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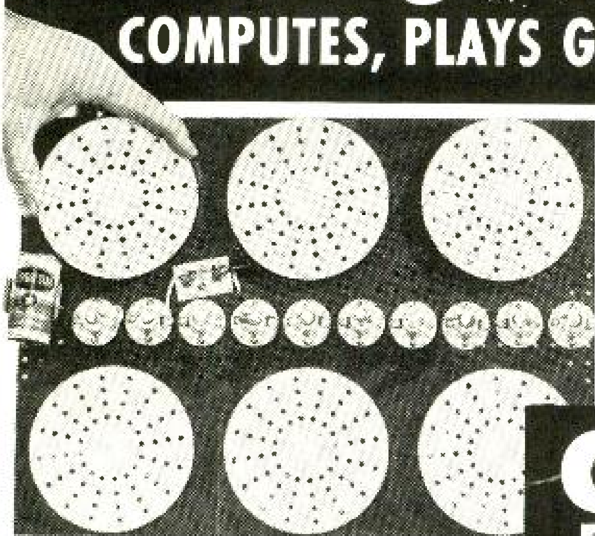

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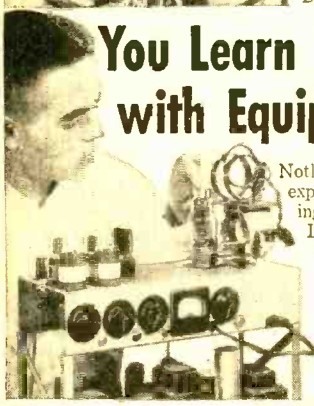

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POPULAR ELECTRONICS is published monthly by Ziff-Davis Publishing Company, William B. Ziff, Chairman of the Board (1946-1953), at 64 E. Lake St., Chicago 1, Ill. Entered as second class matter August 27, 1954 at the Post Office, Chicago, Illinois. SUBSCRIPTION RATES: One year U.S. and possessions, and Canada $3.00; Pan-American Union Countries $3.50; all other foreign countries $4.00.

POPULAR ELECTRONICS

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Average Net Paid Circulation 205,193

AUGUST 1956

VOL. 5—NUMBER 2

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NEWS of Electronic Developments

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IN THIS MONTH'S

RADIO & TELEVISION NEWS

(AUGUST)

A New Approach to Hi-Fi Stereophonics
Transistorized Beach Phonograph
The Dual-Cone Loudspeaker
A Simple Preamplifier for the Home Builder

By JOHN T. FRYE

Bosco Has His Day

IT WAS EVENING, and the boys were sitting on the back steps of Jerry's house. Carl had Bosco, his dog, firmly clamped between his knees and was wooling the dog's ears affectionately while Bosco growled in mock protest at this treatment that he actually loved.

"You stupid, no-account, dumb mutt," Carl muttered softly, as he looked morosely out at the long shadows creeping across the back lawn.

"What's Bosco done now?" Jerry wanted to know.

"It's what he hasn't done—or won't do," Carl replied. "A couple of days ago, as I was riding home on my bike after swimming, I ran across a fellow about our age working with a bird dog in a field out at the edge of town. He would hide a little cloth-covered ball that he called a 'bird' and send the dog in search of it. In nothing flat that dog would sniff out the bird and come trotting back to the guy with it in his mouth. This was interesting, and I was enjoying talking with the joker, but all at once he sort of looked down his nose at Bosco and wanted to know what kind of a dog *that* was.

"I said Bosco was just a plain dog, which seemed to strike him as real hilarious. Anyway, he gave out with a nasty laugh, and started a lot of who-shot-John about how he had papers for *his* dog, called Golden Arrow III, and that unless a dog had breeding you couldn't expect him to amount to much.

"Well, I got my back up at this, and remarked that it took more than a few sheets of paper to make a dog smart. I should have stopped there, but I got carried away and went on to say that if I couldn't teach Bosco to do everything Golden Arrow III was doing within a couple of weeks I'd eat my beanie. This character, whose name is Merrill, promptly took me up on it and said that if Bosco could equal Golden Arrow's performance *he* would eat *his* beanie."

"Well, how's it look?"

"Let me put it this way: do you think white or red sauce would go best with my beanie? I still believe old Bosco here is as

Carl & Jerry (*Continued from page 8*)

smart as any dog that ever chased a cat, but I learn to my sorrow that he has a serious physical defect: he can't smell."

"Can't smell! I thought all dogs had a keen scent."

"So did I, but you can take my word for it that Bosco couldn't follow the trail of a ten-pound limburger cheese dragged over the ground 30 seconds before. By actual scientific tests, I have found that the absolute limit of his sense of smell is sniffing out a dog biscuit at a distance of two feet. Beyond that—nothing! I don't mind losing the bet so much, but I do hate to have poor Bosco made to look like a dummy simply because he can't smell so hot."

"Maybe you could teach him to locate the bird by sight."

"Not a chance. I have to hide the bird for Golden Arrow, and Merrill will hide it for Bosco. I know from watching him that he'll hide the bird down under leaves and stuff so it can't be seen. And, anyway, I can't make Bosco *want* to find that little cloth-covered ball. He's too smart to work for nothing and displays about as much interest in locating that artificial bird as I show in helping Mom find the castor oil bottle when I'm not feeling well."

"LET'S NOT give up too easy," Jerry said, as his interest in the problem began to mount. "Maybe we can appeal to one of Bosco's baser instincts. What does he like?"

"That's easy. Bosco's interested in just one thing, twenty-four hours a day: *food!* He's a real glutton."

"Then we'll start with that. I'm getting an idea. Remember that description of the transistorized golf ball in POPULAR ELECTRONICS some months back? You'll recall that the golf ball had a tiny transistor transmitter built right into it which sent out a continuous signal. This signal was picked up on a transistor-type receiver and led the owner of the ball right to it, no matter how well it was hidden."

"What's that got to do with making a bird dog out of Bosco?"

"Suppose we build a tiny transmitter into the artificial 'bird' you hide from Bosco. Then we'll fit him with a hidden receiver that will pick up the signal from the transmitter. In a short time, he should learn that when the signal gets stronger he must be getting closer—that is, he should be able to learn it if he's as smart as you say he is."

"Oh, he can learn that all right if he wants to, but what's going to make him want to?"

"We'll 'condition' him to expect food as

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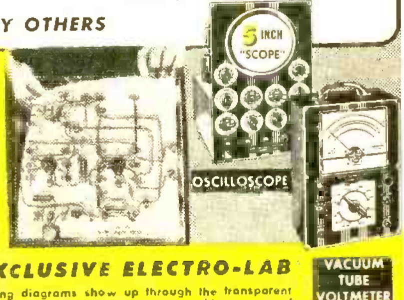

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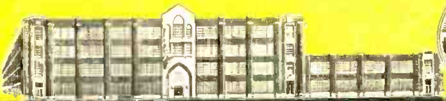

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Carl & Jerry *(Continued from page 10)*

a reward for finding the bird and bringing it to you," Jerry explained. "After he gets used to wearing the receiver, which we'll conceal in some sort of headgear, we turn on the receiver and let him hear the sound of the hidden bird. Then we drag him to the bird, put it into his mouth, clamp the mouth shut, and drag him back to where you're standing. The instant you take the bird out of his mouth, you replace it with a dog biscuit. After we do this a few dozen times, he should get the idea and go find the bird by himself."

"So let's get going!" Carl exclaimed, as he slapped his hands on his knees and rose to his feet. "I'm willing to try anything, even an idea as crazy as that."

WITH THE ENTHUSIASM of youth that enables it to undertake blithely something an older and wiser person—fully appreciating the difficulties—would never start, the two boys dashed down into Jerry's basement laboratory and immediately started building up the electronic equipment designed to convert Bosco from a biscuit dog to a bird dog.

Carl built the small one-transistor transmitter according to a plan for an i.f. signal alignment generator. This tiny little unit delivered an r.f. signal, tone-modulated, on a frequency that could be adjusted from about 400 to 500 kilocycles. Two extra-small penlite batteries furnished the power, and the whole thing fitted neatly into a safety match box that in turn was mounted inside a cloth-covered little plastic box selected to serve as the body of the artificial bird.

Jerry had the harder job of building a fixed-tuned receiver for picking up the weak signal from the tiny transmitter. In order to keep size to a minimum, he used a circuit employing two transistors and a crystal diode in a regenerative circuit. Careful planning and layout, dispensing with sockets and soldering leads directly, employing the smallest of miniature parts . . . and similar space-conserving measures . . . produced a receiver on a very tiny flat fiberboard chassis. This chassis was sewn into the crown of a boldly checked "Sherlock Holmes" type of hat the boys cajoled Carl's mother into making for them. Bosco was then made to wear this hat in a rather unconventional manner. The normal fore-and-aft projections were pulled down tightly over his ears and fastened under his chin, and a dynamic earphone was concealed in one of the flaps so that

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Carl & Jerry (*Continued from page* 12)

it would be held close to the dog's ear.

Do not think that all this was done overnight and that everything worked perfectly as soon as it was put together. Designing electronic equipment just doesn't work that way, not even in commercial laboratories where the finest engineers work with the best equipment. There is always a period of de-bugging, adjusting, and peaking. It took the boys a full three days to build up the two pieces of equipment, to squeeze the last microwatt of power out of the little transmitter, and to peak up the receiver for maximum stable sensitivity. Finally, though, the receiver was capable of picking up the transmitter over the restricted radius that Carl said would be more than adequate for the test that was planned.

Then the equipment was introduced to Bosco, and it certainly was not a case of love at first sight. He spent the first half hour after the cap was fastened on him in a determined effort to shake it off, rub it off on the ground or the trunks of trees, and—finally—to claw it off with all four paws. But the boys had anticipated this, and the cap stayed firmly in place. Finally Bosco gave up and stared at his masters with a hurt look that said plainly, "How can you guys do this to me?"

The boys promptly started his training along the lines Jerry had outlined. It was quickly apparent that Jerry's estimate of "a few dozen" times being needed to show Bosco what was expected of him was highly optimistic. By the time he began to show some faint interest whenever the hidden switch in his cap turned on the receiver and let him hear the signal from the concealed transmitter, the sod of Jerry's backyard was deeply furrowed with hundreds of tracks made by Bosco's stubbornly braced legs as he was dragged back and forth, and both boys were worn to a frazzle. But they stuck at it. Finally, on the last evening before the test, things looked pretty good; and as Jerry wearily took leave of his friend, he said:

"That's about all we can do. Don't feed Bosco tomorrow morning, for we really want him eager."

"Okay, but Bosco the Bottomless Pit would be eager anyway. I'll see you tomorrow."

WHEN THE BOYS and Bosco arrived at the little field in which the test was to take place, Merrill, Golden Arrow, and a gentleman with a stopwatch prominently displayed in his hand were already there.

"Boys, I thought we should have an im-

Carl & Jerry (Continued from page 14)

partial judge for this test; so I brought along my Uncle Milford. He's known all over the country for his work with bird dogs," Merrill explained.

"Thank you, Nephew," Uncle Milford said, with a fond smile. "Now I suppose we may as well get on with this. To be fair, I think the winner should be the dog that finds his bird quickest in three times out of five trials. You can hide the bird for Golden Arrow, boy, and Merrill can hide it for—for—what on earth is that on your animal's head?" he exclaimed to Carl as he took a good look at Bosco jauntily wearing his ludicrous cap.

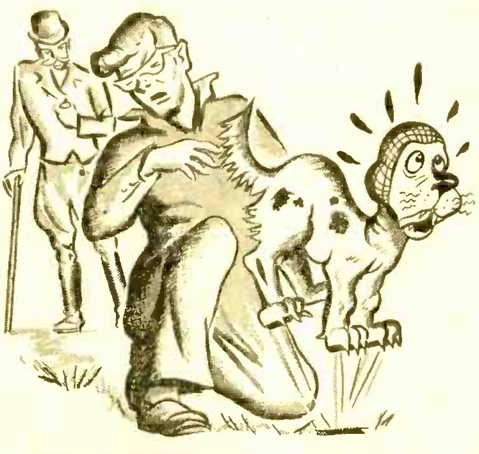
"Bosco is a dog of many parts," Carl explained glibly, "and he likes to dress for each role he plays. Since he feels he's playing a sort of detective right now, he insisted on wearing his Sherlock Holmes cap this morning."

Uncle Milford looked strangely at Carl as he muttered, "I see," in tones that clearly indicated he didn't. "Well, you hide Arrow's bird and we'll start."

Carl tucked the artificial bird Merrill handed him beneath a bush some 75 feet away, and then Merrill sent Golden Arrow in search of it with a wave of his hand. Instantly the dog started quartering the ground in a methodical manner that was beautiful to watch, and in a short time his body stiffened as he caught the scent of the hidden bird; then at a command from Merrill he moved forward, picked it up in his mouth, and returned it to his master.

"Forty-seven seconds!" Uncle Milford announced triumphantly. "Now let's see what the other dog can do."

Merrill tucked Bosco's bird under a



. . . When Uncle Milford gave the signal, stopwatch in hand, Carl flipped the hidden switch in Bosco's cap with results that were truly galvanic . . .

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clump of leaves about the same distance away that Golden Arrow's had been. When Uncle Milford gave the signal, Carl flipped the hidden switch in Bosco's cap with results that were truly galvanic. Bosco gave a whimper of eagerness as he stood straight up on his hind legs and waltzed crazily about. Then he dropped to all fours and went dashing madly about the place without apparent rhyme or reason, but in an amazingly short time he rooted down through the leaves to the hidden bird and came galloping back to Carl with slobbers of anticipation dripping from his mouth.

"Fourteen seconds!" Uncle Milford said, in an awed voice. "It doesn't seem possible. I've never seen anything like it. It must have been an accident."

But it was no accident, as the next two trials quickly proved. Golden Arrow III, displaying the same beautifully consistent method and form, turned in times very close to forty-five seconds on both occasions; but Bosco, using his own crazy system that sent him dashing full tilt, only to come to such an abrupt halt that he often went rolling end over end before he scrambled up and took off on a tangent, located his second bird in twenty-two seconds and his third in the astounding time of six seconds flat.

"WELL, Merrill, I guess there's no question about the winner," Uncle Milford said, with a stunned look. "I've never seen anything like the way that dog performs. Very unorthodox! Very! Would you consider entering him in some field trials, boy?"

"Aw, no," Carl said casually, as he unfastened the cap from Bosco's head and let the dog give himself an ear-slapping shake. "Bosco doesn't mind putting on a little show like this now and then, just for relaxation, but he's got much more serious things on his mind than fiddling around with anything so silly as hunting artificial birds."

There was a long pause, and then Uncle Milford inquired timidly: "May I ask what sort of things?"

Carl looked cautiously around before he answered in hushed tones: "All I'm allowed to tell you is that it's top-secret research in the commissary department. And speaking of eating, Merrill, as soon as you've decided how you're going to prepare your beanie, let Jerry and me know and we'll be glad to drop over to watch you eat it."

"All right, fellows," Merrill said weakly. "I'll let you know." —30—

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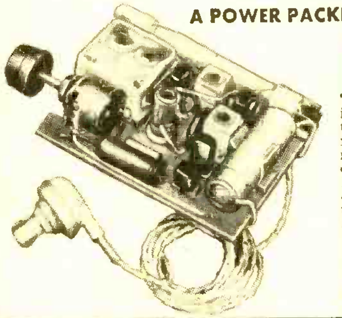

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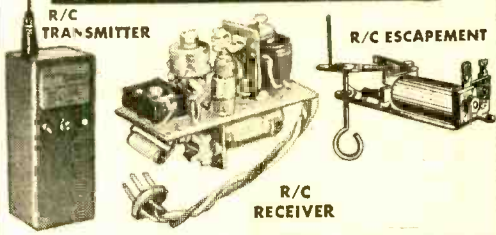

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Free Literature Roundup

Properties and uses of "thin-based" magnetic recording tape are discussed in "Sound Talk Bulletin No. 32," available from Minneapolis Mining & Manufacturing Co., 900 Fauquier Ave., St. Paul 6, Minn.

More than 40 standard accessories used in electronics and TV installations are described in Catalog No. 257, issued by JAVEX, P.O. Box 646, Redlands, Calif. Included are hints for using the items.

Probes for use with volt-ohm-milliammeters are catalogued in a six-page brochure available from Futuramic Co., 2500 W. 23rd St., Chicago 8, Ill.

VECO brand thermistors, varistors, and assemblies are listed in a new catalog. Copies are available upon request from Victory Engineering Corp., 90 Springfield Rd., Union, N. J.

The new edition of Triad's "Catalog No. TR-56" describes and illustrates nearly 700 items, 76 of which are new to the line. For a copy, write to Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Data on over 250 TV picture tubes are included in "Bulletin PA-2." To obtain a copy, write to Advertising Service Dept., CBS-Hytron, Salem, Mass.

