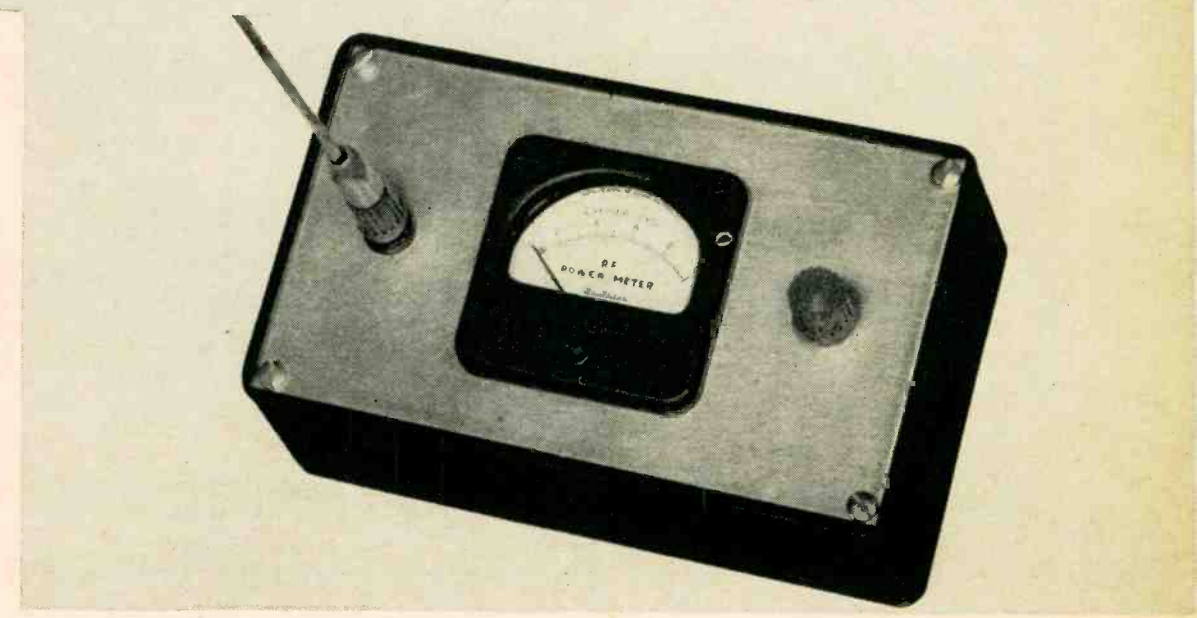
Actually, one fuse would be enough. Two sockets are provided because one becomes a very convenient connection point for an ammeter. This meter, which measures current in amperes, must be inserted somewhere in *series* with the appliance. Cutting into the power wires is such a nuisance that few electronic technicians bother to do it. With this box, it isn't necessary. One fuse is replaced by a screw-in attachment plug, into the top of which the ammeter is connected by a regular two-prong plug. The meter now reads when the appliance is turned on.

Because fuses out of the same container may have slightly different characteristics, usually one fuse in the box blows first, opening the circuit and leaving the other intact. A blown fuse does not necessarily mean that the circuit is now open and safe. It is quite possible for the good-fuse side of the line to remain "hot" in relation to any grounded object, so beware. Disconnect the faulty appliance before touching any exposed connection in it. •—*R. H.*

Sure You're on the Air, Mate?

This device assures you your transmitter works before you head out into open water.





Simply assembled and operated, the R.F. power meter, shown in top and chassis views, contains but half a dozen components, weighs but a pound, case included.

THE TREMENDOUS INCREASE in pleasure boating by week-end sailors in recent years has also called for a new look at maritime safety practices. Even as this is being written, the Merchant Marine and Fisheries Committee of the United States House of Representatives is conducting hearings concerning possible new boating legislation.

But whatever may come of these hearings, there is one thing this refugee from Uncle Sam's Navy knows! My family and my putt-putt will never venture into open water unless our two-way radiotelephone is in good working condition.

Since not every boating fan carries an electrical engineering degree in his hip pocket, however, the design of small marine radiofone systems is necessarily kept as simple as possible. So simple, in fact, that we not-so-able-bodied seamen cannot be certain that our transmitters are actually putting a solid signal on the air. And if they are not, we may some unhappy day find that our frantic shouts of *m'aider!* are only getting out as far as the wind will carry them.

Now, however, there has just been announced a compact, sure-fire device for indicating accurately the condition of the signal our radiofone puts on the air. It will immediately tell, first, if the signal is on the air at all. Second, it can tell at once if the signal strength is up to normal. Third, it can aid in adjusting the transmitter for maximum output and efficiency.

Although it is available only in kit form, and is known commercially as the Heathkit R.F. Power Meter Model PM-1, it is very easily and quickly assembled (it only has a half-dozen components), and is well worth the trouble for the peace of mind it affords.

Basically, a tiny radio receiver with a meter across its output instead of headphones or speaker, it is operated entirely by the signal radiated by the transmitter. No external source of operating power is required. It is entirely portable, measuring only 6¼x3¾x2 inches, and weighing just one pound complete with case.

Operation of the unit is exceedingly simple. The meter with antenna installed is placed fairly close to the transmitter. A three-foot length of hookup wire with a banana plug attached to one end is provided as an antenna, although a length of coat hanger wire is sturdier and works just as well.

In marine applications, the transmitter is switched to 2638 or 2738 kc. Listen before transmitting, of course, so as not to interfere with any traffic being carried on the frequency. When the channel is clear, press the push-to-talk switch briefly and note the deflection on the power meter.

If the meter goes off scale, rotate the sensitivity control counterclockwise until a convenient mid-scale reading is found. If this is not possible, cut a chunk off the end of the pickup antenna, or move the unit a little further away from the transmitter. The higher the transmitter power, the smaller the antenna need be.

Now, without further adjusting or relocating of the power meter, peak up the transmitter on all of the frequencies normally used. If the transmitter has a control marked OUTPUT, ANTENNA, ANTENNA TUNING, or some similar inscription, adjust this control on each of the frequencies for maximum reading on the meter. *Note, however, that casual operation on the Coast Guard frequencies is forbidden, as they are reserved for distress traffic. Do not use them for testing.*

As the transmitter is tuned, the control setting and power meter reading for each frequency should be logged. The meter should now be permanently installed in the place it was used for the tests. Henceforth, just an occasional glance at the meter will assure you that the transmitter is operating correctly. For a more precise check, however, reference can be made to the entries in the log.

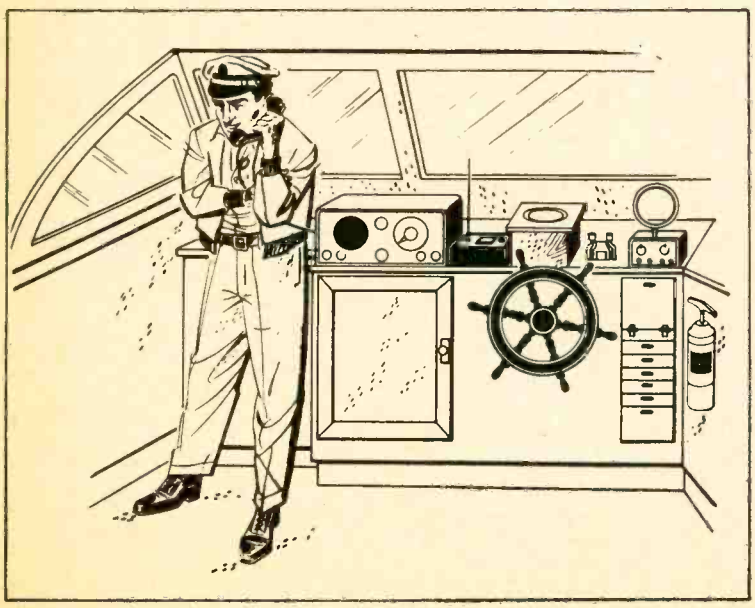
Since the Heathkit R.F. Power Meter has an operating range of from 100 kc to over 250 megacycles, it also has many other useful applications. Other mobile services, such as police, fire, taxi and amateur, are also using it for on-the-air monitoring and transmitter tuning. Even broadcast stations, both AM and FM, can employ it for an on-the-air check. Some amateur operators use it as a portable field-strength meter to determine the radiation pattern of their antennas.

With the antenna used as a probe, the meter may be used to indicate radio-frequency leakage around louvers and cabling of otherwise sealed transmitters. Sensitivity of this instrument is so great that, while it will give adequate readings when the pickup antenna is brought near the oscillator coil in a superheterodyne receiver, it may still be used with transmitters generating many kilowatts of power.

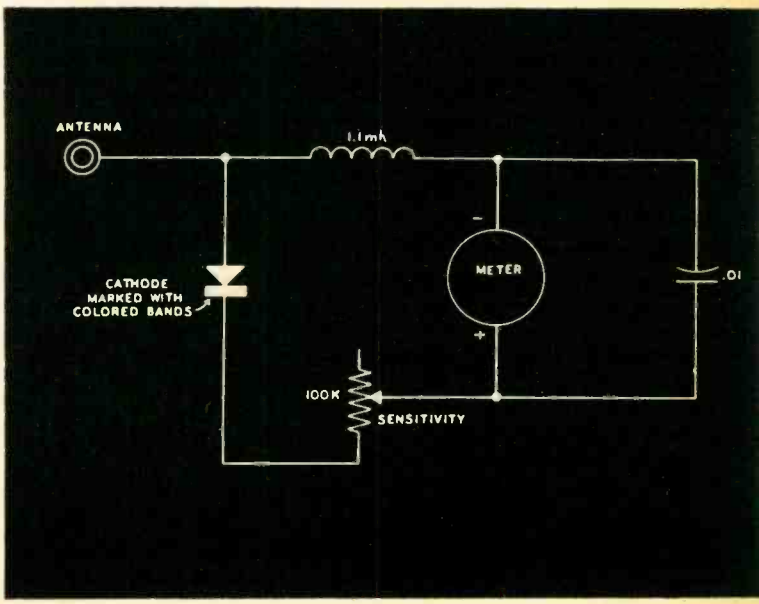
It is therefore obvious that the R. F. Power Meter is not restricted to marine applications. Servicemen could use it to check signal injectors. With a sensitive relay added to the circuit, it might be used to operate warning lights, for loudspeaker muting or a carrier-off alarm. Dozens of other possibilities suggest themselves to experiments.

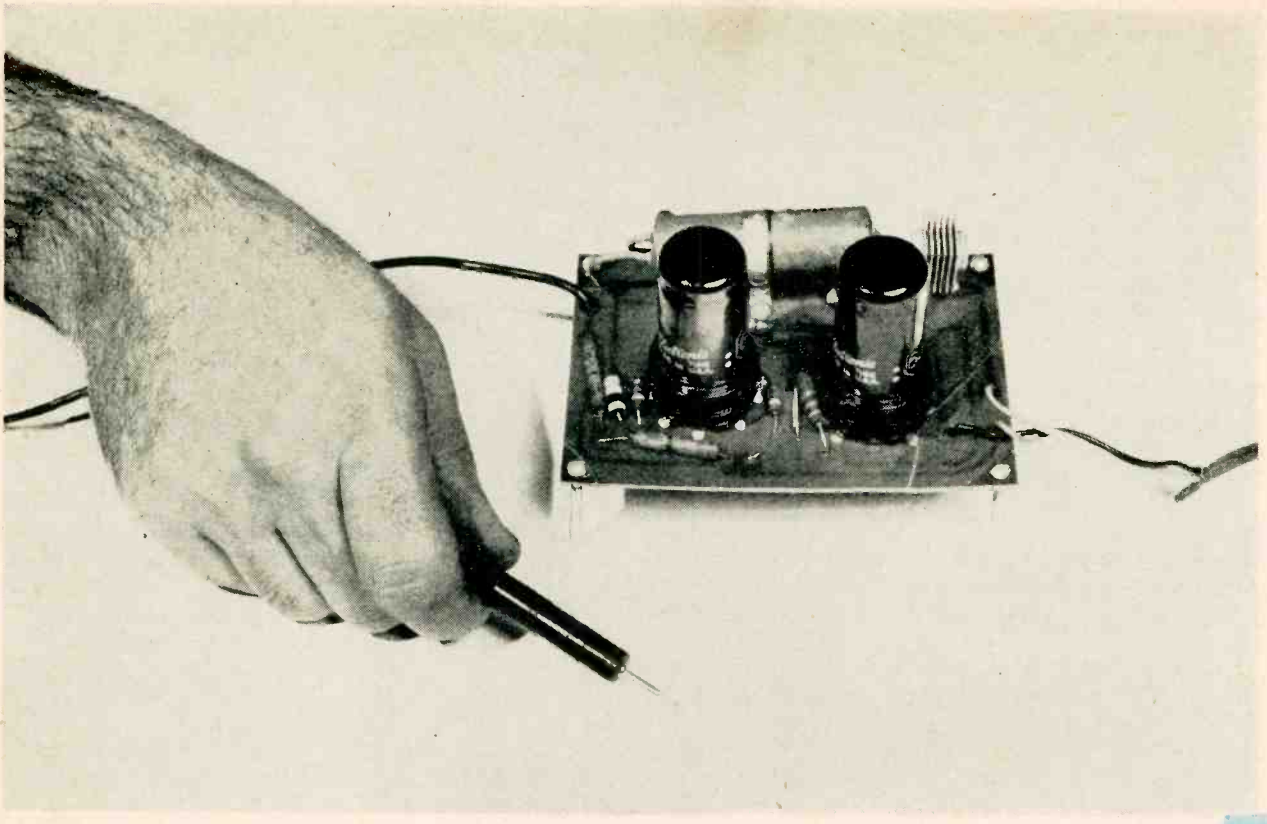
But whatever other handy-dandy applications it may have, there is one thing definite. The R.F. Power Meter will be standard equipment on my cruiser from the first time she hits the water next spring. •—*D. H.*

Typical installation of the R.F. meter. It has an operating range from 100 kilocycles to over 250 megacycles.



Basically, the Heathkit Model PM-1 is a tiny receiver with a meter across its output instead of phones or speaker.





Small printed-circuit signal injector, smaller than a man's hand, does a large job in electronic trouble shooting; it's Progressive kit.

Signal Injector

Trouble shooting the signal-injection way is quick and easy; here's the lowdown on a kit made specifically for the purpose.

HERE'S A SWELL LITTLE PROJECT which provides good construction experience, a knowledge of printed circuitry, and practice in electronic servicing. What's more, when it's finished it become an exceedingly handy test instrument.

Printed circuitry is the newest method of wiring electrical and electronic circuits. Everywhere one looks to find modern electronic applications today, he is almost certain to see some form of printed circuit. In radio, television, hi-fi, hearing aids, test equipment, guided missiles, rockets, jets, radar, computers—in fact anywhere that electronics serves, there is the printed circuit.

It should be understood at the outset that the term *printed circuit* really has two meanings, one general and one specific. In the general sense, it is applied almost universally to all types of wiring which are mechanically applied. In its specific sense it refers to the *printed circuit plate* as opposed to the *etched wiring board*.

The printed circuit plate is usually a small ceramic wafer on which the wiring pattern has been applied by oven-firing. The components, such as resistors and condensers are normally molded in as an integral part of the unit. Often the molding is of such size and shape as to completely obscure the nature of the insides of the unit, and the only means of identification is by a type number or other descriptive matter stamped on the case. The printed circuit plate is most often found to comprise just a couple of components, as in a resistance-capacitance network for a television receiver. It may, however, appear as a complete circuit, particularly in miniaturized systems, such as hearing aids and electronic stethoscopes.