A bulletin on "Type EP" Audiotape, an "extra-precision" magnetic tape for special recording applications, may be obtained from Audio Devices, Inc., 444 Madison Ave., New York 22, N.Y.

Speaker enclosures and hi-fi furniture in kit and factory-finished form are described in a catalog available from Cabinart, 99 North 11th St., Brooklyn, N. Y. —30—

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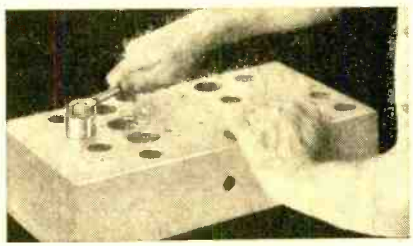

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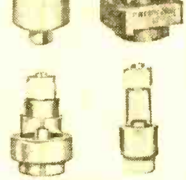

GREENLEE

LETTERS FROM OUR READERS

Better Tape Coupling Method

■ I think that an improvement to provide radio or TV audio to a tape recorder can be easily worked with receivers having a single-ended power amplifier.

Usually these sets have a cathode bias resistor and bypass capacitor. The bypass capacitor can be disconnected (resulting in an improvement in audio capacity, by the way) and the tape recorder input attached to the cathode of the power amplifier so that this stage now operates as a cathode follower.

Normally, a coupling capacitor is required between the cathode of the output tube in the receiver and the input of the amplifier or tape recorder. The value of the capacitor will depend upon the input impedance of the recorder.

C. W. MARTEL
Raytheon Mfg. Co.

Rally Timer

■ I like your article about the radar speed meters. How about an electronic speed timer for "hot rod" races, rallies, and drags?

FRED RIDEL
Cleveland, Ohio

Glad to have your suggestion, Fred, and we know you'll be pleased to hear that we are working in co-operation with Sports Car Illustrated on the development of just such a timer. The project is off the drawing boards and is now being tested. Look for published details soon.

Citizens Band

■ What happens to the Novice ham who now holds a license but is younger than 18? Can he obtain a Citizens band license?

BEN MOSES, KN9CNC
Mt. Vernon, Ill.

■ I would like to build a Citizens band transceiver using some 2G21 tubes that I have.

D. J. SCHINKER
Omaha, Nebr.

Reader Moses' problem does not seem to be fully covered in the FCC Rules. Apparently the FCC feels that if you're a ham you will have no use for a Citizens band license. We'll check into this further.

In reply to the gentleman from Omaha, we must point out that Citizens band equipment must bear an FCC approval—if it is to be used for radiotelephone communication.

Radar Speed Meters

■ Since you didn't say anything in your July issue, what was the reaction to the radar speed meter story? Did someone complain, or what?

ARTHUR RAYBURN
Newark, N. J.

In reply to reader Rayburn's inquiry, as well as others along the same line, we can report that we were deluged with mail. Approximately 98%

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You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Here is an excerpt from a letter that we received from Loren DePriest, 1496 4th St., Mansfield, Ohio: "I have spent many pleasant hours in constructing the radios from the schematics in your book, and have learned a great deal from them. Being as I am interested in Radio, I consider the money spent for your course as a wise investment. I have learned more from your course by actually doing than I did from an expensive course."

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

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

FROM OUR MAIL BAG

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

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

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of it was favorable, although some readers did think that unveiling the mystery behind the radar speed meter might encourage lawlessness.

A list of those writing in to recommend publication of a speed meter detector would consume several pages. Most readers have received a form letter reply. If you did not, please accept this note as a word of appreciation for comments and suggestions.

No definite decision on whether to publish or not to publish detector plans has been effected. That subject is being investigated with great care and consideration.

Geiger Counter Works Well

■ I built the Geiger counter in the June issue which uses the output transformer to develop the high voltage (p. 92). It works very well, and I must compliment you on the choice of material.

A. KRUEDENER-STRUVE
New York, N. Y.

OABT OABT Mystery Solved (We Hope!)

■ Concerning the letter from S. Swerling in your June issue, I wonder if this could be a station located in Ohio. It could mean Ohio Aviation Broadcasting Transmitter.

I have picked up signals on 535 kc. that read SSC and which I believe to be located in Greater Huntington, W. Va. This is an aircraft beam station.

W. L. HARRIS
Lafayette, Ind.

■ The station call OABT is not listed in the 17th edition of the International Telecommunications Union listing. Probably it is a ship under the Peruvian registry, since the call signs OAA-OCZ are assigned to that country.

W. B. WOODINGTON
Philadelphia, Pa.

■ I hear OABT in Philadelphia on my HRO.

W. A. DUFF, W3AMF

■ In answer to Swerling's letter, the call OAB is that of a radio range station on 540 kc. The station is located at Otis Air Force Base, near Falmouth, Mass.

The range station operates as an aid to radio navigation. The long tone at the end of the call is not a "T," but a signal transmitted for DF purposes. More information on this station can be found on radio Facility Charts.

THOMAS DIMILLA, JR.
Medford, Mass.

Reader Tom DiMilla seems to be right, and his information was verified by readers Frohock, Jones, Jecuso, Sewell, Alley, and many others.

Make Visible the Invisible

■ Has anyone come up with a good idea for making the tube numbers legible again once they have faded out?

GERARD GRENIER
Quebec City, Que.

This is a perennial problem and is probably one which has many solutions. Would any of our readers care to offer suggestions? —30—

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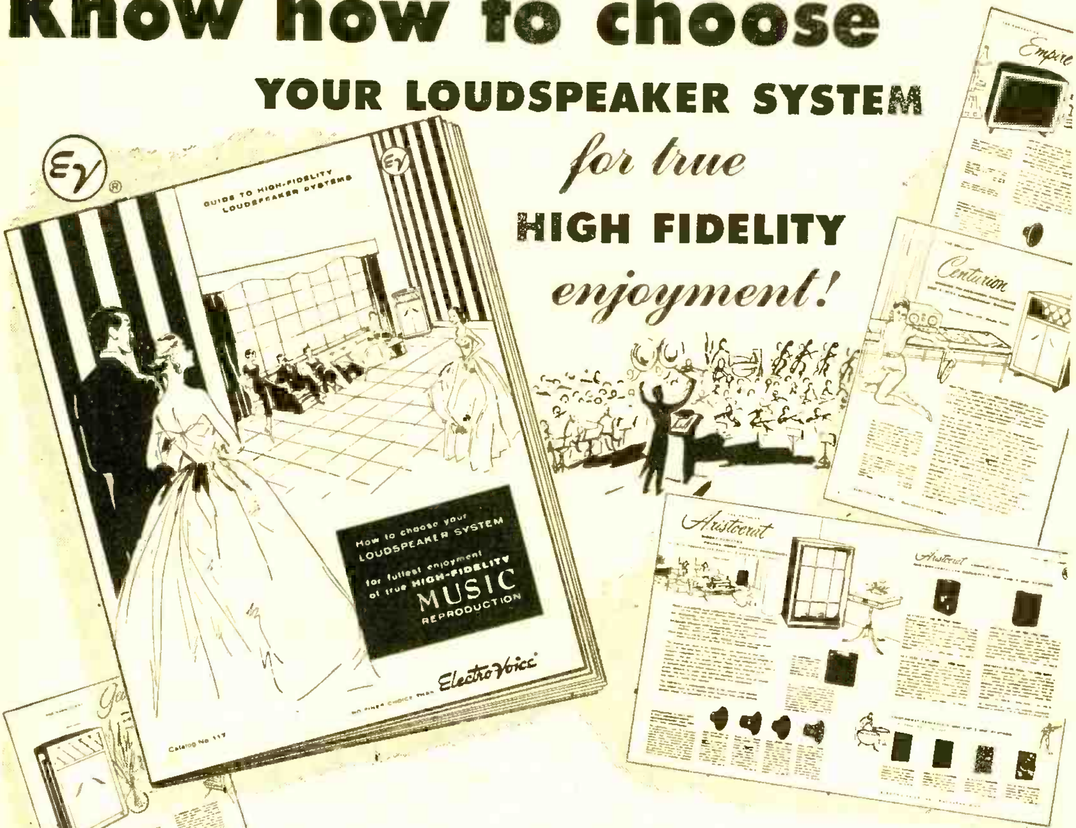

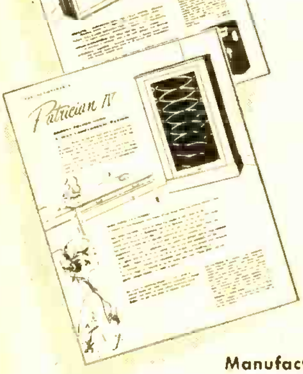

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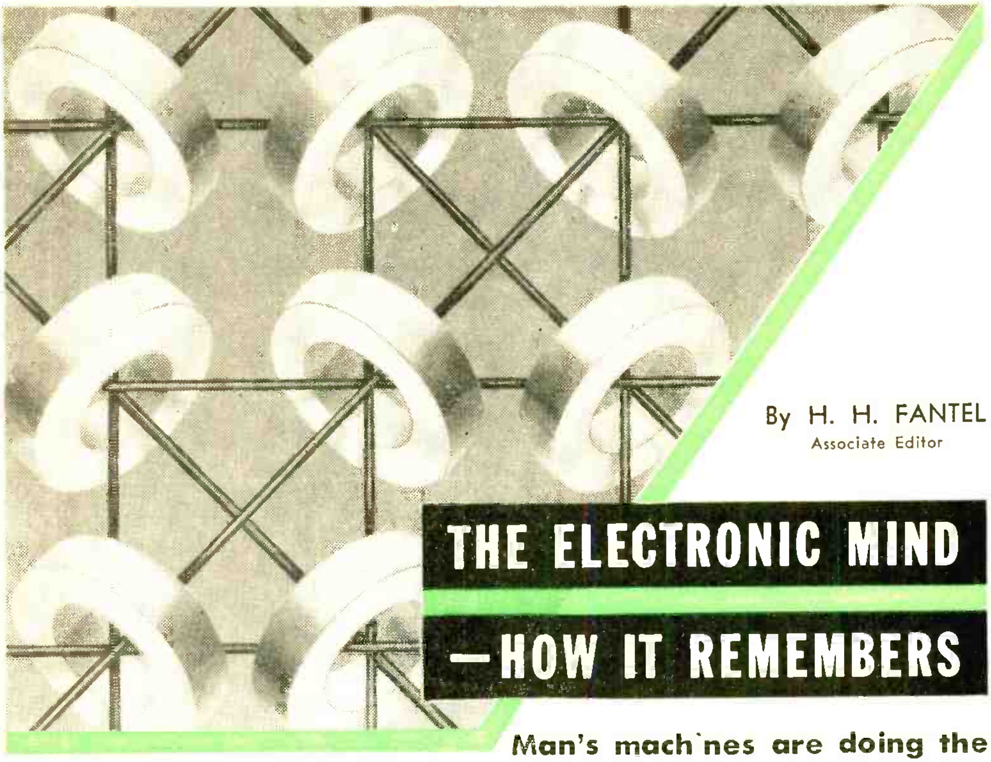


By H. H. FANTEL
Associate Editor

THE ELECTRONIC MIND —HOW IT REMEMBERS

Man's mach'nes are doing the work of his muscles . . . now, electronics explores ways to take the load off his mind

Close-up of magnetic core memory consisting of small ferrite rings retaining information imparted through pulses from the wire network.

WHEN I WAS about five years old, I always carried a piece of string in my pocket. I used to tie knots in it to remind myself of things I shouldn't forget. Without knowing it at the time, I had, in effect, developed a "machine mind." To be sure, it wasn't capable of very fine mental distinctions. But it could tell the difference between yes and no. A knot meant "yes" (= there is something I ought to do). No knot meant "no" (= relax and do nothing).

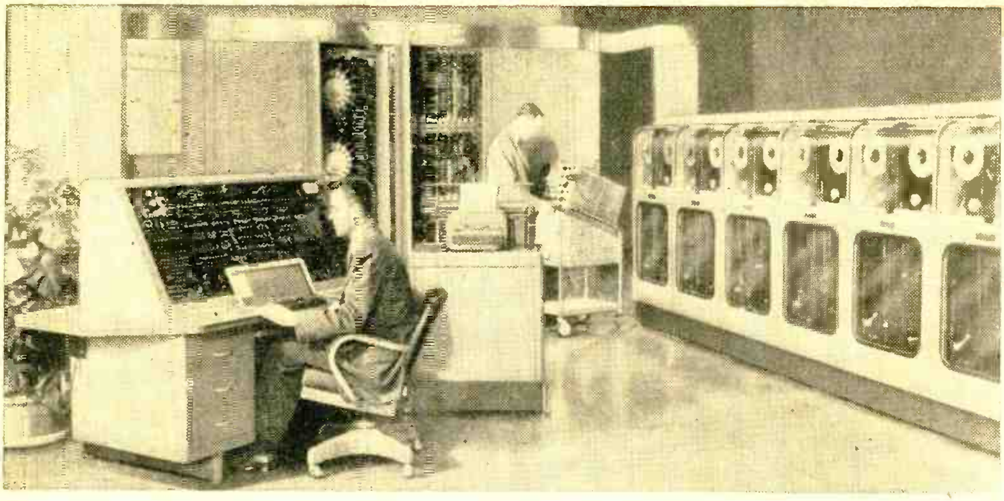
Today's digital computers use essentially the same system. Instead of a string, there is a wire. Instead of a knot, there is a voltage pulse. Otherwise, it's the same. The pulse means: go ahead and do something. No pulse means: rest.

In the language of computer engineers, each "pulse" or each "no-pulse" is called a "bit," because each represents one specific bit of information. Together, and arranged in logical sequence, billions of bits make up the complex patterns which direct the computers toward the solution of a problem. Yet everything the machine needs to know is broken down into simple yes-or-no propositions. "Pulse" or "no-pulse" is all that any part of the machine ever needs to distinguish, all it ever needs to remember. The computer's memory is therefore a device for storing electrical pulses in predetermined patterns.

External and Internal Memory. Most electronic computers have two basic types of memory—external and internal. As the names imply, the *external* memory is a sort of auxiliary, tacked onto the central computer mechanism. The *internal* memory is located right within the works of the computer.

The external memory acts as a go-between for the machine and its human masters. It remembers the instructions given to the computer by human mathematicians. By setting up the external memory, scientists can "program" the computer to do a given job. This memory also acts as a sort of "time transformer" to match the slow speed of human beings to the high speed of the machine. Scientists might take days to punch a set of instructions into the external memory. Later, the memory can reel out this row of instructions fast enough to keep up with a computer when it zooms through the whole problem.

Physically, the external memory takes



Over-all view of the basic components of a Univac computer. Behind the control desk in foreground, the central computer mechanism occupies cabinet at rear. The two round objects showing through open center door are mercury delay lines, part of the machine's "internal memory." The array of tape recorders at right serves as "external memory." Automatic typewriter in center spells out answers to problems.

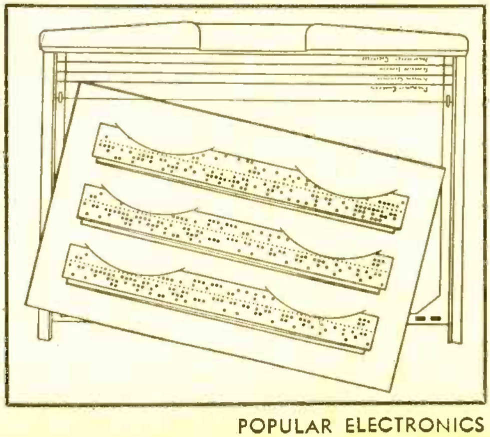
Human concepts expressed through words and numbers must be broken down into simple yes-or-no "bits," somewhat like playing "20 Questions," except that here the elementary items of information run into billions. This machine converts numerical data from keyboard into monosyllabic computer code recorded on tape. The information is then retained in the computer's "external memory."

Punched cards (right) are also used to give instructions to the computer. The pattern of holes is then converted into a sequence of electric pulses.

the form of punched cards, magnetic tape, or punched paper tape.

Punched cards and paper tape have long been in use with conventional office equipment as data storage media—punched-card tabulating equipment, for example, has become commonplace in American business, and the paper-tape-driven automatic typewriter has relieved many a typist of repetitive labor. The data storage principle in each of these cases is extremely simple: information is recorded on the card or tape in the form of punched holes. A hole means an electric pulse; no hole, no pulse. Because of the wide use of these storage devices, some computers have been equipped with punched-card and punched-tape readers, and a number of machines have been developed to convert these media automatically to magnetic tape.