The etched wiring board, on the other hand, begins with a thin slab of some nonconducting material, often of the phenol family, to which is bonded a thin conductive layer, usually copper foil. After the desired wiring pattern has been determined, the rest of the copper is etched away, so that only the "printed" conductors remain.

Conventional components are then mounted in place on this board and soldered to the copper wiring as required. It is this etched process which is the basis of the Printed Circuit Signal Injector developed by Progressive "Edu-Kits" Inc.

This is really a fine little sensitive instrument, useful for trouble-shooting many types of radio and audio equipment. When used properly, it can locate many sorts of trouble. It will reduce servicing time considerably, and even the greenest beginner will find himself performing real trouble-shooting with just a few minutes of practice.

The signal injector is a specially-designed multi-vibrator oscillator, a circuit which is often employed in television receivers. This type of oscillator has an output which is exceedingly rich in harmonics. This means that it emits many different frequencies, ranging from the low audio to the high radio ranges. This makes it ideal for determining the behavior of a signal as it passes through both audio and radio-frequency amplifiers.

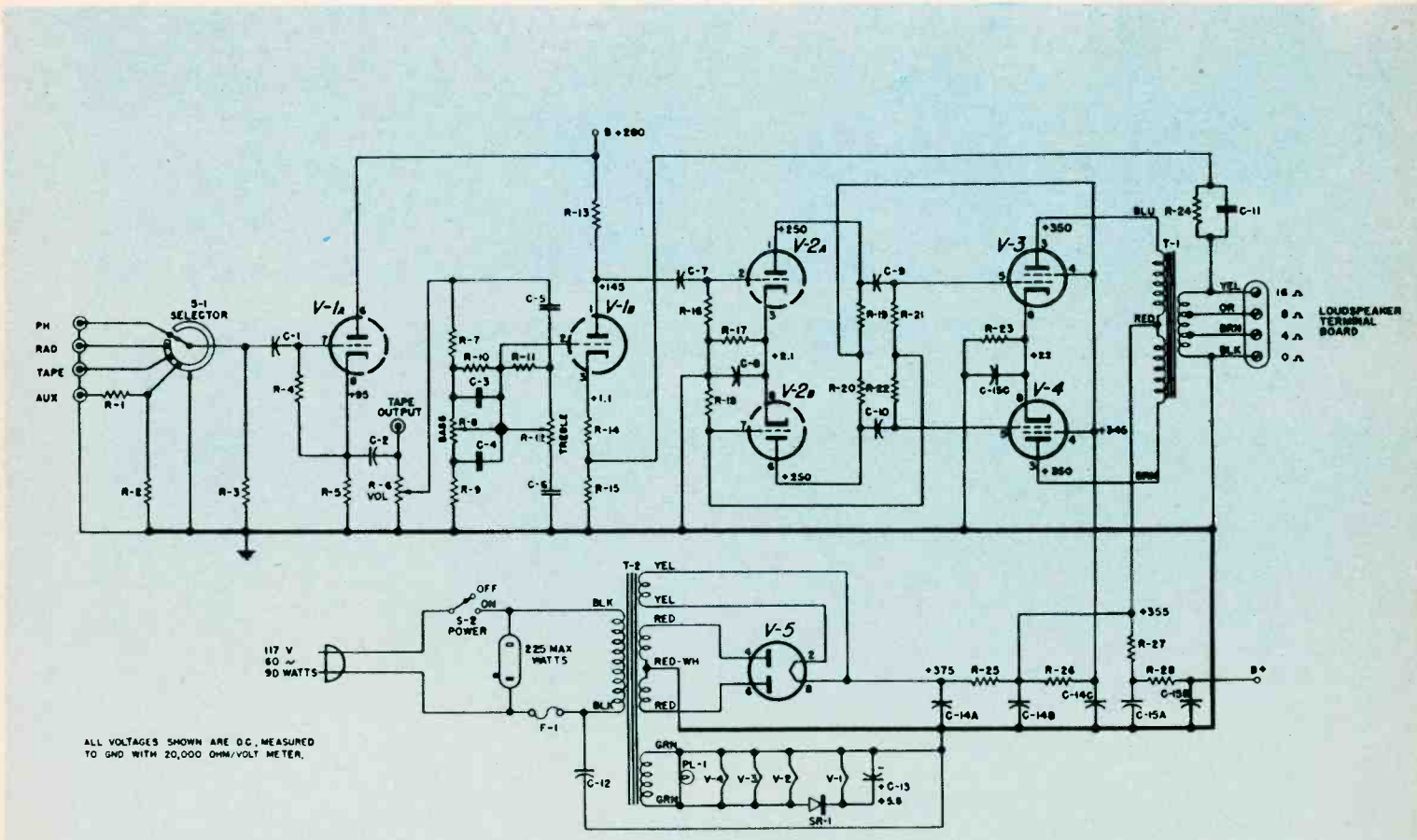
In building the printed circuit signal injector, the first notable difference from conventional construction is in the tube sockets, which are specially designed for this application. Instead of the usual tube socket mounting ring, we find a set of lugs which act both as a pressure mounting against the circuit plate and as conductors for the tube prongs. When the socket is properly turned in place, each lug is soldered to its respective "wire" on the etched plate, and the mounting and electrical connection is thus completed at the same time.

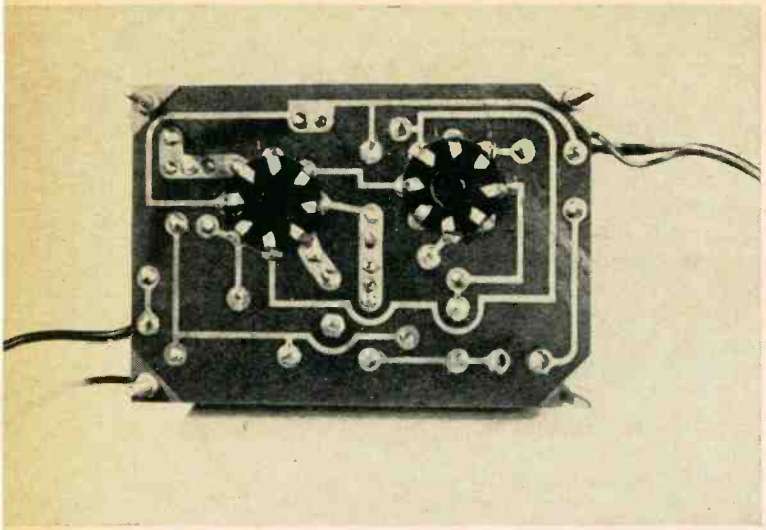
Wiring in the resistors and condensers is equally simple. The parts are simply positioned on the non-conducting side of the circuit board, and their "pigtail" wire leads passed through the appropriate holes on the board. The opposite side of the hole will be found to contain a copper terminal in each case, and the lead is simply cut short and soldered in right at the hole.

Operation of the signal injector relies upon the fact that the oscillator output, when applied to the plate or grid of any tube by means of the probe, will "ride through" a well-functioning amplifier and be heard on a loudspeaker at the output. This will be true of any radio set, tuner, or hi-fi amplifier.

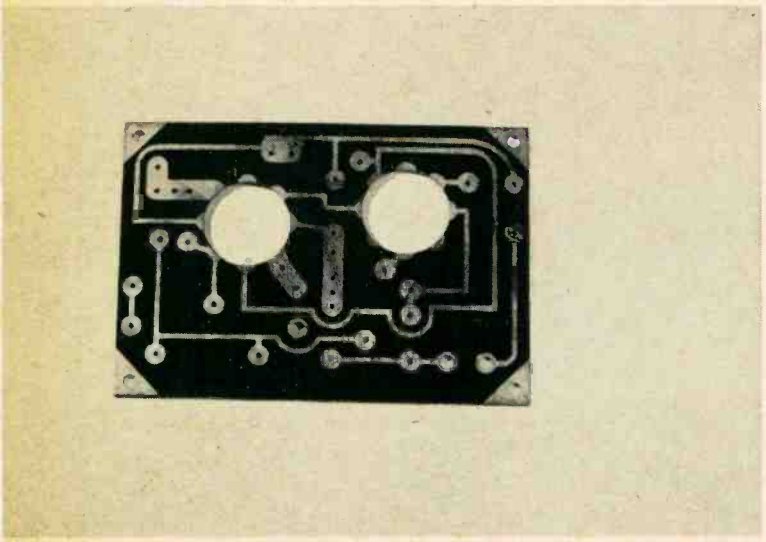
Let us suppose, for example, that we encounter trouble in our Sonotone HFA-100, a typical high-grade amplifier. A brief examination reveals that the tubes all light, nothing is visibly out of order, but still no sound appears at the

Circuit diagram of Sonotone HF-100, a typical hi-fi amplifier, is shown; it can be serviced with signal injector.

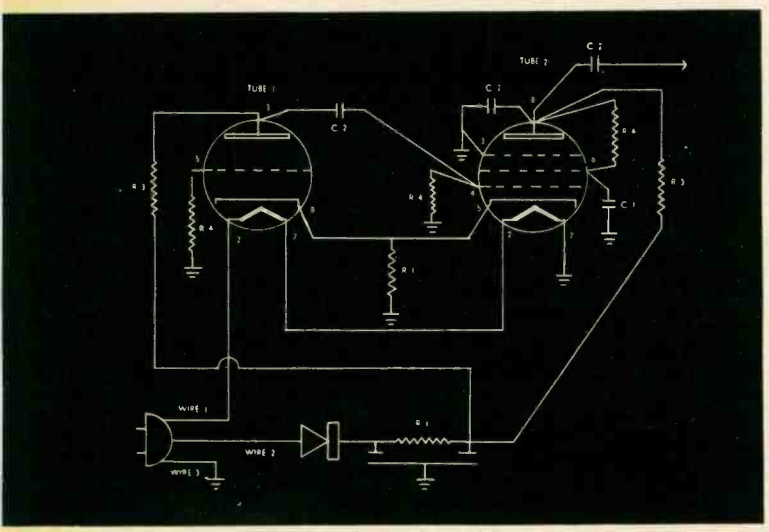




"Wiring" of signal injector involves simply applying solder to component pigtail ends coming through the board.



Heart of signal injector is etched wiring board, above. This differs from the printed circuit plate. See text for details.



Two-tube circuit, which is AC operated, is basic multi-vibrator oscillator. Output signal is fed to probe through C2.

output on any of the four input selector positions. Our problem, then, is to determine where the signal gets lost.

The best procedure in signal tracing is to begin near the output of the system and work toward the front. So let us suppose that when we touch our injector probe to the grids (pin 5) of both V-3 and V-4, the tone from the oscillator is heard quite distinctly. The same thing is true when the probe is applied to the plates (pins 1 and 6) of V-2. But when we probe the grid circuits (pins 2 and 7) the signal disappears. *Eureka!* The trouble is between the input and output of tube V-2, which means the tube itself is at fault. Replacing it will, in all probability, clear up the trouble completely.

It is true that we could have found this trouble by removing all of the tubes and checking them on a tester. Or we might have methodically replaced each tube in the amplifier, one by one, until the guilty one became conspicuous by its absence. Neither method, however, would have been as quick and easy as the signal injection way.

And here's one which no amount of tube checking or substitution would clear up. Suppose that the injected signal gets through V-2 when applied to its grids, but cannot be heard when it is applied to the plate (pin 1) of V-1B. The trouble is immediately localized to the coupling and phase-inverter network between V-1B and V-2. A further check may reveal that condenser C-7 is open. At any rate, the number of suspects is immediately quite small, and further measures with other instruments can easily ferret out the guilty party.

It should be remembered that the signal injector probe should be applied only to the control grid or plate of the stage being tested. Grid and plate pin numbers of typical popular tube types are given in the table below. •—*D. H.*

TABLE OF POPULAR TUBE PIN CONNECTIONS

Type	Grid Pin	Plate Pin
1R5	4	2
1S4	3	2, 6
1T4	6	2
1T5	5	3
3Q5	5	3
3S4	3	2, 6
6AQ5	1, 7	5
6AQ6	1	5, 6, 7
6AR5	1	5
6AT6	1	5, 6, 7
6BA6	1	5
6BA7	7	9
6BE6	1	5
6J5	5	3
6K6	5	3
6L6	5	3
6SA7	8	3
6SJ7	4	8
6SK7	4	8
6SN7	1, 4	2, 5
6SQ7	2	4, 5, 6
6V6	5	3
35B5	1, 7	5
35C5	2, 5	7
50B5	1, 7	5
70L7	5	3

* Note that the number prefix often indicates the filament voltage, and that tubes having the same suffix are identical in pin connection. Viz., 6SJ7 and 12SJ7; 6L6, 25L6, 35L6 and 50L6.

Offset tower supports Harvard University's giant 60-foot radio telescope. Box-like objects hanging from rim of the reflector dish are cement block balancing weights.

Radio Telescope "Sees" Into The Heavens

SOMEWHERE in the nearly empty reaches of outer space, two hydrogen atoms collide, and release a tiny shower of electrons. After a 100-million year journey at the speed of 186,000 miles per second, these electrons are picked up by a giant, super-sensitive radio antenna in Massachusetts. Although they are at best faint signals, they are giving astronomers much valuable new information about the distant heavens.

The big antenna is properly called a radio "telescope," because its electronic action closely resembles the optical action of a regular reflecting telescope. In the latter, a concave mirror collects light and concentrates it on an eyepiece or a photographic film at its focal point. In the former, a concave aluminum-mesh dish collects the star signals and concentrates them into a pick-up antenna at its focal point.

The radio telescope shown in the accompanying photograph is a new 60-foot monster put into service recently by Harvard University. As tall as a seven-story building, it is built entirely of aluminum, and weighs a total of 36 tons. It is rotated about its polar axis, for sky-scanning purposes, by a motor no larger than those used in portable power drills. This revolves at 1,800 revolutions per minute, but is geared down to *only one turn per day.*

The imposing structure is located about 25 miles west of Cambridge, Massachusetts. It is a real eye-stopper, not only because of the size of the reflector dish but also because of the seemingly crazy angle of the supporting base and the wigwam-like tower. The tilt is deliberate, to give the telescope access to the entire visible sky. The entire telescope was designed and built by the firm of D. S. Kennedy and Co., of Cohasset, Massachusetts. •—*R. H.*

All Aboard! You're An "Audio Engineer"

Others will envy the owner of this wonder-toy—if he can get it away from Dad!

A word spoken into the "mike" of this precision electronic instrument and electric train starts, stops and backs up.

"Toy trains can't think!", I muttered. "Confound it! Even big trains can't think!"

"What did you say, dear?", asked my very patient spouse.

"Nothing. But an ad here in TRUE says you can talk into a microphone, tell an electric train what to do, and then it will do it. An insult to the intelligence. Whose insult, they have the nerve to call the thing 'Audio-Engineer.' "

"Well, you're an audio engineer, or so you tell me." My very patient spouse can also be very, very catty. "Why don't you expose the whole thing as a fraud?"

And so I did. Well, I intended to, anyway. The ad said the gadget was sold by Magic Mold, 467 Livonia Avenue, Brooklyn, N. Y., so I called them to find out just what the gimmick was. They set up a demonstration for me, and I arrived well prepared for the old pitchman switcheroo.