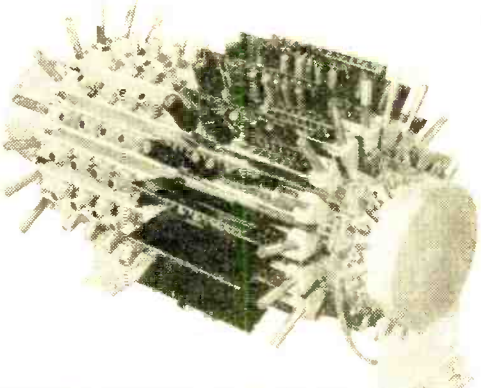
In magnetic tape storage, the most commonly used form of external storage for



the electronic computer, characters are represented by combinations of tiny magnetized and unmagnetized spots, each representing a "bit" of information. When data recorded on the tape is fed into the computer, the magnetic tape reader translates the combination of magnetized and non-magnetized spots to a series of electronic pulse/no pulse combinations which, in computer language, have a definite meaning.

The great advantage of magnetic tape over other external memory devices is its tremendous capacity. One reel of magnetic tape, eight inches in diameter and one-half inch wide, can store approximately 2,880,000 characters, with up to 200 characters recorded per linear inch. The tape will preserve data permanently and will not corrode. It can be "erased" and used again for new data.

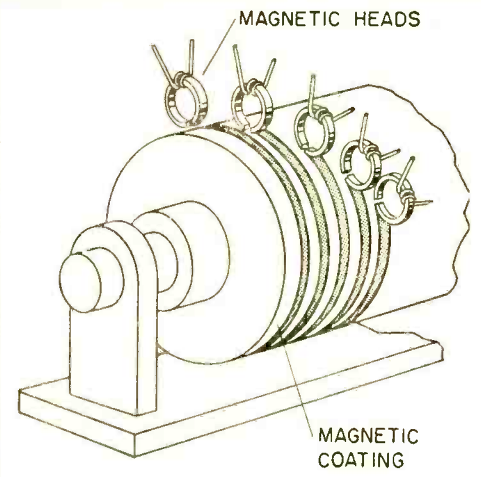
The machine uses its internal memory in the same way that human beings use scratch pads in solving a math problem. It is a place to put down intermediate results and the auxiliary numbers in the course of a calculation. Since such figures—in the form of electronic pulses—must be quickly jotted down, stashed away, or shifted from one place to another, some very tricky mechanisms were developed to do all this

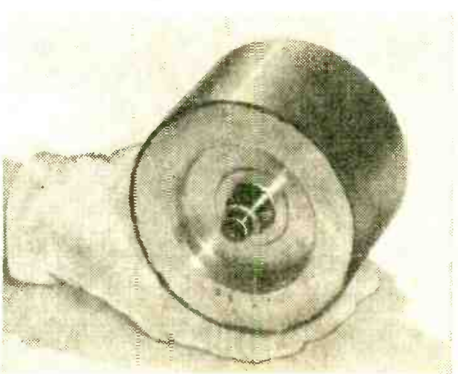


Mercury delay line serves the Univac I as internal memory. Porcupine appearance is due to circuitry on tank surface, amplifying and re-shaping pulses for endless repetition in this "talk-to-yourself" mumble-tub.

juggling of "bits." Mainly, they are storage devices permitting information bits to be quickly put in, quickly taken out, and accurately placed in a meaningful over-all pattern.

Electrostatic Storage. These storage devices are cathode-ray tubes resembling picture tubes in television sets. The screen of such a tube acts like a checkerboard of

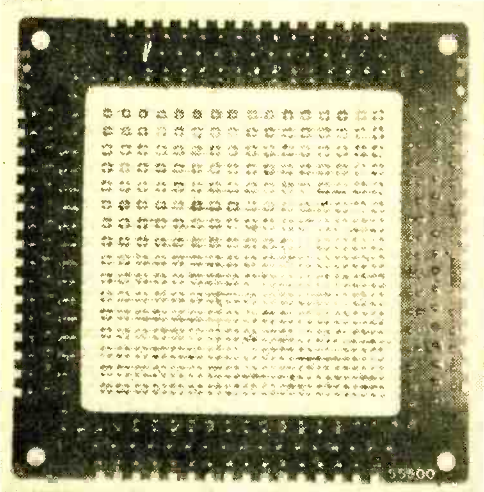




Magnetic drum principle is illustrated in simplified drawing above. Each magnetic head reads or writes pulses received from the computer onto its own track on the magnetically coated rotating drum.

Family of drums, ranging from giant roller to small twirler held by the engineer (upper right), make a veritable "memory lane" for Remington Rand.

Small drum rotor (right) whirls within the Univac at 16,500 rpm in an atmosphere of helium, which reduces friction and draws off excess heat.



Magnetic core matrix is a net of tiny ferrite rings, each storing one "bit" of information.

small capacitors. Whenever the "writing beam" of the tube hits one of the "squares" on this checkerboard, its capacitor effect stores up an electric charge imparted to it by the beam. The guided beam places a pattern of charged and uncharged areas on the checkerboard screen. Each area is a "bit," and the arrangement of the bits on the board spells out a numerical meaning. This pattern of electrostatic charges can be "read" by another beam scanning the area.

Information stored in such a way can be reached very quickly. It only takes between five- and ten-millionths of a second to "read out" a digit of information and shift it to wherever it is needed for the next logical operation of the computer. Because the computer must spend much of its operating time searching its memory for data and instructions, the speed of access to specific information largely determines the over-all speed of the system.

The storage capacity of a single tube is limited usually to about 1000 bits. Tubes can, of course, be used in combination to form large-capacity storage units.

One disadvantage of electrostatic storage is that the data are lost from the tube's surface unless they are constantly regenerated by the writing beam. In other words, the machine has to keep talking to itself to remember what it is saying. Although this is done entirely by automatic circuitry, the stored data are lost in the event of a power failure.

A certain unreliability stems from the fact that beam guidance is highly critical. A small temporary voltage change on the deflection plates can direct the beam to the wrong checkerboard area on the face of the tube, resulting in false information. Frequent adjustment by engineering personnel is essential for operating reliability.

Electro-Acoustic Delay Line. One of the first memory systems to gain wide commercial acceptance for electronic computers was the electro-acoustic delay line. In simplest terms, a delay line memory stores electronic data by constantly recirculating the information pulse pattern in the form of sound through a delay element, usually a tank of mercury. At the precise moment when the information must be inserted into the calculation, it is picked up by a "listening" device at the far end of the tank and transferred to where it is needed. The memory tank can then stop mumbling to itself.

The process may be likened to the short-range human device of repeating a phone number to oneself from the time it is located in the phone book until it has been dialed.

A mercury delay line memory channel consists simply of a mercury tank capped at each end by a transducing crystal, and a closed recirculation circuit. As pulses are delivered to the memory from the computer's control circuits, the crystal at one end acts as a sort of loudspeaker and sends a series of pulse/no-pulse tones through the mercury. These pulses thus travel through the mercury at the speed of sound, much lower than the speed of electronic pulses through wire. This provides the delay needed to hold information for controlled lengths of time.

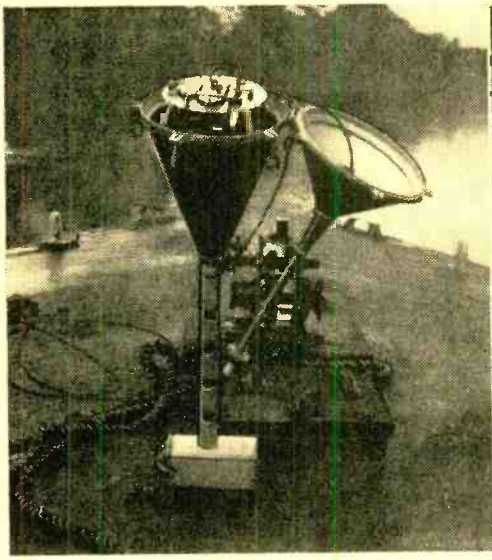
As the pulses reach the end of the mercury column, they strike the second transducing crystal—which acts as a microphone—and produce small electrical voltages that can be amplified and fed back to the input. In this way, the bits continually go in circles until they are replaced by other data from the control circuits. Then the whole cycle starts anew.

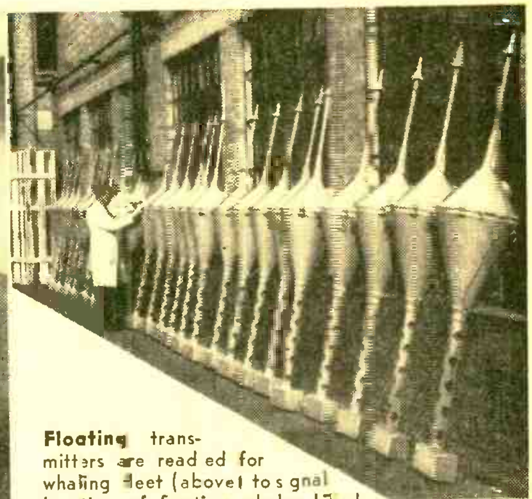
Each tank has automatic counting devices, which count the number of times a message is repeated. This provides accurate timing within a few thousandths of a second for picking up the message when it is needed.

Magnetic Drum Storage. The magnetic drum is an aluminum cylinder or "drum" coated with a magnetic material and equipped with a row of read-write heads. As the drum spins at high speed, each head monitors a narrow "track" around the circumference.

When data are to be stored, the pulse combinations are flashed to the heads and are recorded in the form of magnetized and unmagnetized areas on the drum's surface. The operation is very much like re-

(*Continued on page* 122)





Floating transmitters are readied for whaling fleet (above) to signal location of floating whales killed by catcher boats to the factory ship which gathers them in. Transmitter is shown on open buoy at left.

Dead Whale "Calls" Ship by Radio Buoy

DEAD MEN supposedly tell no tales. For whales, however, it's different now. With this new radio buoy tied to his body, the late whale, killed by a catcher ship, broadcasts a macabre dirge telling the factory ship to come and pick up his floating corpse.

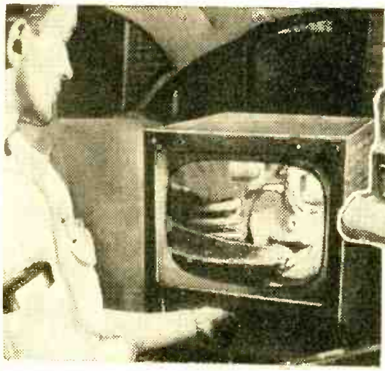
After the whale is harpooned, the buoy, made by Venner Electronics Ltd. of England, is fastened to the whale by means of a line long enough to keep the buoy from being dragged under in case the whale rolls over. Operated automatically by clockwork, the floating transmitter works intermittently, making its batteries last 22 hours.

Each buoy sends out an individual call sign and a long continuous signal for direction-finding purposes. In the radio silence of polar whaling regions, the signal is heard over 150 miles, assuring recovery of killed whales regardless of visibility.

"EVA" Paints Hot and Cold for Thermal Study

THE ARMY Signal Corps recently declassified a new device which is able to "see" in total darkness by painting a picture with infrared heat rays. The new Evaporograph, called "EVA" for short, was developed by Baird Associates from a German wartime idea. It detects heat variations of as little as 1°. Working somewhat like a camera, it focuses the heat rays on an oil film, which then evaporates according to the temperature pattern. Hot and cold are thus translated into varying film thicknesses, which, in turn, show up as different colors in refracted light.

In EVA's picture of the girl holding a glass of water (lower right), cold areas appear light, hot areas dark. Above, EVA maps thermal flow in a radio chassis by simply looking at it. Presenting a "live" picture of heat spreading through electronic devices, EVA spots potential trouble sources and lengthens the life expectancy of the equipment.



Action of underchassis spring is observed on TV screen located in rear of the car while vehicle undergoes strenuous road test.

TV Checks Your Bounce

IF IT'S "LIVE" television you want, try going along with General Motors engineers on one of their road tests of a new car. These boys put an automobile through a motorized obstacle course and see how its critical parts behave under stress by means of a television screen. Cameras to pick up the action are located in spots about the vehicle that no human observer could squeeze into during a rough road run.

A small, rugged, bomb-shaped TV camera is used. The picture is transmitted, via a closed-circuit system, to a 14" monitoring screen in the rear of the test car. It is also possible to flash the picture to a larger screen in an office or laboratory miles away. The driver of the car careens around curves, jolts over bumps, and generally commits automotive havoc while the engineers conveniently watch what is happening.

The equipment for this unique application of closed-circuit TV was developed for GM by General Precision Laboratory of Pleasantville, N. Y. For watching the action of a car's suspension system, a camera is attached to the underside of the car's front or rear bumper and focused on the suspension system. It can also provide on-the-spot observations of tire roll when a car is making a sharp turn.

In other tests, GM men have mounted the TV "eye" beneath the car's hood. This helps them observe engine "rock," fan blade "bending," and the action of throttle and choke controls. By teaming the TV camera with a strobe light, the whirling engine fan blades can be "stopped" for first-hand study.

In addition to its use on moving cars, this type of TV is also employed in test rooms to observe close-up action of high-speed rotating parts, where direct observation might prove too hazardous.

No Sleeping at This Switch!

A GADGET THAT SOUNDS an alarm the minute you doze off may have wide use as a safety device for drowsy drivers, sleepy sentries, and exhausted electricians—or in any situation where catching a catnap may be your last living act.

Invented and patented by Hugo Campisi, P. O. Box 304, Belmont, Calif., the device resembles a pair of spectacles that is worn by the user. An invisible light beam is focused from each bow of the frame onto the nosepiece. Should the wearer shut his eyes and not reopen them promptly, the interrupted light beam triggers a circuit which sounds a loud warning buzz.

The photo shows the complete gear. Inveterate flirters need have no fears; the alarm—it is claimed—will not respond to "normal winking and blinking of the eyelids."

Dodging the Weather—*with Radar*

Radar picks safe spots amid stormy skies

Radar indicator installed in cockpit of Delta airliner tells pilot at a glance the kind of cloud formation he is heading for. Analyzing the radar pattern, he can steer the plane clear of turbulent areas, avoiding risks and bumpy ride.

HEADING for the clouds can be tricky business if you haven't got your feet on the ground. In fact, unexpected weather fronts constitute one of the main hazards of flight.

Collins Radio Company has recently developed an airborne weather radar system that provides immediate indication of the weather ahead. The information is displayed in the form of a weather map showing conditions within a radius of 150 miles and approximately 240 degrees around the nose of the aircraft. This map-like image on the radar screen shows the location of weather fronts in terms of range and azimuth bearing relative to the position of the aircraft. It identifies areas potentially dangerous to flight, such as thunderheads, hailstorms, or turbulent areas associated with heavy rainfall. With this map as a guide, pilots can investigate aircraft to avoid storms or turbulent areas, usually by detours of five miles or less from the planned flight path.

Compact cockpit control features special adjustment to gage cloud density, turbulence and force of precipitation.

The weather map is created by the reflection of high-frequency radar waves from rain, hail, snow and ice. When these elements are not present in a cloud structure, energy is not reflected and hence no warning weather map is displayed on the cockpit indicator. Such "empty" clouds can be traversed with little or no difficulty.

Top: Indicator at right shows plane flying toward a weather front approximately 10 miles ahead. Rings indicate distance.

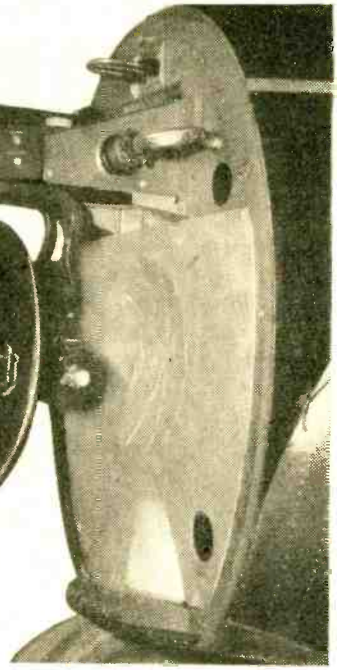
Center: Aircraft is approaching "soft" spot with rain centers (showing black) about seven to ten miles out on each side.

Bottom: Plane is now cutting through minimum turbulence area with clear sky straight ahead.

To allow aircraft to be piloted safely through thunderstorms, information regarding turbulence, rain, snow and icing conditions must be obtained. Such information is based upon rainfall gradients (i.e., varying rainfall densities at different distances) which can be displayed on the radar screen by a unique circuit.

These rainfall gradients are pictured by insertion of a so-called "iso-echo" circuit, which shows areas of heavy rainfall as dark areas—or black holes within the brighter image of areas with only light precipitation. In this way it is possible for the pilot to spot the more dangerous areas within the cloud formations themselves.