The demonstrator, of course, had no idea what a precarious spot he was in, so he calmly stepped up to the track, lifted the mike and said "Proceed." Doggone if the train

Literally, "mike" is pressure-activated switch; explosive sounds of voice in certain words supplies the pressure.

didn't do just that! Then "Stop!", and it did. And "Back up," and still this fool train is doing just what the guy says.

"Aha!", I say, "Now I've got it. You're just pushing the button on that thing. The audio part is just window dressing."

"Partly true," he replies. "But the switch is only a push-to-talk arrangement just like you see on many mikes."

Seeing that I was getting nowhere with this wise guy, I gave in and took one of his gadgets home with me, determined to find out what made it tick.

To begin with, the "microphone" isn't really a mike at all in the strict sense. You might call it a pressure-actuated switch. The pressure comes from the explosive sounds of the voice, in words having letters such as *f*, *p*, or *t*. The letter *p*, however, is by far the most effective.

Now this "mike" switch is inserted between the transformer and the track power connector. That means that the switch, when pressed, cuts off track power.

A vital factor in the operation of this gadget is the design of the train itself. Just about all modern toy electric trains are equipped with stepping relays which, as power is alternately turned on and off, go through a cycle consisting of STOP-FORWARD-STOP-BACKWARD-STOP. Unless this stepping relay is disabled, the train is going to go through that cycle no matter what.

Obviously, then, if the train is stopped and BACKWARD is the next step in the cycle, you can say "petunias" into the mike, and the train will immediately start backward. But if you said "pretty petunias," then the train would start backward and then stop. In this case each "puh" of the *p* letters in the two words would actuate the switch once, a total of two switchings for two steps in the cycle.

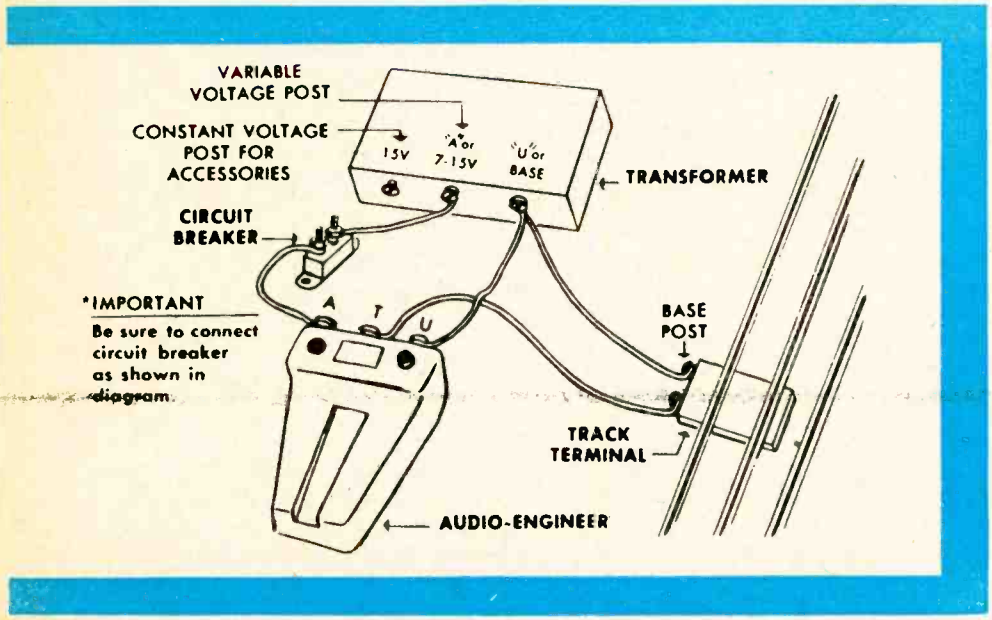
But for a more realistic performance, your monologue will stick to more sensible wordings. As long as the train is running, in either direction, STOP is the obvious command. But when the train is stopped, and you don't know which moving direction is next in the cycle, you must be coy. A nice, non-committal command for such occasions is PROCEED. Then once the train takes off and you have your bearings, put on a show.

Since *p* is really the key letter in the operation of the unit, care must be taken in its use. But with the proper choice of phrasing, any combination is possible. If, for example, the train is going forward and you want it to back up immediately without a stop command, you might say PLEASE BACK UP. Then the first *p* in "please" will step the relay ahead a notch, while the second *p* in "up" will send the train off in reverse.

Or you can ignore commands altogether. Just ad-lib any kind of complicated instructions you want with the mike button closed, but press the button and whisper a "puh" into the unit whenever you want to trip the relay.

Of course, now that the novelty has worn off and I know how it operates, I'm a little tired of it. After all, it *is* just a gadget and you do get bored after a while.

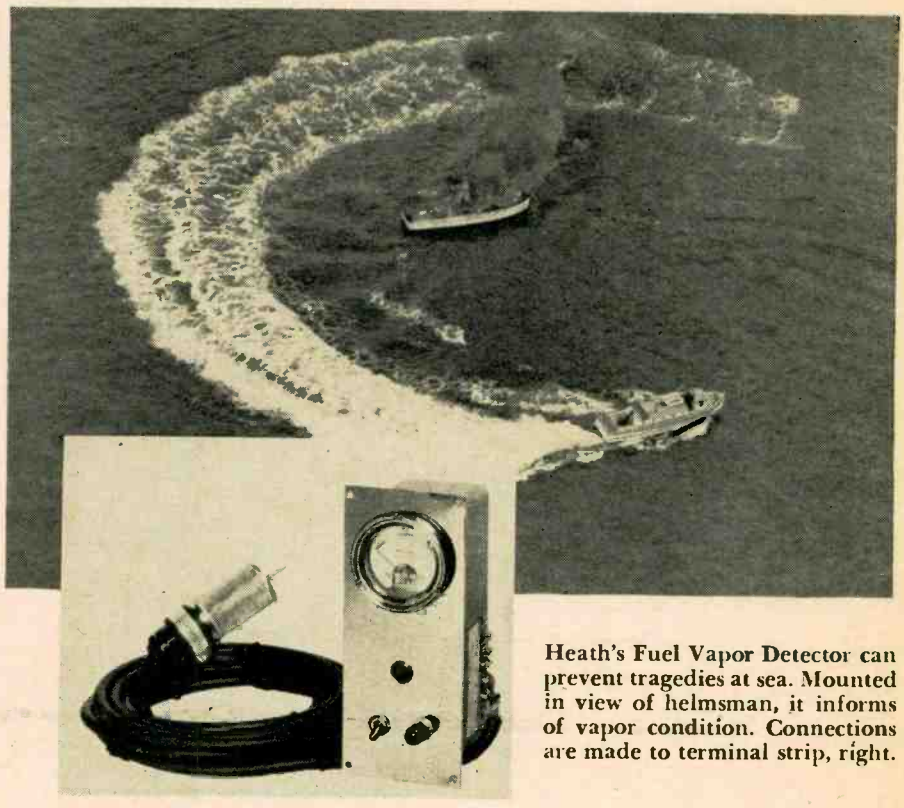
"No, David, you can't have it now. Yes, it's yours, but Daddy is busy. All aboard? PUH-RO-CEED! . . ." •—*D. H.*



"Audio Engineer" is connected in this manner. "Mike" switch, being between the transformer and track power connector, can cut off, restore power as preferred.

Defeat Davy Jones

Forewarn yourself against the danger of fumes afloat.



Heath's Fuel Vapor Detector can prevent tragedies at sea. Mounted in view of helmsman, it informs of vapor condition. Connections are made to terminal strip, right.

DISASTER AT SEA is one of the greatest of human tragedies. And any tragedy is doubly deplorable if it could have been prevented. One of the greatest of maritime killers today is a preventable destroyer. It could easily be wiped out and the vital statistics it creates could themselves be relegated to the locker of Davy Jones.

Small craft operators are increasing by the thousands every year, and many are turning to inboard operation. And it is they who daily risk dangers of lethal proportions. And some outboarders have learned just a split second too late that it can happen to them, too.

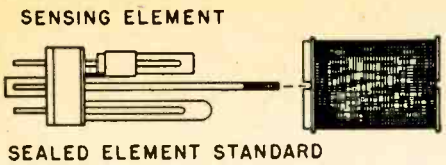
Aboard a boat, a mere half cup of gasoline in the wrong place is a potential killer. That much, spilled in the bilge or other closed area, can vaporize and then lie there, just waiting to be triggered. All it needs is just one tiny spark—just one—to create an explosion of destructive and deadly violence.

Yet any boat owner, if he only knew in advance of the existence of such lethal vapors abroad his craft, could and would immediately take the necessary precautions. And he can know at all times whether vapor conditions are safe, dangerous, or explosive. A new electronic Fuel Vapor Detector, a Heathkit, will, after assembly, give this information instantly and accurately.

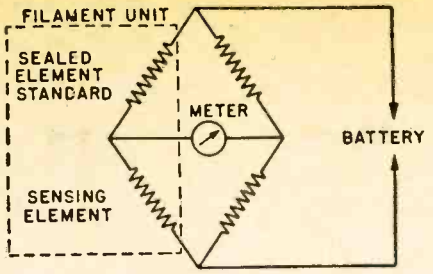
The detector unit itself is installed in the engine compartment, and is connected to the control head through a neoprene-insulated cable. This type of insulation is highly resistant to the effects of gasoline and oil. The control head is mounted on the bridge or in the cockpit near the wheel, preferably on the engine control panel, where the indicator will be in constant view of the helmsman. If desired, the detector may be connected through the ignition system, so that the engine cannot be started unless the unit is operating.

The detector consists of two glass-enclosed filaments, which in turn are encased in an explosion-proof Monel-metal-screened housing. One of the filaments, known as the *standard*, is hermetically sealed in its glass tube. The other filament, known as the *sensing element*, has its glass tube open at the end.

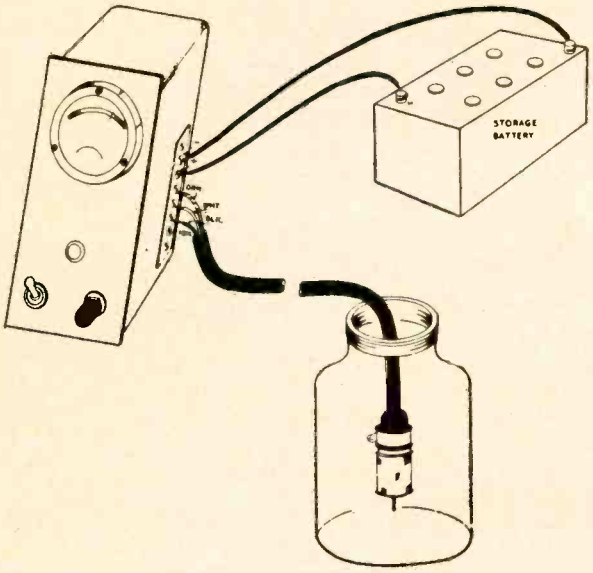
These two filaments comprise part of a Wheatstone Bridge circuit, so familiar



Shown here is detector unit detail. On right is explosion-proof shield.



Simplified equivalent of schematic diagram of the Heath Fuel Vapor Detector



Test set-up: quart canning jar, few drops of gas or lighter fluid are used.

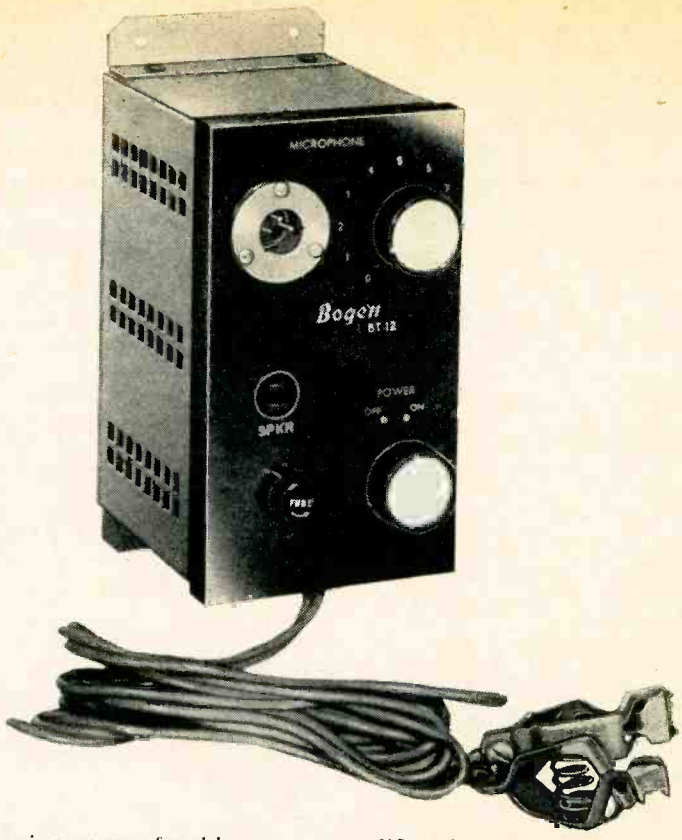
to every high-school physics student. When the resistance of the two elements is equal, which is the case in fresh air, no voltage appears across the meter, and it reads zero or SAFE. But in the presence of fumes, the resistance of the sensing element will depart from that of the sealed standard. In that case a difference of potential (voltage) appears across the meter, which it immediately indicates. The stronger the fumes become, the greater the difference between the senser and the standard, the greater the voltage across the meter, and the higher the meter reads, in the yellow or DANGEROUS region, or up into the red EXPLOSIVE area.

After the unit is completely wired and assembled, it is essential that it be tested for accuracy before installation. With battery voltage applied, it is first tested in fresh air, preferably outdoors, but not in a draft. At this point any minor differences in the bridge circuit elements are compensated for by adjustment of a meter zero control. Next we find out what the unit does in the presence of an explosive vapor.

Five to seven drops of lighter fuel or white gasoline are placed in a one-quart canning jar, after which the lid is screwed in place. Following a wait of five minutes or more for the fuel to evaporate completely, the detector is placed in the jar, resting upright on the bottom. The meter needle will then slowly rise up to the red EXPLOSIVE area on the scale. Then when the detector is removed from the jar and the vapors removed by blowing through the screen, the meter will return to the green SAFE area and remain there.

The detector unit is mounted in the engine compartment, usually under the carburetor. Enough slack should be left in the cable to permit the unit to be removed for periodic testing. A spare filament is included as a part of the kit, for replacement in case of failure, and when this is put into service another one should be obtained from the manufacturer immediately.

With this instrument properly installed and correctly operated, you may be certain that no explosion of trapped vapors will ever send you, your guests and your pleasure craft to the locker of Davy Jones! •—*D. H.*



No vibrator is necessary for this compact amplifier, thus eliminating one of the more vulnerable elements in ordinary mobile amplifier installations. Voltages are low, safe.

Tubeless P.A. System

Portable is the key word to describe this Bogen amplifier; it uses five transistors and operates off a 12-volt battery.

ONLY A VERY FEW YEARS AGO, but many giant steps back in terms of electronic development, the thought of an all-transistor public-address amplifier with real power was strictly in the dream class.

But even dreams have a way of coming true when backed by American scientific ingenuity, and today we have that amplifier, completely mobile, measuring only 3¾ inches wide by 4⅜ deep by 6⅝ inches high, and having the remarkably low weight of only 3½ pounds!