Turbulence is recorded indirectly. Varying degrees of turbulence exist in the areas of heavy rainfall. While turbulence itself cannot be seen on a weather map, it is known to be greatest where the rainfall gradient is highest, i.e., where the pattern is



Radome nose, made of special plastic transparent to microwave radiation with only minimum power loss, is bolted onto the fuselage of Delta airliner housing the first commercial Collins Airborne Weather Radar. With radome removed, you can see antenna at right.

dark. The system may also be used to provide a ground map which gives a visual display of cities, rivers, lakes, shorelines, mountains and other terrain conformations. This ground map serves as an invaluable navigation aid, effectively extending the vision of the pilot during all conditions which restrict visibility.

To enhance reliability, magnetic amplifiers and mineral diodes are used wherever practical since these components have no filaments and thus avoid the possibility of filament failure. In addition, this assures an efficient system with low heat dissipation, low current drain and power demand.

The system can be used with two indicators operating simultaneously. This arrangement offers the advantage that each indicator can be set to a different range, so that both nearby and distant conditions are depicted simultaneously.

Printed wiring is used to provide physical strength and to insure precise placement of components and proper length of leads. Delta Airlines, the first to use this installation, has thereby added another safety factor as well as passenger comfort to its flights. —30—

Soviets Use British TV Equipment

REPORTS reaching us from Russia tell of the growing popularity of television in the cities of the Soviet Union. While programs lean heavily on propaganda, they nevertheless excel in the artistic quality of theatrical and musical productions. Of course, there is no private telecasting, and no commercials. All activities of the Russian Broadcasting Authority are state-controlled.

To improve their technical facilities, Russian telecasters recently bought the remote pickup truck shown in the picture at right and various associated microwave relays from Marconi's Wireless Telegraph Company, Ltd., of England. The purchase is evidence of the improving trade relations between Russia and the Western World. Electronics, for once, plays a peaceful role.

Talking letters and tape clubs spur world-wide traffic in music, ideas, fun and friendship

By CELIA WEBSTER

Voices in the Mail

FROM COAST TO COAST, round the world and back again, the mails are now carrying small, flat boxes. Inside the boxes are voices. And the voices are spoken letters on magnetic tape.

Tape recording helps form friendships through various clubs which have been organized throughout the world. The four leading tape correspondence clubs which have appeared in the past few years are World Tape Pals, International Tapeworms, Tape Respondents International, and Voicespondence.

Instead of being "pen pals," the members of these organizations talk with each other on tape. They have found it a fascinating and deeply rewarding hobby. Magnetic tape brings friendship to the lonely, knowledge to those eager to learn, reading to the blind, and adventure to armchair travelers.

Often the narrow strip of tape forms a firm bridge between people of different countries and continents. It acts as an emissary of better international relations, carrying the human voice, warm and convincing, across all geographic and political barriers.

People from all walks of life make up the rosters of the tape clubs. They include teachers, firemen, business executives, artists, writers, professors, doctors, students, farmers, truck drivers, policemen, bankers, grocerymen, and many others.

Hobby Exchange. The tape correspondence clubs act as clearing houses to bring members with similar tastes and hobbies in contact with one another. The brochures of these clubs contain long lists of varied subjects in which the members are interested. A new participant chooses a few members as his special tape pals, and tape-responds with them. The same tape can be erased and used over and over again, continually sent back and forth between the same two members; or a spoken letter can be permanently retained.

Here are some typical listings from the Membership Roster of World Tape Pals:

John J. Pollock, Red Deer, Alberta, Canada. High school woodwork instructor; age 38, married. Revere T-700 and Revere T-1100 recorders. Two daughters: Carolyn 14, and Susan, a toddler. Wife, Mary, also interested in WTP. Photography in color, and in black and white, and processing. We like music and radio programs not available on commercial records—folk music of other countries—and clever disc jockeys; good drama. Let's discuss current affairs, philosophy, history (modern and ancient), archaeology, and education in other lands. Send me some of your favorite music, and a little chin-wag so we can get going. English only spoken.

Richard A. Drost, 1743 W. Nelson St., Chicago 13, Ill. Operatic singer; age 20, single. Wilcox-Gay 3A10. Also three-speed disc recorder. Operatic and classical vocal music. English, Italian, and some Swedish spoken. I am handicapped to a small extent with muscular dystrophy and have about 90 disc-recorded complete Met radio operas which might be of interest to some WTP. Also would like to receive some vocal music taken from RAI (Italy), the BBC (England), or from German radio.

Henk Johan Mulder, Fisherstr. 88, The Hague, Netherlands. Grocer; age 31, married. Philips recorder. I would like to receive a real impression of the American way of life. Dutch and English spoken.

The cost of mailing a 3" tape reel in the United States is only a few pennies—two

Prof. James H. Boren heads the International Committee on Tapes for Education, sponsored by World Tape Pals to encourage exchange of tapes among students and teachers of various countries.

Chile—Fernando Ceruti of Vina del Mar won first place at the International Amateur Recording Contest. Ceruti entered his binaural recordings of Chilean orchestral music through World Tape Pals.

Harry Matthews, a printer from Dallas, Texas, is the founder and secretary of World Tape Pals.

cents for third class, six cents for first.

Tape correspondents consider "talking" letters infinitely superior to written ones because they can add a background of authentic sound effects. Erik Lindgren, of Sweden, puts it like this:

"How exciting it is to listen to tapes from a friend in Beirut, recorded against a background of the exotic cries of Arab hawkers from the street."

Words and Music. Exchanging folk songs with people in all parts of the world is in itself a fascinating sideline. What's more, this exchange can take place even where language difficulties prevent the exchange of elaborate personal messages. For example, World Tape Pals, the most far-flung of all tape clubs, reaches 48 countries and their colonies. "We trade a lot of music since it is the international language," says Harry Matthews of World Tape Pals. "But where there is no language barrier, we start off more long-distance conversations on such subjects as freedom." Far from being inane gab-fests, these exchanges are conducted on a surprisingly mature level.

Of course, tape corresponding is an ideal way to improve one's knowledge of a foreign language once the fundamentals are mastered. You not only get the proper accent of native speech, but you also gain insight into the opinions, customs and attitudes of different people. It is precisely this kind of interchange that creates more good will at the grass-roots level (where it counts) than all sorts of official state visits. Next to traveling in person, tape exchange with people in other countries is one of the best ways to develop a broader understanding of the world in which we live.

If you have no knowledge whatever of any foreign language, you can still get plenty of fun and satisfaction from international tape correspondence. English, after all, has become an internationally spoken language and most overseas tape correspondents can speak it. Lars Svensson, a Swedish member of the Voicespondence Club, uses the English language so much with his foreign tape friends that he finds it strange communicating in Swedish when he talks to his tape-pal countrymen. Many members of the various organiza-

England—A warm friendship has been formed by the tape exchanges of Margery Elliott of Birmingham with the B. Sam Taylor family of Medford, Oregon. She plans to travel over 14,000 miles to visit them this summer and to see the United States.

tions, after having exchanged taped messages for a period of time, often plan their vacations in other cities and different parts of the world where their tape pals live.

Even the old-fashioned round-robin letter has its tape equivalent. This works on the principle of combining different recordings on a single tape. With the help of a church organist, the originator of the idea, Bob Crouse, a Voicespondence member, chose a familiar hymn and taped it on his recorder. He then mailed the tape to a tape pal in another state who played it on his own machine while re-recording it on a borrowed machine and at the same time singing in harmony with the original. The re-recorded tape was then sent on to another member who played the tape, re-recorded on another machine and sang simultaneously to complete the master tape. A bit complicated, but fun! They now have three master tapes of the trio who blended their voices in three different states.

Tape fans catch on quickly to the tricks of the audio trade. Often their letters are imaginative blends of talk, background sound effects and music, edited with a skill that would do credit to professional producers of radio shows. Of course, tape correspondents swap tips and ideas about the technical side of their hobby. Often they transcribe and trade radio programs, live entertainment, or lectures from their particular countries. Such tapes sometimes have real documentary value.

World Tape Pals was founded by Harry Matthews, a printer from Dallas, Texas. It grew out of Harry's former hobby of short-wave amateur radio. As a ham, he liked to chat by radio with people from practically everywhere. But often unfavorable atmospheric conditions kept him and his friends from getting through to one another. Harry then thought of tape correspondence to supplement his ham contacts. While this lacks the spontaneous give and take of ham radio conversations, he found that by carefully preparing and editing his tapes, inserting on-the-spot items, etc., he could exchange a wider range of more meaningful news with his friends. He also gets out

Germany—Erich Bomke of West Germany uses technical skill and excellent equipment to send German folk music to his friends all over the world.

Switzerland—Wilfred Francfort tapes a news commentary in his role of reporter. A dentist by profession, he is head of the Swiss Sound Chasers Association and assists news agencies and radio stations with on-the-spot recordings.

New Zealand—John E. MacDonald, headmaster, and six pupils from Taupaki School, Auckland, make a tape recording to be sent to Shady Cove School, Oregon, USA. MacDonald is known to other World Tape Pals for his excellent recordings of Maori children singing folk music, and for the interesting 35-mm. slide shows with tape commentary which he exchanges with other members.

"Snoopy" the cat (at left), took up the tape hobby of his roommates, Don and Millie Edwards. He exchanges meows with lots of other cats.

a small newspaper called "Tape Topics."

Mrs. Matthews has been swapping tape-recorded recipes with housewives from other countries. One from Australia suggested kangaroo-tail soup made like oxtail soup. Mrs. Matthews taped back a sad report about the perennial shortage of kangaroos in Texas.

Special Projects. World Tape Pals has organized a "tape bank." This is a sort of lending library consisting of hundreds of interesting and worthwhile tapes from practically everywhere on a wide variety of subjects. Lately, the tape bank has branched out into projects that present a real challenge to the imagination of tape correspondents. They set up a group called "World Tapes for Education." This is a planned program for interchanging tapes chiefly between schools, teachers, and students the world over.

Other tape clubs also have their special projects. The Voicespondence Club, under the guidance of Charles and Melva Owen, organized what they call a Committee For The Blind to aid the blind members in getting the best results from their recorders. They are also enlisting volunteers to read to them via tape.

Another group called International Tapeworms has been concentrating its recording efforts on the men and women in the Armed Services. Art Rubin, top Tapeworm, records the messages for them on his recorders and the families pay the postage. When the tapes are received at camp, they are taken to the Red Cross headquarters where they can be played. Many service men and women who have been away from home for a long time find this warm, gratifying method of communication much more satisfying than a letter because it brings the actual voices of their families to them.

The broader meaning of the tape clubs extends far beyond their actual membership to all of us who are interested in electronics. For in a world where electronics must often serve purposes of war and build barbed fences of propaganda between people, the unifying work of the tape clubs and their human sidelights set a heartening counter-theme. —30—

WANT TO JOIN A CLUB?

TAPE RESPONDENTS INTERNATIONAL
Jim Greene, Secretary
P. O. Box 21, Dept. T.
Little Rock, Ark.

THE VOICESPONDENCE CLUB
Charles Owen, Secretary
Noel, Virginia

WORLD TAPE PALS
Harry Matthews, Secretary
P. O. Box 9211
Dallas, Texas

INTERNATIONAL TAPEWORMS
Art Rubin, National Chairman
P. O. Box 215
Cedarhurst, L. I., N. Y.

GLOBAL RECORDING FRIENDS
Alfred L. Sferra, D.D.S., Secretary
125 Hamilton St.
Bound Brook, N. J.

Direction center and computer are housed in this windowless, reinforced concrete blockhouse at Lincoln Laboratory—the nerve center of the SAGE system.

Department of Defense Photos

SAGE-

Whirlwind Defense Quarterback Goes into Operation

By E. D. MORGAN

Plunging through the enemy line of aerial and atomic attack, SAGE is ready to make a touchdown for national defense

THE DESTRUCTIVE power of atomic warfare coupled with the growing array of aerial weapons which could reach our shores raises frightening misgivings. A swift and efficient defense must be instantly available to counter an attack if we are to survive. Fortunately, the same brand of ingenuity that developed these offensive means has been working to give us the weapons and organized control of them that a defense requires.

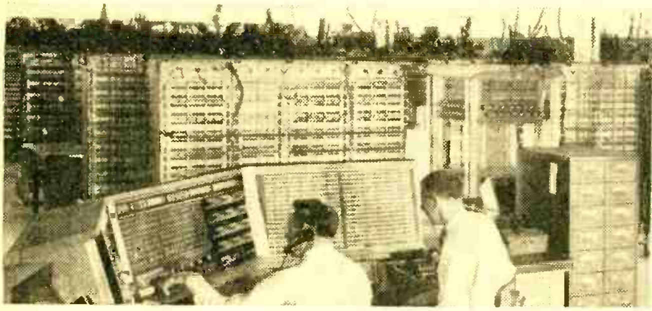
The task of assignment and control of interceptors, ground-to-air guided missiles, and anti-aircraft guns—the means by which we must defend ourselves—has led to the development of a huge electronic quarterback called the "SAGE" system. The name "SAGE" is derived from its more formal title, the Semi-Automatic Ground Environment system.

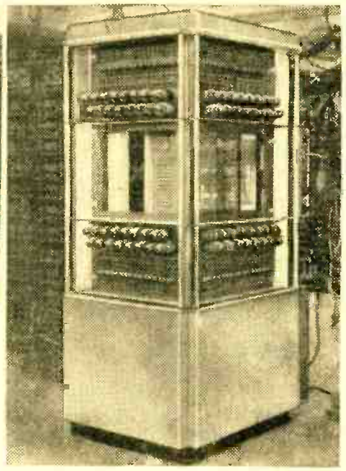
Directing Defense. One of the world's largest, fastest and brightest electronic computers is the heart of this fantastic system. It relieves men of the hopeless task of sorting, weighing and evaluating the thousands of pieces of information our radar networks and other detection means can supply. It determines the best assignments of our defensive means to cope with the situation. Then, it directs these aerial weapons until the attacking plane or missile is downed.

The first of these fabulous systems is centered at Lincoln Laboratory in Lexington, Mass. At this secret laboratory, operated by the Massachusetts Institute of Technology, the system was conceived and developed for the military forces. In all, 32 similar systems will be constructed, protecting our borders with the largest electronic defensive system ever constructed.

At the outer boundaries of the system is a ring of radar detection stations. Long-range surveillance radars and height finders are included, as well as smaller gap-filler radars to detect low-flying planes trying to slip beneath the skirts of the longer range detection systems.

The edge of the system is not confined to coverage from land stations, however;





The computer which forms the nucleus of the SAGE system is known as an AN/FSQ-7. One of the world's largest and fastest, it contains 25,000 vacuum tubes. Maintenance console is shown above.

Memory unit of computer (right), made up of three-dimensional array of ferrite cores, receives a constant stream of flight data.

"Texas Towers" constructed far from the shore extend the coverage seaward. These man-made islands are huge platforms standing on legs which reach to the ocean floor. Their name comes from a technique used successfully for offshore oil well rigs in the gulf of Mexico.

Other seaward defensive lines are manned by radar picket ships and AEW (Airborne Early Warning) planes carrying powerful radars. Constant patrols insure that the system remains on the alert.

Interpreting Signals. The mass of information provided by these surveillance systems is transmitted continuously and automatically by either telephone lines or ultra-high-frequency radio networks to a direction center.

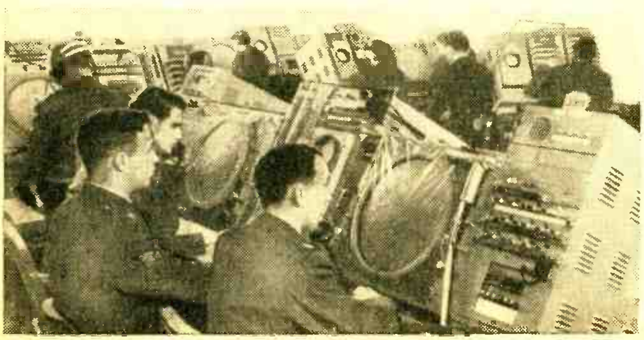
Also pouring into this direction center is additional data from other sources: flight plans of friendly aircraft to aid in their identification, up-to-date weather data vital to the successful interception of an enemy, reports from the Ground Observer Corps, data on the readiness of our defensive weapons, etc.

This constant stream of courses, speeds, altitudes and locations is continually digested by the computing facilities. The direction center is located in a windowless concrete blockhouse. It houses the dual-channel computer built by IBM. One channel is on a standby basis, but all the pertinent information is fed into it so that it is immediately ready for action if necessary.

The computer busily compares reports and compiles, sorts and processes the input information. Composite pictures of the air situation are displayed on 30" cathode-ray tubes in a television-like manner. Locations of all aircraft and their identifications can be observed. In addition, the computer weighs all the possible means of eliminating enemy planes or missiles and indicates them. The different weapons that might be used, and the time and place of the interception, are all available to the men making the tactical decisions.

When a particular type of defensive strategy is decided upon, the computer continues its work. It can direct an interceptor or missile until it contacts the enemy. If radio data links and automatic pilots are in an interceptor, it actually flies the plane to its destination. After the kill has been made, the computer continues its task to bring the plane back to its home base.

If the air battle nears the boundary of a



Cathode-ray tubes are used to display composite pictures of the changing air situation in a television-like manner. Locations of all aircraft and their identifications can be observed. The consoles at the left are part of Whirlwind I, a forerunner of the present computer.

Ground-to-air guided missiles are a key factor in our defense. A "Nike" battery, shown below ready for firing, can locate and destroy enemy aircraft by means of electronic brain. The "Nike" is the nation's first combat-ready surface-to-air guided missile.

Electronic equipment shown above is installed in one of the gap-filler radar stations which are located between more powerful long-range search transmitters.

Many radar locations have control centers where the search and height-finding radars work as a team (right). The information is then relayed to the system's direction center for processing.

Interceptors like this all-weather F-86D Sabre provide one means of downing enemy planes. The SAGE computer is capable of flying the plane to its destination using a u.h.f. data link and automatic pilot. "Mighty Mouse" 2.75-inch rockets are fired from a retractable pod beneath the fusilage.

particular system, it transfers the problem to the computer in the adjacent sector. With its speed, accuracy and capacity, it can handle many intercepts simultaneously while continuing its function of surveillance.

Over-All Picture. The immensity of the task has involved the cooperation of companies like Western Electric, IBM, Bell Labs, Burroughs and Rand along with Lincoln Laboratory.

The computer contains 25,000 vacuum tubes and covers 10,000 square feet. While it is supervised and monitored by men, it releases them from the overwhelming task of coping with thousands of details. This frees them for the more important job of making tactical decisions. Even in this category, they are guided and aided by the electronic machines.

SAGE changes the basic building block in our defense picture from a single radar and its operator to an entire geographical area treated as a unit. The capacity and efficiency of this technique serve to keep our defensive ability in step with the growing offensive might which may someday be directed against us. —30—

R/C Drone Is Television-Equipped

FLYING TELEVISION CAMERAS, carried aloft in radio-controlled "drone" aircraft, are being tested by the U. S. Army Signal Corps for possible use as instantaneous reconaissance devices. Live TV shots can be made of strategic territory and then transmitted to a ground control station. This, it is expected, will aid

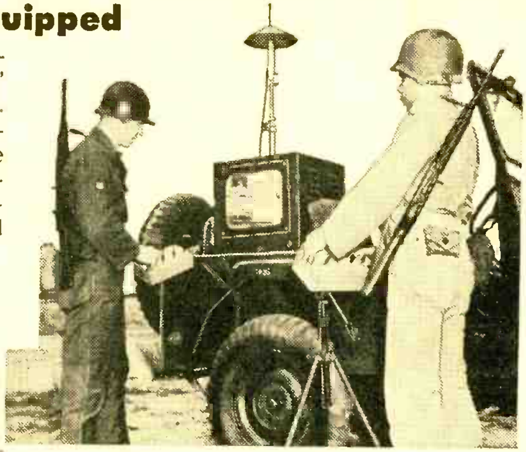
Converted L-17 is drone; box in foreground is ground control.

combat commanders in evaluating ground conditions prior to taking any action.

The pilotless system consists of an L-17 aircraft modified for television "photo-drone" operation; an auto-pilot which provides effective remote control by means of off-on type radio signals; and a ground control station that can be carried in a jeep.

Signals sent from the ground station to the L-17's 42-pound auto-pilot regulate stability, altitude, and air speed. Complying with remote commands, the aircraft will perform a scheduled climb or glide. Special control provisions prevent stalls, overspeeding, excessive loss of altitude, and other hazardous conditions.

When the drone's mission is completed, the ground controller flicks an "approach" switch which automatically positions land-



Pictures taken by drone in flight are flashed to television monitor screen. Receiver and ground control unit may be carried in jeep.

ing gear, flaps, prop pitch, and power in proper sequence for landing.

The modified L-17 may be used pilotless, or it may carry a safety pilot who can operate the aircraft himself, or turn command over to a ground controller.

Both weather- and shock-resistant, the 250-pound ground station includes radio links for commanding the drone as well as for communicating with the safety pilot. Still photos may also be made using this system. The ground control operator can, by actuating the proper switches, maintain complete out-of-sight command.

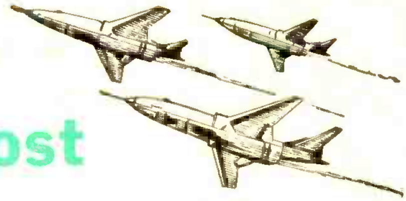
The complete system was built for the Signal Corps by Temco Aircraft Corp., Dallas, Texas. Company spokesmen claim they telescoped more than a year's quota of research and development into six months in order to achieve an early flight of the prototype.

Present range of the converted L-17's is a 25-mile area, to be augmented later by the use of radar.

Ultrasonics Slices Quartz

CUTTING critical slabs from a chunk of quartz is as easy as slicing bread with a new "sound slicer" developed by Raytheon for the Signal Corps. The device uses ultrasonic energy at 25,000 cps to cut 21 paper-thin wafers of the tough mineral without ever touching it. As a result, three times as many usable crystals for frequency control in electronic equipment can be obtained from a block of the strategic mineral than with the best diamond saw.

"Ears" for the CD Observer Post



By **LOUIS E. GARNER, JR.**

You can intercept conversations held in normal tone of voice more than 100 yards away with this sensitive "Listening Post"

WHILE you may never be able to provide your feet with Seven League Boots, if you're an electronics hobbyist who likes "off-beat" projects, you can provide your ears with similar long-range facilities. By using the instrument shown in the photographs, you can listen to birds chirping in trees at distances of hundreds of feet . . . or you can eavesdrop on conversations a hundred *yards*, or more, away.

In addition to its use in "just for fun" activities, this long-range listening device has many practical applications. A naturalist might couple its output to a tape or wire recorder and use it to pick up woodland sounds, bird songs, insect chirps, or animal calls. And since it is battery-operated, and thus completely portable, it might well be carried to desolate areas and used to listen for calls from lost hunters and campers, or survivors of airplane accidents—its directional pickup characteristics will aid in locating survivors and in guiding rescuers to the proper place. Other possible applications include its use as an adjunct to a Ground Observer Corps listening post and by police or detectives to obtain evidence on suspected criminals.

The complete "Listening Post" consists of two relatively independent units—a directional pickup assembly and a high-gain transistorized audio amplifier. Only standard commercial parts, available both through local distributors and mail order parts supply houses are used in constructing the project. While assembling the complete instrument in the exact form shown in the photographs may be a little costly for the average experimenter, the basic

Cover Photo by Al Gruen

Listening for distant sounds. If you build this device, you can start your own private Civil Defense project. It consists of two relatively independent units—a directional pickup assembly and a high-gain transistorized audio amplifier. Only standard commercial parts are used.

Using the "Listening Post." Three "cobra" type loudspeaker paging trumpets are connected in series to form pickup unit. In the model, these trumpets are mounted along a support arm made of aluminum.

design, as we shall see later, is subject to considerable modification. By applying your ingenuity, you should be able to tailor the design to fit both your technical inclinations *and* your budget. For the moment, however, let's discuss the assembly of the model.

Horizontal Arm and Pickup. Three University "cobra" type loudspeaker paging trumpets were connected in series and used as the sensitive pickup unit. "Cobra" type trumpets were chosen because they provided both a directional pickup characteristic and a proper match to the low input impedance of the transistorized amplifier.

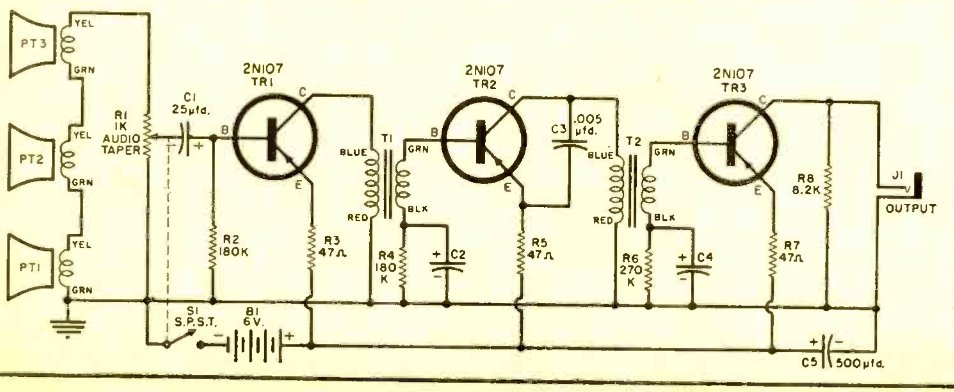
The pickup trumpets were mounted along a horizontal support arm which, in turn, was built up from four pieces of extruded aluminum stock. Standard 6′ lengths of Reynolds "do-it-yourself" aluminum angle stock in 1/16″ x 1″ x 1″ and 1/8″ x 3/4″ x 3/4″ sizes were cut in half and bolted together to make up the 3′-long arm. (You can obtain this aluminum angle stock at most hardware stores.) Mounting plates of 1/16″ aluminum, measuring 2 1/2″ x 3″ over-all, were bolted to the ends and middle of the arm—both for reinforcement and to provide smooth mounting surfaces for the trumpet support brackets.

Three holes, 3/8″ in diameter and fitted with rubber grommets, were spaced along the horizontal support arm alongside each trumpet mounting bracket, to permit the connecting leads to pass to the back of the arm. These leads were too short to reach the length of the arm, so extra lengths of hookup wire were added, with each splice protected by short pieces of spaghetti tubing. The leads were then twisted together and run under protective "U-Channel" stock to the rear center of the support arm, where the amplifier was to be mounted.

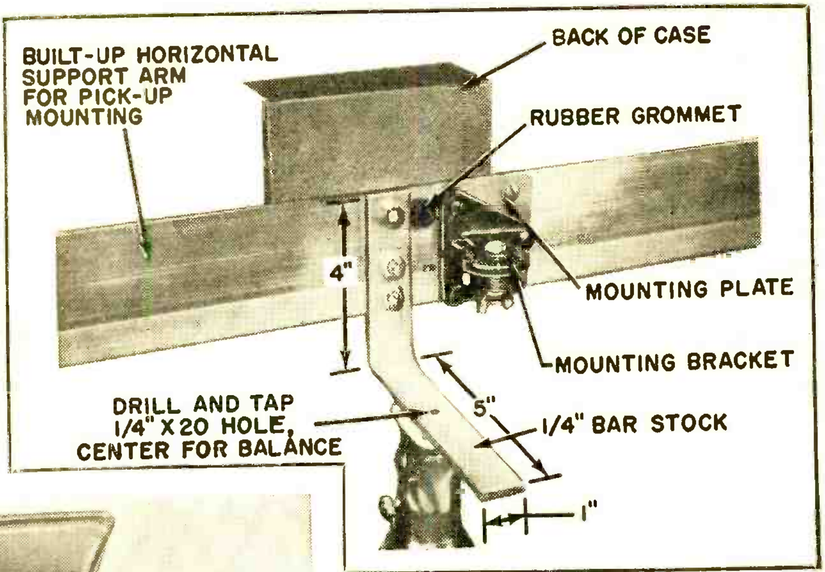
If mechanical construction isn't one of

Fig. 1. Schematic wiring diagram and parts list for the transistorized audio amplifier.

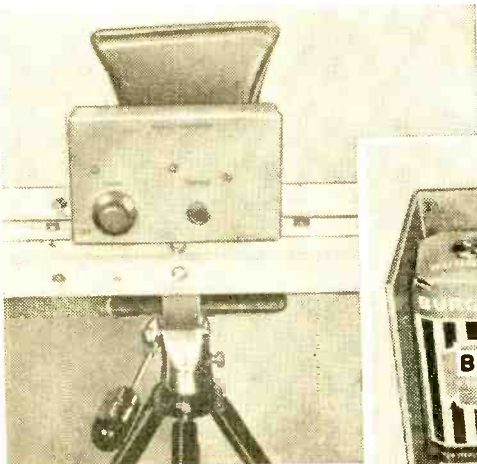
B1—6-volt battery (Burgess Type Z4)
C1—25-µfd., 6-volt electrolytic capacitor (Barco No. P6-25)
C2, C4—8-µfd., 6-volt electrolytic capacitors (Barco No. P6-8)
C3—0.005-µfd. disc ceramic capacitor
C5—500-µfd., 6-volt electrolytic capacitor (Sprague No. TVA-1103)
J1—Open-circuit phone jack
PT1, PT2, PT3—"Cobra" type paging trumpets, used as pickups, 45 ohms impedance (University Type CMIL-45)—see text
R1—1000-ohm carbon potentiometer, audio taper (with switch)
R2, R4—180,000-ohm, 1/2-watt carbon resistor
R3, R5, R7—47-ohm, 1/2-watt carbon resistor
R6—270,000-ohm, 1/2-watt carbon resistor
R8—8200-ohm, 1/2-watt carbon resistor
S1—S.p.s.t. switch (on R1)
T1, T2—Interstage transistor transformer, 20,000-ohm primary to 1000-ohm secondary (Argonne No. AR-104)
TR1, TR2, TR3—P-n-p junction transistors (G.E. Type 2N107)
1—2 1/8″ x 5 1/4″ x 3″ case (ICA No. 29410)
1—Knob
3—"In-Line" transistor sockets
1—Subchassis (bent from piece of aluminum 2″ x 3 1/4″)
1—Pair of headphones (accessory)
1—Standard camera tripod, preferably heavy-duty (accessory)
Misc. terminal strips, decals, ground lugs, wire, solder, machine screws and nuts, etc.

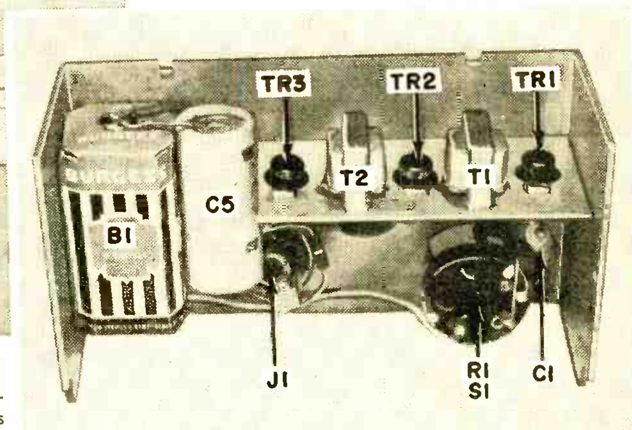


Details of "L" bracket used to support entire assembly. Be sure to mount the bracket at the balance point in the center of the arm.



Rear view of the listening post with close-up of amplifier. Assembly is mounted on a standard camera tripod.





Above-chassis view of the completed amplifier showing location of components. The transistorized circuit insures light weight and long battery life.