Made by the David Bogen Company, of Paramus, New Jersey, this little baby employs five transistors in all, beginning with three Raytheon 2N130's in cascade, followed by a pair of CBS-Hytron 2N156's in the push-pull output. Besides permitting a tiny size and ready portability, the use of transistors in place of tubes throughout provides a degree of reliability which was heretofore unattainable.

Since there are no tubes to burn out or become damaged, this unit assures ruggedness and long trouble-free performance, for applications where dependability is essential. Operating voltages are at a low, safe figure, and current drain is extremely low.

The amplifier, which the manufacturer designates as Model BT12, is designed primarily for mobile operation in emergency cars, busses, boats and other conveyances, and operates off the 12-volt battery already carried for the engine. Since this is the highest voltage appearing at any point in the circuit, no vibrator is necessary, thus eliminating one of the more vulnerable elements in ordinary mobile installations.

The input to the first transistor stage matches directly to low-impedance (200 to 500 ohms) microphones, without an intervening matching transformer. Receptacles are provided on the amplifier case for both microphone and loudspeaker plugs.

The remaining connection is for power, by means of a 7-foot cable with alligator-type battery clips. When connecting the leads to the battery, it is very important that the alligator clip with the

plus sign (+) be connected to the positive battery terminal, while the unmarked clip goes to the negative (—) post on the battery. Failure to observe this precaution will almost certainly cause the transistors to be burned out. After making sure that the battery connections are correctly polarized, it is then a simple matter to run the cable to the amplifier and insert its plug into the receptacle on the front panel.

Before plugging in the microphone, the correct connection for the mike plug should be established by reference to the diagram. If the microphone is unbalanced, its cable usually consists of a single conductor enclosed by insulation and a metallic braid shield. In this case the center conductor (known as the high side) must go to terminal 2, while the shield (called the low side) is connected to terminal 3. If, on the other hand, the microphone is balanced, it will usually have two separate conductors in addition to the shield. In this case, either wire may go to terminal 2 while the other is connected to terminal 3. The shield, if any, then goes to terminal 1.

Since the current drain varies with signal level, from 0.05 ampere with zero signal to only a little over a half ampere for the full rated output of four watts, the unit may be left with the power switch on for extended periods without seriously loading the battery. After the power, microphone, and speaker cables have been connected, operation consists simply of turning the power switch to the ON position, and rotating the volume control clockwise to the desired sound level. After that, if intermittent operation is desired, the low power drain permits leaving the unit turned on.

An interesting protective device, in addition to the conventional fuse, is a thermostat inserted into one leg of the power line. This is intended to prevent damage to the transistors due to high temperatures. It is preset at 135° F., and will remove power from the equipment if the surrounding temperature should exceed this figure.

Although transistors do have this one drawback of sensitivity to heat, they do not deteriorate with age, nor do they burn out in the sense that a vacuum tube does.

If, however, a transistor is suspected, it must be removed, and due to its heat sensitivity this operation must be performed with great care. When soldering or unsoldering transistors, it is essential to use a pair of pliers to grip the wire lead between the transistor case and the solder joint. The metal pliers then act as a "heat sink," conducting enough heat away from the transistor to keep it at a safe temperature.

Whenever performing soldering or other construction operations on any electronic equipment, one should always first remove the source of power, either by turning off a switch or, preferably, disconnecting a cable. Although in this transistor amplifier there are no voltages which are dangerous to life, it is nevertheless important to observe this rule for the protection of the transistors themselves. When connections are made or broken while power is on, it is quite possible that voltage surges will develop in the circuit sufficient to burn out the transistor. As a final precaution, one should avoid bending wire leads closer than 1/16 inch away from the transistor body. There will then be less mechanical strain on the component.

Although this unit is designed for mobile operation at speech quality, many other interesting possibilities immediately come to mind. How would it work as an audio walkie-talkie, powered by "hot shot" type batteries? What about using a mixer with it to provide more input channels? How would it work with a spring-wound turntable and low-impedance pickup, for phono reproduction on picnics, at the beach, or even in a canoe? Would hunters find any use for it as an amplifier of decoy calls? Literally dozens of such questions come to mind, and doubtless many electronics experimenters will soon be providing the answers. •—*D. H.*

A thermostat is inserted into one leg of the power line as a protective device for transistors in addition to fuse; it's preset at 135°F, cuts power at higher temperatures.

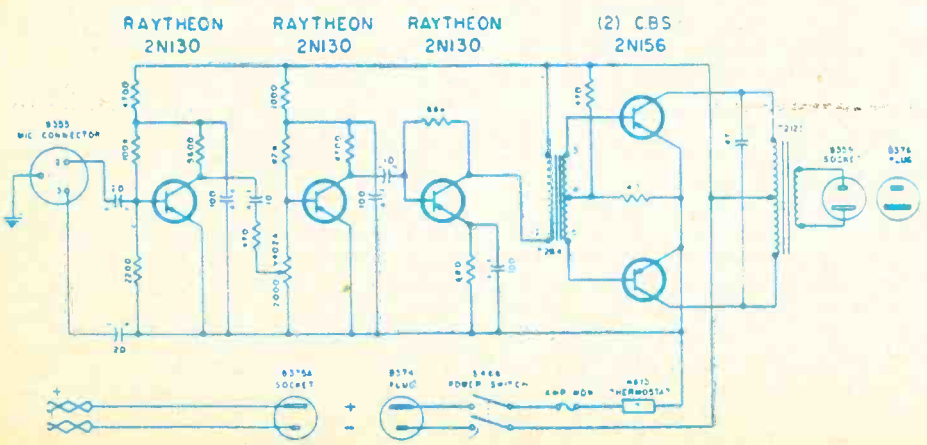
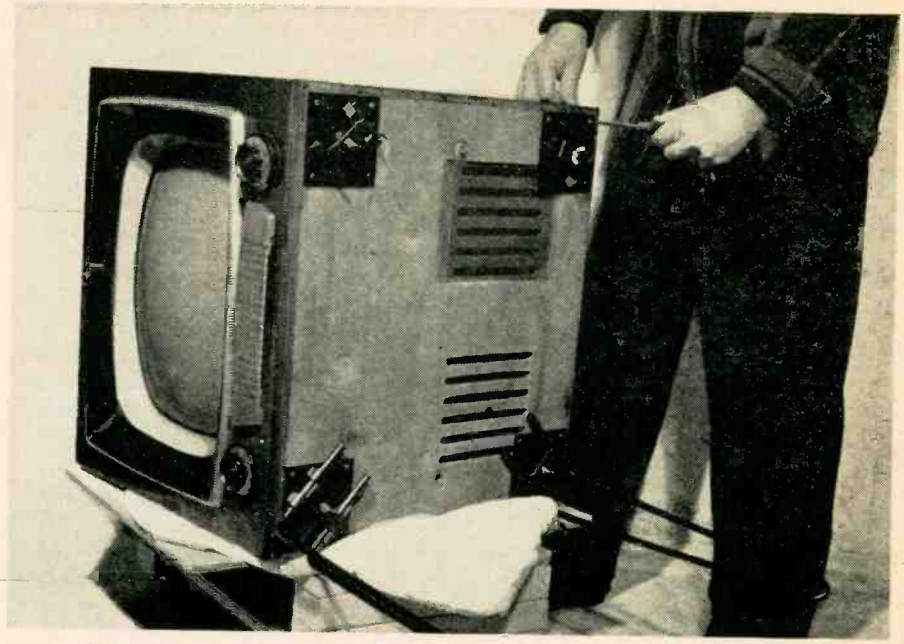
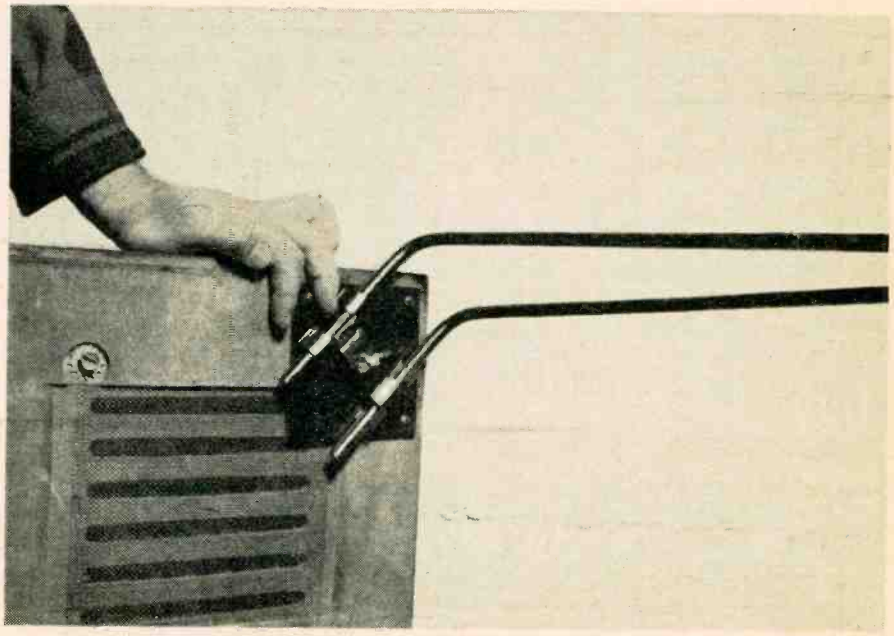