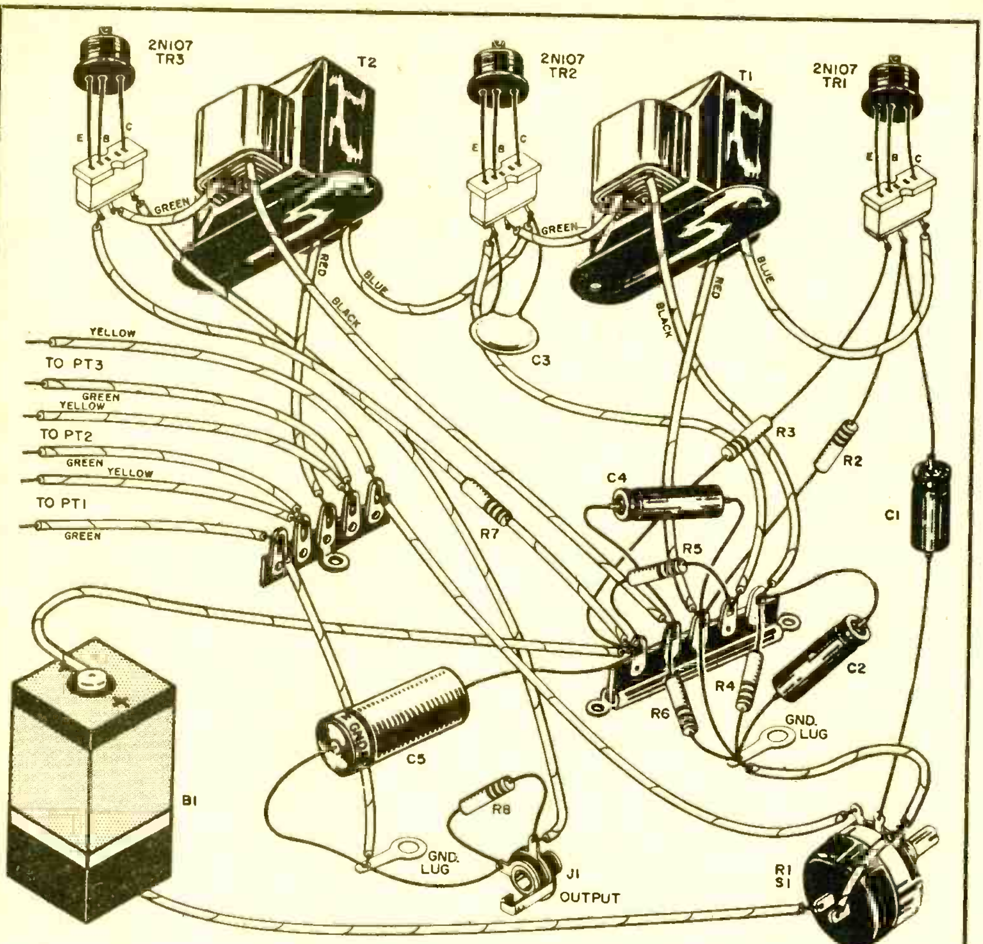
your strong points, you needn't follow the rather elaborate construction used by the author in assembling the horizontal support arm. A quite satisfactory support arm may be made from a 3′ or 4′ length of 2″ x 4″ or 4″ x 4″ timber, available at any lumber yard. Use wood screws to mount the pick-up trumpets.

But whether you use an elaborate metal arm or a simple wooden support, you'll want to mount a strong "L" bracket at the balance point in the center of the arm. In the model, this was bent from a 9″ length of ¼″ x 1″ aluminum bar stock. Three ¼-20 x ¾″ machine bolts were used to attach this bracket to the horizontal arm, and a ¼-20 tapped hole was provided to permit mounting the entire assembly on a standard camera tripod.

Audio Amplifier. The schematic diagram for the three-stage transistorized audio amplifier used is given in Fig. 1. In order to provide maximum gain, transformer coupling has been employed between stages. A single long-life six-volt battery serves as the power supply.

You'll have no trouble assembling the amplifier in the standard 3″ x 5¼″ x 2⅛″ aluminum case specified in the parts list. The back of the case is permanently mounted on the horizontal support arm, together with a four-terminal tie-point strip which serves as a common connection point for the trumpet pickup leads. In the model, the small audio transformers and transistor sockets were mounted on an aluminum sub-chassis which, in turn, was bolted to the aluminum case with two machine screws and hex nuts.

The battery is held in place against the side of the case with a simple "L" bracket. Connections are made by soldering leads to



Pictorial diagram shows how the various components of the audio amplifier are interconnected.

HOW IT WORKS

Loudspeaker paging trumpets (*PT1, PT2,* and *PT3*) serve as directional microphone pickups, converting sounds into audio electrical signals. These signals appear across control *R1*, with the setting of this potentiometer determining the amount of signal fed through coupling capacitor *C1* to the first stage.

The audio signal coupled through *C1* is amplified by *p-n-p* transistor *TR1* and coupled through transformer *T1* to the second stage. Both transformers (*T1* and *T2*) serve to match the high output impedance of a transistor amplifier to the low input impedance of the following stage.

Additional amplification is provided by the second transistor, *TR2*, with the output signal coupled through transformer *T2* to the final stage. Capacitor *C3* serves to detune the primary winding of *T2* to reduce the possibility of over-all oscillation at the "natural" resonant frequencies of the transformers. Transistor *TR3* serves as the output amplifier stage, with the output signal appearing across collector load resistor *R8*.

Base bias current for transistors *TR1, TR2* and *TR3* are provided by resistors *R2, R4*, and *R6*, respectively. Resistors *R4* and *R6* are bypassed by miniature electrolytic capacitors *C2* and *C4* to minimize the effect of these resistors on the audio signal. Dynamic and d.c. stabilization is provided by unbypassed emitter resistors *R3, R5* and *R7*.

the terminals. Again, to avoid heat damage, make these connections as quickly as possible.

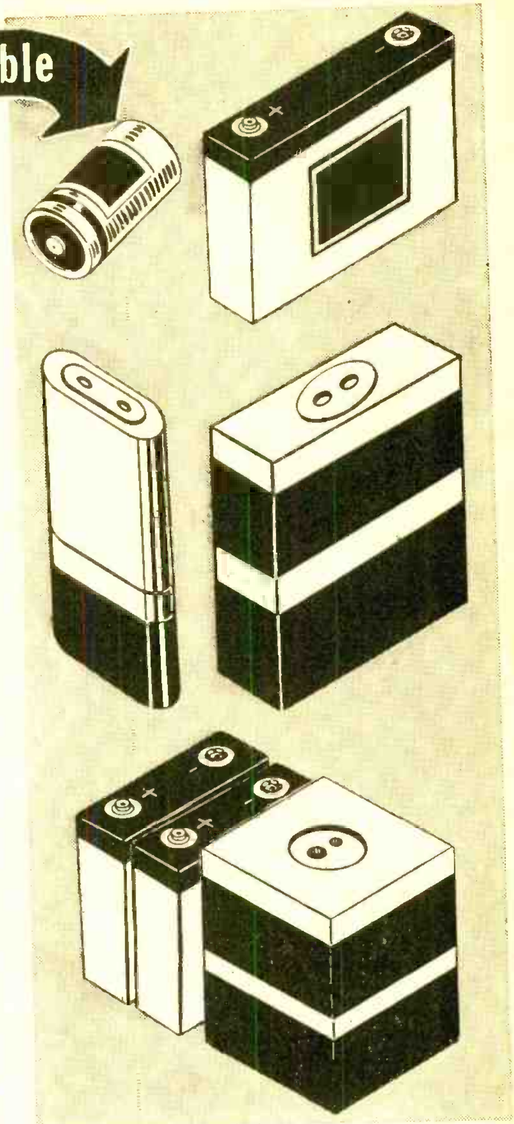
Final Test. With the amplifier wiring completed, *double-check* for errors *before* installing the transistors. Pay particular attention to the polarity of battery and electrolytic capacitor connections. Make sure you've made connections to the proper transistor terminals.

Next, give the amplifier a quick "operational" test. Install the transistors in their sockets and plug a pair of headphones (crystal or magnetic, 1000 ohms or higher impedance) into output jack *J1*. Listening to the headphones, turn the amplifier "on" and the gain full up. Touch the "hot" side of the gain control with your finger. You should hear noises, and possibly hum, in the earphones. If there is a strong broadcast station nearby, you may even hear some music!

Once you've checked out the amplifier,

(*Continued on page* 123)

The Batteries in Your Portable



DOES YOUR PORTABLE radio have that weak and run-down feeling? Did it serve you better in December than it did in July? If so, check for battery trouble. The batteries in your portable are simply boxes of chemicals in a zinc container. They inevitably deteriorate with use, are sometimes affected by temperature and humidity, and are impossible to store over long periods of time.

Two types of batteries are required in most portables. The tube filaments are supplied a fairly heavy current of perhaps a tenth of an ampere from an A battery at 1.5 volts. The tube plates require a much lower current drain of several milliamperes from a B battery at 90 volts; this might be provided by two batteries in series. Some sets use a single "battery pack" in which both types of battery are enclosed.

Batteries are made to do a specific job under certain limiting conditions. They will give maximum performance if you will observe a few simple precautions:

1. When the batteries are so weak that the portable plays only at low volume—or fades out after a short period, replace them.

2. Don't leave dead batteries in the portable. They may leak and cause corrosion or other damage to set or case. Remove the batteries from the radio if you don't plan to use the set for long periods.

3. Test batteries under load. Even partially worn-out batteries may show somewhere near normal voltage on open circuit test. Your dealer has the proper tester.

4. When buying batteries, see if they have a date stamped on them, and don't accept any on which the date has expired.

5. Keep batteries snug in the case. Shim them lightly if necessary with wooden blocks. Don't jam them in.

6. Dry batteries are made for intermittent use, so don't play your portable for seven or eight hours at a time. Even a brief rest between use periods is helpful.

7. While portable radios generally can't afford the drain of a pilot light, they are sometimes provided with a "flag" visible through an opening in the panel when the set is turned on. Make sure this works, and repaint the flag in a brighter color if necessary to assure maximum "noticeability."

8. If the set has an on/off switch operated by the case lid, make sure the switch really turns the set off when the lid is closed.

9. Don't store batteries—or sets with batteries—in a warm place. Heat speeds up the action of the battery chemicals and shortens battery life. For the same reason, try to provide some shade for your radio at the beach.

10. On the large a.c.-d.c. battery portables with short-wave bands, which use a single battery pack, additional hours of service can often be obtained from the pack by paralleling its "A" section with nine volts of A battery. There is sometimes room in the case for the extra battery, or it can be attached externally to the back panel, thereby reinforcing the pack "A" section which often fails before the "B" section.

—Eugene F. Coriell, Lt. Col., USAF

AM Tuner for Low-Cost Hi-Fi

By JOHN A. NORMAN

Attractive and efficient, the Miller AM tuner fits right in with other components that comprise low-cost system.

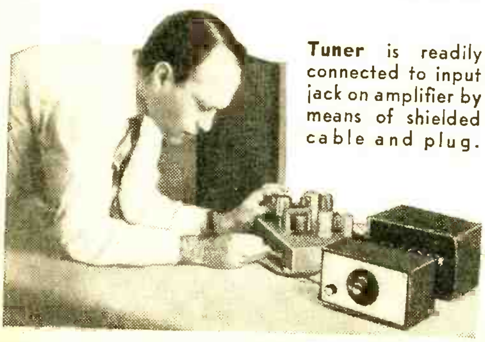
Photos by Maynard Frank Wolfe

Small in size and modest in price, this tuner—connected to a hi-fi system—puts out sound that is both "clean" and "big"

READERS WHO assembled the low-cost hi-fi system described in our June issue have asked about a likely AM tuner to add to the system. Interest in AM reception is gaining among hi-fi enthusiasts, what with improved AM facilities and the growing trend toward "binaural" reception. In answer to the requests, POP'tronics put out its editorial scanners and surveyed the field. What we found should meet the demand quite adequately.

The old principle of crystal detection has been pressed into service for hi-fi AM reception. A recent application of the germanium-diode crystal as a detector, surrounded by a clever—but simple—circuit, has produced a top quality tuner. Its fidelity on local stations is almost unbelievable in view of its price.

The little giant in question is the Miller No. 595 AM tuner (net price, $19.50). Using no tubes and no a.c. power, and measuring a mere 7" x 4" x 3½", this unit pulls in signals with a measure of linearity and stability formerly associated only with sets selling for much more.



Tuner is readily connected to input jack on amplifier by means of shielded cable and plug.

Trouble-Free Circuit. The secret lies in the tuning circuit. A germanium diode is used as the detector. Two antenna coils, tuned by a two-gang capacitor, are coupled through a third coil. This circuitry produces broad tuning characteristics with no sideband cutting. Sensitivity is a neat compromise between being high enough for stations within a 25-mile radius and low enough to reject spurious signals and provide very "clean" reception. Selectivity is assured by the use of high-Q coils.

The advantages of this type of circuit are many, adding up to low-cost, high-quality, trouble-free operation. Audio response is not limited by any design factors in the receiver; this set is ready to handle anything the AM broadcast station can throw its way.

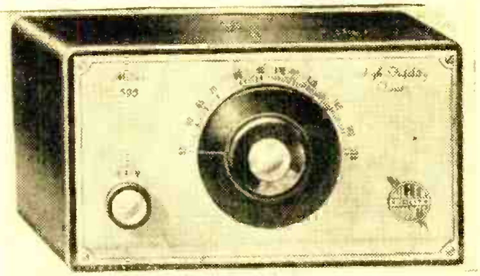
No tubes are used. The audio signal, after detection by the diode, is fed to the external amplifier. No tubes in the tuner mean no power supply. Consequently, the 595 is completely free of both hum and tube microphonics. What's more, there is nothing to wear out and replace. The germanium diode itself is inherently rugged and resistant to shock. A long and economical life expectancy can be claimed for this component.

On listening tests conducted, using the low-cost hi-fi system mentioned earlier, audio response was clocked very close to 10,000 cps. This was checked with the tuner plugged into the "AUX" input jack of the 10-watt amplifier. The general impression, aurally, was one of very clean sound. An undistorted response up to 10,000 cycles may prove more satisfying than a distorted response that goes higher. As things stand now, many AM stations do not transmit audio frequencies above 10,000 cycles, although they may if it doesn't interfere with other stations. The average inexpensive AM radio will not, ordinarily, handle frequencies in this range.

Installing the Tuner. To use the Miller tuner, insert the signal output lead (already fitted with a standard phono plug) into the "AUX" or "SPARE" jack on the amplifier. Two controls are provided: a station selector and a gain adjustment. We recommend setting the gain to maximum. Then you get the full benefit of the detected radio signal and can use the amplifier's volume and tone controls to suit your own listening tastes.

Incoming signal strength depends largely on the length of the antenna used. A 75' length of ordinary lamp cord will serve nicely as the antenna.

Available As Kit. For those who want to build their own, and "get their feet wet" on a simple, foolproof, and rewarding project, the tuner is available as a kit (Model No. 565) for $14.70 net. Everything needed is supplied. Instructions included presume no previous electronic training on the part of the builder. Anyone who can follow simple directions and hold a soldering iron can successfully complete this tuner—and have it playing—in less than two hours. When assembled, the kit version is identical to the factory-made job.



Two controls are used on the Miller 595 AM tuner. Knob at left is a gain control; the center dial is a station selector. There is no "on-off" switch needed because the tuner uses no power supply.

Either way—kit or factory-assembled—this tuner is a worthy addition to low-cost, good-quality audio. —30—

90-Volt Neon Lamp Runs on 4½-Volt Battery

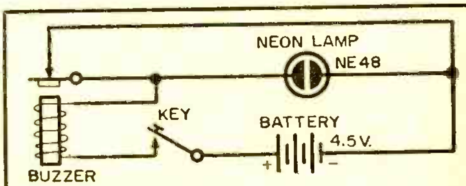
AN EXCELLENT demonstration of the storage and conversion of electrical energy in an electromagnetic field can easily be accomplished with a few simple parts in the experimenter's junkbox.

When an electric current is sent through a coil of wire, or solenoid, it does not reach its full value instantly because it must first expand an electromagnetic field around the coil. If an iron core is placed in the solenoid, this space-storage-of-electrical-energy effect can be greatly increased. When the current flow is suddenly cut off, it does not instantly return to zero; as the electromagnetic field collapses, energy is returned to the circuit where it is dissipated. This energy will often build up its voltage even to an intensity far above the original voltage which was causing the current to flow.

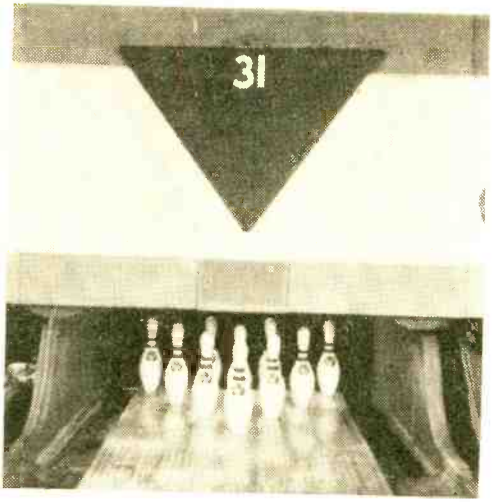
The above-mentioned phenomenon can be demonstrated by taking a neon lamp, say the NE-48, that will not operate until the applied d.c. voltage is at least 90 volts, and connecting it in a circuit which includes a high-speed buzzer in accordance with the schematic drawing. Note that this circuit is so wired that the current from the battery can flow through the electromagnet of the buzzer up to the instant the magnet attracts the armature; then the current is immediately cut off.

The energy stored in the electromagnetic field space surrounding the buzzer is now returned to the coil and the voltage builds up to a peak sufficiently high to jump the open gap between the plates of the neon lamp, where it appears as a flash of red light that proves it has reached at least 90 volts. The current is d.c. and flows in the same direction as the original current when building up and maintaining the electromagnetic field.

All this has happened in spite of the fact that the original pressure could not have exceeded 4½ volts. The buzzer keeps on starting and breaking the current at a high rate of speed, so to all appearances the lamp is continuously burning—although actually it is being lit and extinguished about 1000 times per second. —*George P. Pearce*



Schematic shows how simple it is to demonstrate solenoid's action in lighting 90-volt neon bulb. Polarity of battery is not important.



Automatic Pin Boy

Electronic brain spots pins and returns ball to bowler

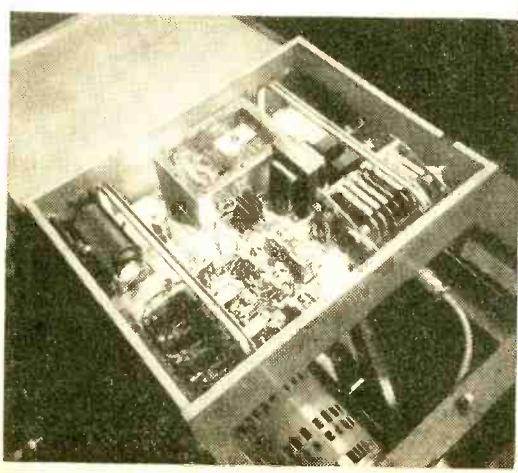
AUTOMATION, guided by electronics, has invaded the American bowling alley with the development of an "Automatic Pinspotter." Produced by American Machine and Foundry Company, more than 10,000 of these devices have been installed in bowling centers throughout the United States. Completely automatic, the Pinspotter does everything that the familiar "pin boy" used to do, except pick up tips and call to bowlers.

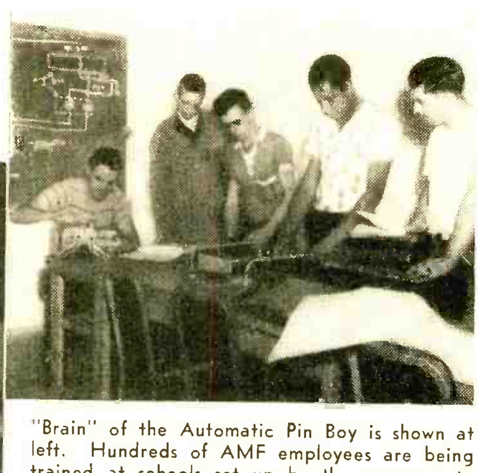
Respotting pins and returning balls, the AMF Pinspotter is a mechanical system controlled by electronics. Details of its operation in a typical sequence are shown on the next page.

So complex is the Pinspotter's design—including power relays, circuit breakers, potentiometers, signaling systems, and a special "Radaray" which detects fouls—that AMF has found it necessary to institute its own schools for training electronic technicians. Fifteen hundred students, from every state in the union, are attending company schools set up at the plant in Shelby, Ohio, and a recently opened branch at Los Angeles, Calif. The course covers the elements of electronics and mechanics and goes on to train personnel to dismantle, overhaul, and service the Pinspotter.

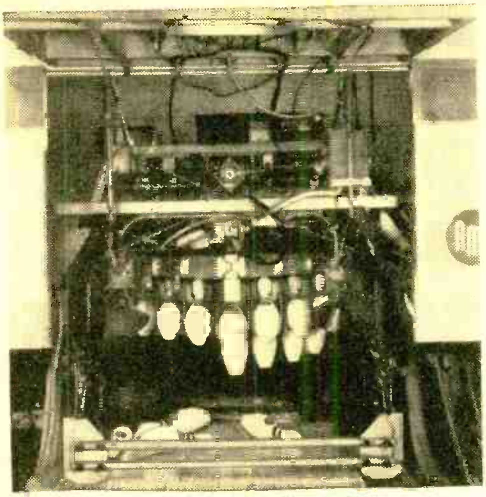
This is one case where the problem of automation replacing people on jobs is no serious issue. In the first place, the pin boy has become a scarcity on the scene because of new opportunities that have opened up for youths in more lucrative and less strenuous areas. Secondly, use of these automatic pin boys has created a new demand for trained technicians to service them, to say nothing of the personnel employed in their manufacture and distribution.

For more information, contact American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y. —30—

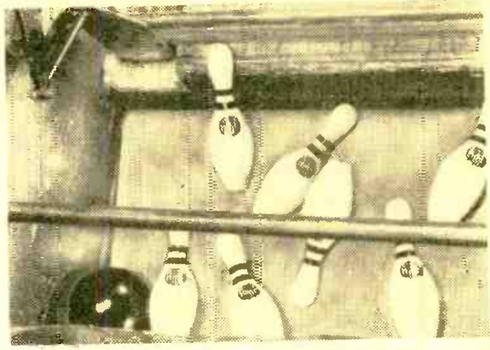




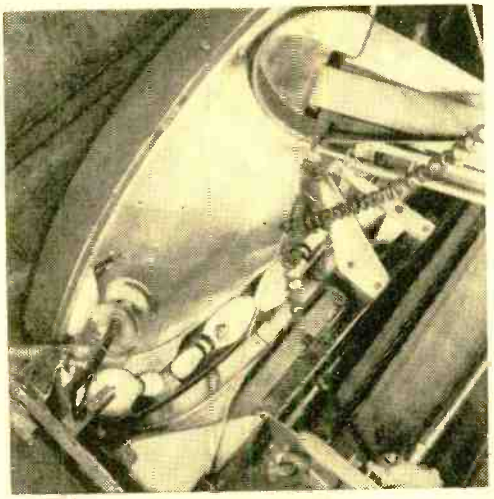
"Brain" of the Automatic Pin Boy is shown at left. Hundreds of AMF employees are being trained at schools set up by the company to dismantle, service, and reassemble this intricate electromechanical system. A large part of the training program consists of a course in basic electronics. Other needed subjects, including mechanics, are also taught. Company expects to train 1500 technicians by end of year.



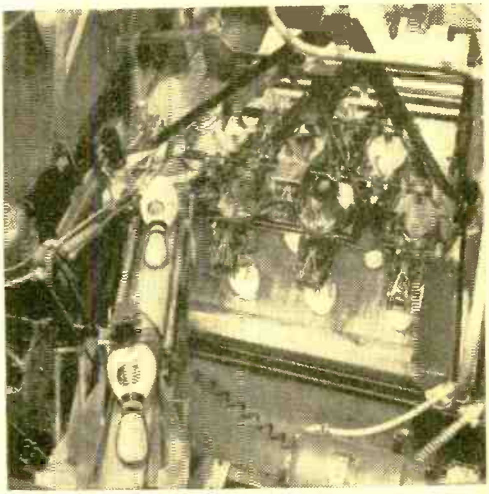
1 First ball sets the AMF Pinspotter in motion by hitting pit cushion, thereby tripping switch, as in above photo. The ball will be moved to "ball lift door" (lower left corner), lifted to return track, and sent on its way back to bowler. Meanwhile, machine's spotting table has lifted standing pins from alley, permitting moving bar to clear deadwood into pit, thence under pit cushion to a "pinwheel" conveyor for reloading. After the alley bed is swept free of fallen pins, table descends and respots the pins, in preparation for next ball.



2 Constantly revolving "magic carpet," an endless belt in pit, moves deadwood to "pinwheel" conveyor which lifts pins to top to be deposited into spotting table cups. Ball is moved by carpet to door of belt-type ball lift in the kickback. This door remains closed at all times except when opened by ball, which keeps pins from jamming lift.

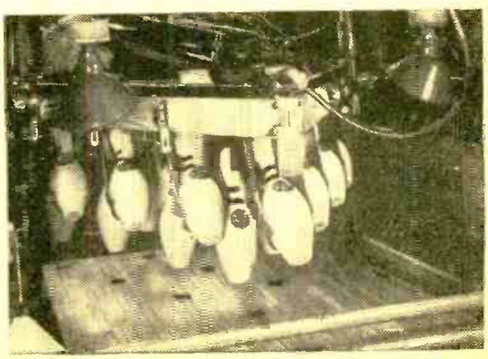


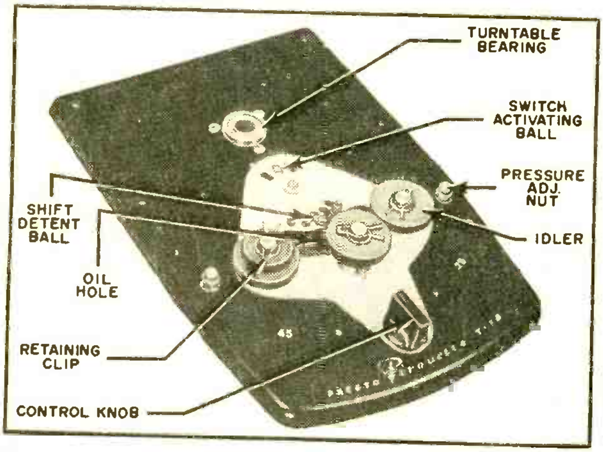
3 "Pinwheel" conveyor at rear receives deadwood carried beneath pin cushion by machine's endless belt. Pins fall into wheel's compartments, are held in place by steel pin and carried to top of wheel where they are released into an "orientor."



4 At top of "pinwheel," steel bar holding pin in place retracts and pins are oriented—base first—onto telescoping distributor whose endless belt indexes pins into cups of spotting table. This action takes place whenever the table needs pins, even when the spotting table is being lowered to respot pins for next throw, as in above photo.

5 "Off-spot" pins (right) are respotted on alley bed for second ball. AMF Pinspotter's action conforms to American Bowling Congress rules which dictate that position of "off-spot" pin cannot be altered in any way. When frame is completed, rail descends to protect new pins as they are spotted. Sequence repeats itself automatically.





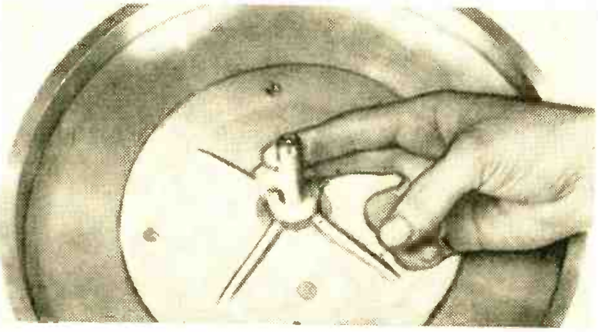
With turntable removed from its shaft, record player base (sometimes called a "motor board") looks like the unit shown at left. Although photos here are of the Presto "Pirouette," maintenance techniques outlined apply to any turntable.

Toothpick may be used for applying two or three drops of oil to the motor bearings (below). Wicks inside the circular openings carry the oil to vital parts. Access to motor is gained by turning base plate upside down. Careful treatment adds years to turntable's life.

Low-Down on Turntable Upkeep

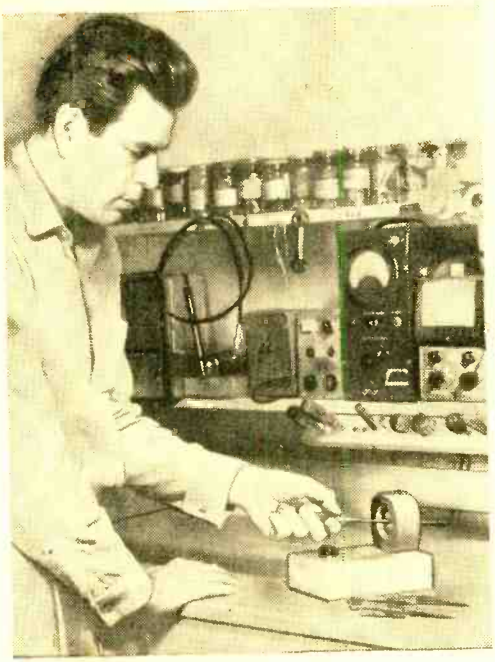
A FEW MINUTES and as many drops of oil—when needed—can assure top performance from your record turntable. First, remove the turntable from its shaft and apply two or three drops of medium motor oil to the motor bearings. Next, make a light grease by mixing the motor oil with petroleum jelly and apply a small amount to the turntable shaft. Third, remove the idler wheels by slipping off the retaining clips, apply grease to their shafts, wash the wheels with warm water and soap, and wipe them dry before replacing them.

To avoid friction in the speed changing mechanism, apply some grease to the switch-activating and shift-detent balls. Lubricate the mechanism's shaft with a drop or two of the motor oil. Before replacing the turntable, use a soft dry cloth to dust and wipe the entire mechanism. Work in a dust-free area; oiled surfaces attract abrasive particles. Do this regularly, and you'll reduce rumble, wow, and flutter. —30—



Mixture of grease and oil may be applied to shaft of turntable by using the fingers, as shown above. Solution is made by mixing medium motor oil with ordinary petroleum jelly. Small amount, just enough to cover shaft with light film, is all that is needed for smooth operation.

Detent balls, indicated by toothpick and arrow at left, get the same grease treatment as the turntable shaft. Proper maintenance of these parts assures smooth operation of the speed-changing mechanism, prevents friction and binding. Shaft for this mechanism should receive a drop or two of oil only (not grease). Caution: oil must be kept off idler wheels.



MAGNETIZE FOR FUN AND UTILITY

By Rhys Samuels

Just pass a tool through the coil of this easy-to-build unit; it will be magnetized in seconds

MAGNETS by the dozen can be yours when you build this simple, inexpensive magnetizer unit. In seconds, you can magnetize hand tools or toys for the youngsters, or you can make your own magnetic cabinet latches and dozens of other devices simply by passing them through the coil of this easy-to-build magnetizer. And you can demagnetize them just as easily by resetting the panel switch.

A magnet is made by passing hardened iron steel or a suitable alloy through a strong magnetic field. This type of field is created whenever a direct current flows through an electrical conductor. If the current flow is increased, or if the conductor is wound into a coil of many turns, such as the one used in this magnetizer, the strength of the magnetic field is greatly increased.

The strength and life of a magnet depend upon the composition of the metal used in the magnet. The best permanent magnets are made of hardened steel or certain alloys such as Alnico (used in many loudspeakers) which is composed of aluminum, nickel, cobalt, and iron. Soft iron loses its magnetism easily and is not recommended for permanent magnets. A magnet can be demagnetized by passing it through an alternating-current field.

This magnetizer is built around an RCA-202D1 focus coil taken from an RCA Model 630TS television receiver, although any focus coil designed to handle a direct current of 120 milliamperes or more can be used. The only operating control is a two-pole, three-position switch. Switch positions are "M" (magnetize), "OFF," and "D" (demagnetize). When the switch is set to "M," the magnetizer supplies direct current to the coil winding, thereby creating a strong unidirectional magnetic field. When the switch is set to "D," the direct current is removed and the coil is connected across the a.c. line, causing an alternating field to be set up around the coil.

The circuit of the magnetizer is shown

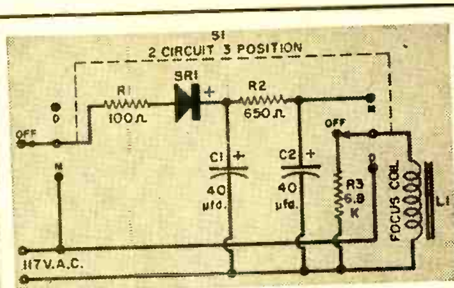
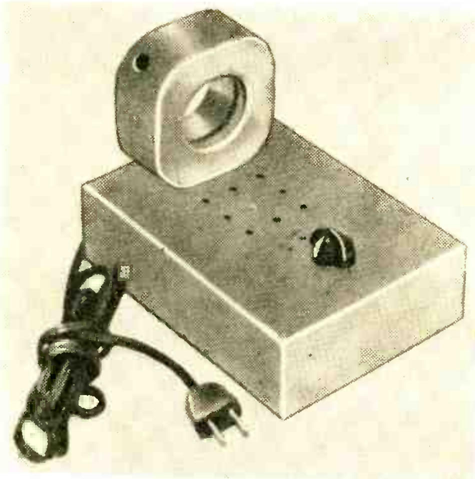


Fig. 1. Schematic diagram. See parts list below.

C1-C2—40/40-µfd., 150-volt dual electrolytic capacitor with mounting clip (Cornell-Dubilier UFE-4415)
L1—Focus coil (RCA 202D1)
R1—100-ohm, 2-watt composition resistor
R2—650-ohm, 20-watt resistor
R3—6800-ohm, 1-watt composition resistor
S1—2-circuit, 3-position rotary switch, shorting type (Mallory 3123J)
SR1—150-ma. selenium rectifier (RCA 201G1)
1—5" x 7" x 2" chassis with ventilated bottom plate



Looking down at the magnetizer, you can see the focus coil, the ventilating holes drilled in top of chassis directly over rectifier, and the three-position switch which is the only operating control.