Table Model TV Into Console



TV receiver should rest on an old blanket or clean rags to protect its finish from being marred while base plates for detachable legs are screwed to corners.



The legs—black iron, in this case—are secured by cross clamps which need but a single wing bolt in the center. They can be attached or removed simply.

MOST "table" model television receivers using tubes of the 16-inch and larger sizes are really too heavy and cumbersome to be put on ordinary tables. Fortunately, it is a very simple job to convert them into self-supporting "consoles" by the addition of four legs.

These legs are available in a variety of materials and sizes. Probably the most popular type is the black iron. Four of these legs can be attached to the bottom of a TV cabinet in about ten minutes.

The base plates are fastened with round-head wood screws, and the open ends of the legs are then clamped tight in them by means of wing nuts. The legs can be removed in a jiffy, a great convenience if the set is to be moved by car to a summer bungalow or other location. •—*R. H.*

Superior's New Streamlined Model TD-55

TUBE TESTER

FOR { The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester.
The Professional Serviceman, who needs an extra Tube Tester for outside calls.
The Busy TV Service Organization, which needs extra Tube Testers for its field men.

Speedy, yet efficient operation is accomplished by: 1. Simplification of all switching and controls. 2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

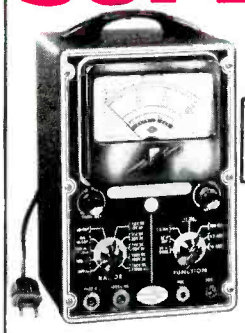
CHECKS FOR SHORTS AND LEAKAGES BETWEEN ALL ELEMENTS—Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. **"FREE-POINT" ELEMENT SWITCHING SYSTEM**—Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap." **ELEMENTAL SWITCHES ARE NUMBERED IN STRICT ACCORDANCE WITH R.M.A. SPECIFICATION**—The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Model TD-55 comes complete with operating instructions and charts. Housed in rugged steel cabinet. Use it on the bench—use it for field calls. A streamlined carrying case, included at no extra charge, accommodates the tester and book of instructions.

$26.95

Superior's New Model 670-A

SUPER-METER



A combination
VOLT-OHM MILLIAMMETER PLUS Capacity, Reactance, Inductance and Decibel Measurements.

ADDED FEATURE:
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

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 Henries to 7,000 Henries
DECIBELS: —6 to +18, +14 to +38, +34 to +58

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

$28.40

Superior's New Model TW-11

STANDARD PROFESSIONAL

TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyraton, 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 TW-11 as any of the pins may be placed in the neutral position when necessary. • The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is **impossible to damage a tube by inserting it in the wrong socket.** • Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

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.

EXTRAORDINARY FEATURE

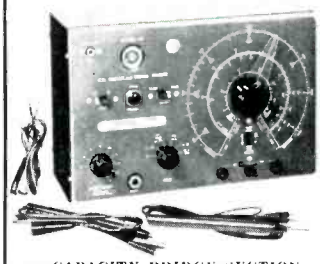
SEPARATE SCALE FOR LOW-CURRENT TUBES—Previously, on standard emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the standard scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50

Superior's New Model **76**

For the first time ever: ONE TESTER PROVIDES ALL THE SERVICES LISTED BELOW!



IT'S A CONDENSER BRIDGE
with a range of .00001 Microfarad to 1600 Microfarads (Measures power factor and leakage too.)

IT'S A RESISTANCE BRIDGE
with a range of 100 ohms to 5 megohms

IT'S A SIGNAL TRACER
which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A TV ANTENNA TESTER
The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

✓ CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to .005 Microfarad; .001 Microfarad to .5 Microfarad; 1 Microfarad to 50 Microfarads; 20 Microfarads to 1000 Microfarads. Will locate shorts, and leakages up to 20 megohms. Will measure the power factor of all condensers.

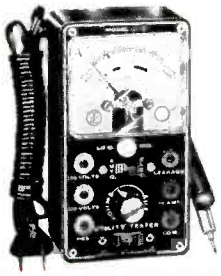
✓ RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

✓ SIGNAL TRACER SECTION
With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

✓ TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? The Model 76 will enable you to locate a break in any TV antenna and if a break does exist, the Model 76 will measure the location of the break in feet from the set terminals.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy

$26.95



FOR TESTING AND REPAIRING ALL ELECTRICAL APPLIANCES, AUTOMOTIVE EQUIPMENT—TV TUBES

Superior's New Model 70 UTILITY TESTER

As an electrical trouble shooter the Model 70:
Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Will measure current consumption **while the appliance under test is in operation.** • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms). • Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Will test all TV tubes for open filaments, inter-element shorts, burned out tubes, etc. (Will not test TV tubes for quality. An emission type tester such as the models TD-55, TW-11 described on this page is required to test tubes for quality.)

As an Automotive Tester the Model 70 will test:
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Handsome round-cornered molded bakelite case, $3\frac{1}{8}$"x$5\frac{7}{8}$"x$2\frac{1}{4}$". Complete with all test leads. Also included is a 64 page book giving detailed instructions, for testing all electrical appliances, automotive equipment, TV tubes, etc. Only

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

☐ **Model 76** ..... Total Price $26.95 — $6.95 within 10 days. Balance $5.00 monthly for 4 months.

☐ **Model TD-55** ..... Total Price $26.95 — $6.95 within 10 days. Balance $5.00 monthly for 4 months.

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

☐ **Model 70** ..... Total Price $15.85 — $3.85 within 10 days. Balance $4.00 monthly for 3 months.

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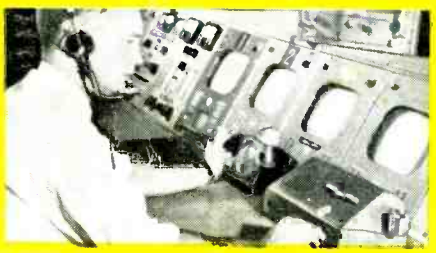

RADIO-TV BROADCASTING (see above) offers important positions as Operators and Technicians. RADIO-TV SERVICING Technicians (see below) needed in every community. Their services are respected, their skill appreciated.

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J. E. SMITH
Founder

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