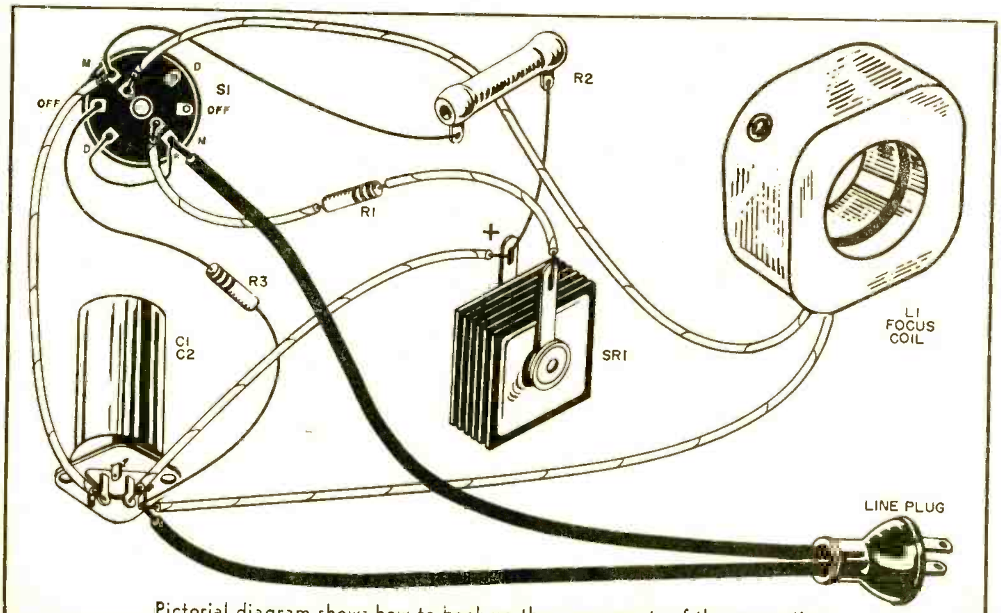
in Fig. 1. The simple power-supply circuit utilizes a selenium rectifier which rectifies the alternating current from the line, delivering a pulsating direct current on the "plus" side of the rectifier. Resistor *R1* is a protective resistor which limits the surge current through the rectifier when the switch is first set to "M." Capacitors *C1* and *C2* and the resistor *R2* filter out any ripple voltage so that substantially pure direct current is applied to the coil. *R3* is connected across the coil in the "OFF" position, and helps to reduce arcing at the switch contacts when the switch is operated. When the switch is set to "D," the rectifier-filter circuit is inoperative.

Construction and Operation. A chassis base measuring 5" x 7" x 2" was used by the author. Because the selenium rectifier can become hot under continuous operation, this part should be mounted vertically on a small angle bracket and ventilating holes drilled in the top of the chassis directly over the rectifier.

Before applying power to the magnetizer, trace out all connections and wiring to make sure they correspond to the schematic and pictorial diagrams. Set the switch at "M" and pass a screwdriver or other steel instrument slowly through the hole in the coil. The field should be strong enough to pull the metal piece against the coil frame. Pass the part completely through the coil, removing it from the other side. The part is now magnetized.

Similarly, magnetize another piece of steel, and note that while the two pieces attract each other when brought together at any angle they have maximum attraction in only one position. This characteristic is important and should be considered when installing homemade magnets as cabinet-door latches.

To de-energize a magnet, or magnetized part, simply throw the switch to "D" and pass the part slowly through the coil, continuing along the center axis for a distance of several inches after the part has passed completely through. In some cases, it may be necessary to pass the magnetized part through the coil two or three times. —30—



Pictorial diagram shows how to hook up the components of the magnetizer.

"Printed Wiring" Techniques for the Experimenter

Courtesy of Bell Telephone Labs.

By LOUIS E. GARNER, Jr.

Part 1 of two-part series discusses methods of printed wiring and tells how to make an etched circuit board

A RADIO RECEIVER "wired" *without* hookup wire! An audio amplifier assembled *without* terminal strips! A television receiver with hundreds of soldered connections . . . but all made *without* a soldering iron!

Far-fetched? No. All of these production miracles may occur as a matter of course when a manufacturer substitutes "printed" wiring methods for conventional hand wiring. Since the elimination of hand wiring can cut labor production costs as much as 50%, manufacturers have a sound economic reason for using such methods.

But the savings in labor costs is not the only reason for going to printed wiring. The finished equipment may be more compact, work better, and require fewer adjustments. Finally, since every unit is wired exactly alike, wiring errors are virtually eliminated, "rejects" are minimized, and inspection time and costs are reduced.

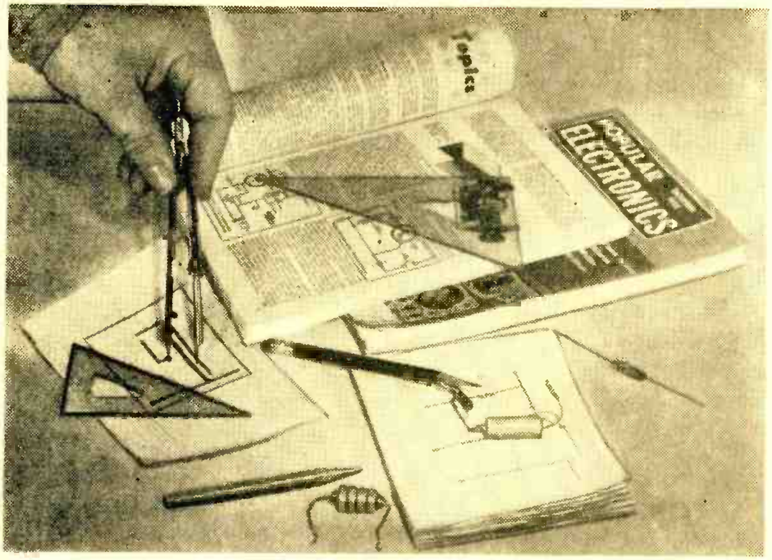
METHODS OF PRINTED WIRING. The general term "printed wiring" is used to describe any electrical or conductive pattern reproduced on an insulating base, although technically the term applies only to wiring and circuits reproduced with the aid of printing techniques . . . that is, using conductive inks printed in the desired pattern. Commercially, printed wiring may be of two general forms—"deposit" and "stripped."

If a "deposit" method is used, the conductive pattern is *applied* to the insulating base plate. Typical "deposit" methods include printing with metallic inks, spraying liquid metal onto the base through a stencil, and pressing a metallic foil pattern into a plastic base, using a heated die.

Where a "stripping" method is used, the insulated base is covered with the conducting material. The desired pattern is applied to the surface, and the excess conductor "stripped" away. The more popular "stripping" techniques include etching and embossing.

Use of printed wiring methods offers advantages to the home experimenter, student, or gadgeteer making up a single circuit as well as to the manufacturer producing thousands of units. When reasonable skill is acquired through practice, it is often possible to lay out, produce and assemble a piece of equipment using printed wiring in less time than it takes to make up the same circuit using conventional wiring techniques . . . and with the final equipment much more "professional" in appearance, more compact, and likely to work better.

With the advantages to the experimenter in mind, several manufacturers are offering printed-circuit kits. These kits include all the materials necessary to make up etched circuit boards. Basic printed wiring techniques have been described briefly in past issues of POP'tronics in regard to specific



In making up a printed-circuit layout, you start with a schematic wiring diagram of the project you plan to assemble, redrawing it until you have eliminated all circuit wiring crossovers. See text for more details.

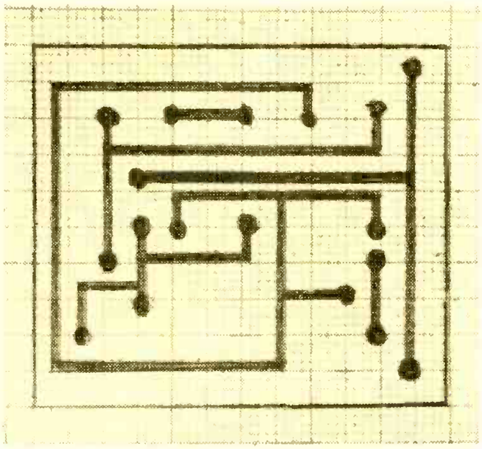
projects. See H. J. Carter's, "Making an Etched Preamp" (November, 1955, p. 87), and Paul F. Runge's "Printed Circuitry for R/C" (August, 1955, p. 74). But now we'll discuss these techniques in detail and show how you can apply printed wiring methods to virtually any project that you wish to assemble.

Of the various printed wiring techniques used industrially, the techniques of "etching" and "painting" are best suited to home use. Of the two, etching is by far the most popular and is, in fact, the most widely used commercial technique. The majority of printed-circuit kits utilize etching techniques.

MAKING ETCHED CIRCUITS. The basic steps in producing an etched wiring board and assembling a circuit are illustrated in Fig. 1 (p. 62). The raw material is a laminated board consisting of an insulating base with a layer of metal foil bonded to its surface. The foil may be on either one or both sides. In most work, a copper-foil clad laminated paper-base phenolic is used.

You can make up your own etched circuit boards by following these essential steps—plus the additional steps of making up the original circuit pattern layout and transferring the layout to the board. Follow the procedure detailed below:

Step 1—Making a Layout. Start with the schematic wiring diagram of the project you plan to assemble. Redraw the schematic one or more times, trying to eliminate all circuit wiring crossovers. When you have a tentative circuit, gather the components you plan to use and *make a full-size scale drawing* of the final circuit. Locate components where they will serve



Typical etched circuit layout on cross-section paper. Drawing should be made to full-size scale.

to bypass conductor crossovers which are not easily eliminated. Individual leads or "wires" should have a thickness of at least 1/32", with the spacing between adjacent conductors not less than 1/32". Thicker leads may be used if desired, and you may find it easier to work with 1/16"- or even ⅛"-wide conductors on the first few boards you make up.

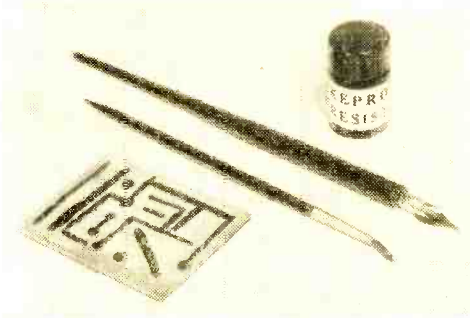
Where components are to be mounted or leads attached to the board, draw small circles. Entire patches of foil conductor may be used for shielding, although it is generally best to "break up" solid areas with diagonal bars. The spacing between adjacent bars may approximate or be slightly greater than the width of the bars. Where 90° turns are made, the conductor may follow a smooth curve or make a sharp bend, as preferred. Where eyelets are to be used, plan on holes large enough to accommodate them. Use slightly smaller holes when leads are to be attached directly to the copper foil.

In general, component and wiring leads can be soldered directly to the copper foil for permanent connections, but if the leads may be removed often, plan on using copper or brass eyelets at such points. Space component mounting holes for the actual parts you plan to use. If the components are to be mounted by their leads (resistors, capacitors, and small coils are generally mounted in this fashion), space the mounting holes with the thought of using a gradual bend in the component leads instead of a sharp bend close to the body . . . sharp bends may cause the leads to break off or can place an undue strain on the component. You will find that cross-section (graph) paper is useful for making up the scale wiring layout.

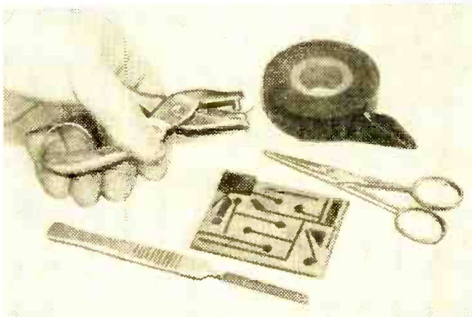
A "typical" printed wiring layout is illustrated in Fig. 2. This layout has been designed to illustrate important points to remember when making up your own layouts and *it does not represent a specific circuit*.

Upon completing a circuit wiring layout, check and double-check for errors. While still in the layout stage, an error may be corrected simply by erasing and redrawing the layout . . . but once the board is etched, it may be necessary to make up an entire new board to correct mistakes.

Step 2—Preparing the Board. The copper-clad phenolic board and other materials you'll need may be purchased individually or in "kits." (See list of suppliers on page 62.) At the beginning, however, you'll find it best to purchase a complete "kit" of materials. Once you've gained a little experience in making up circuit boards, you can purchase individual items in the quantities needed.



Ink resist is applied with brush and pen. Only those parts covered will remain after etching.



Scotch electrical tape may be used as a tape resist. Circles are cut out with a paper punch.

Depending on the circuit layout, use either single-sided (single-clad) or double-clad boards. But until you gain experience, you'll find it best to stick to simple layouts and single-clad board.

Cut a piece of the copper-clad board to fit your circuit layout, using a fine-toothed hacksaw, a jigsaw, or a scroll saw. Cut from the copper side, and back up the thin phenolic board with a piece of hardboard or plywood. If any large holes or cutouts are needed (for tube sockets, for example), they should be cut at this time. Use a hole saw or "flying bar" cutter for cutting large round holes . . . not a conventional chassis punch, which may crack the board. Only the large holes and cutouts are made at this time . . . smaller holes are drilled after the board is etched.

With the board cut to size and rough machine work completed, clean the copper surface of dirt and tarnish, and roughen it slightly to permit the etchant to get a better "bite" on the foil. You can do this by scrubbing the surface with a stiff brush dipped in powdered pumice stone (check your local hardware dealer) or, if pumice stone is unavailable, by using an abrasive household cleanser. Sprinkle the household

Clean the copper-clad phenolic wiring board of dirt and tarnish prior to applying the resist.

cleanser lightly on the foil and scour vigorously with a slightly dampened cloth. With the surface properly prepared, the copper should be bright and shiny, and should have many small scratches . . . visible when the foil is examined through a small magnifying glass. Then you should rinse and dry the prepared board.

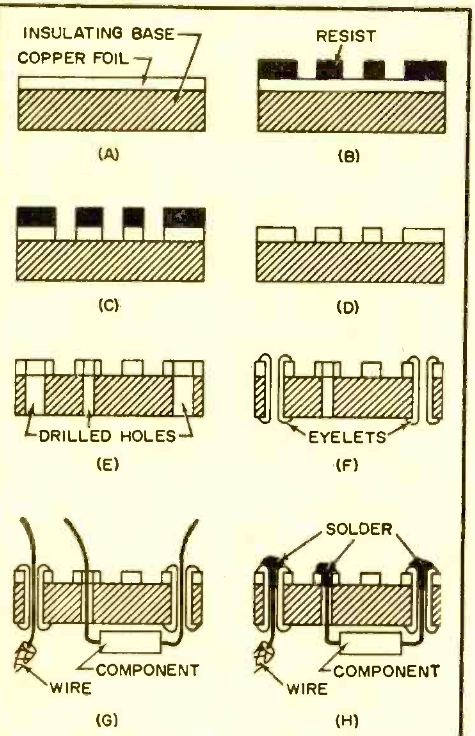


Fig. 1. In the commercial production of etched circuit boards, the plain metal clad board shown at (A) is covered with a special material which resists chemical action. This "resist" is applied in the pattern of the desired final circuit, as shown at (B), using photographic, plating, spraying, stenciling, or printing techniques. With the resist applied, the foil-clad board is placed in a chemical etchant which attacks and eats (etches) away all unprotected metal, leaving only the foil pattern protected by the resist (C). After that, the resist is removed, exposing the bare metal foil (D). Machining is next (E), with mounting and wiring holes drilled or punched at appropriate places in the board. Metal eyelets, if used, are now mounted in the board (F). With step (F), the wiring board itself is completed. To complete the circuit, electrical components are mounted on the back of the board by passing their leads through appropriate holes in the board (G). Finally, the board is soldered and excess lead lengths cut off, resulting in the completed circuit shown at (H). In production work, the entire board is generally soldered in one operation by dipping it into a "pot" of solder—with the operation called, appropriately, "dip soldering." Thus, hundreds of soldered connections may be made at one time without a soldering iron!

Step 3—Transferring Layout. First, obtain a few sheets of "pencil" carbon paper from your local stationer or office supply store. Cut a piece to fit your circuit board and attach the carbon paper and your scale wiring layout to the board with Scotch tape. *Make sure the layout cannot shift its position.* Finally, using a moderately hard pencil, trace the layout onto the copper foil.

Locate small mounting holes by pricking the copper right through the layout and tracing carbon, using a small center punch or a sharp scribe. Use hand pressure or a *very light* hammer tap when locating these holes to avoid cracking the board. Back up the board with a solid piece of hardboard or wood. And double-check your tracing before removing the layout sheet and carbon paper.

Step 4—Applying the Resist. With the circuit layout transferred to the copper-clad board, the acid "resist" may be applied. For experimental "single-shot" circuits, two types of resist are popular: (1) *ink resist* and (2) *tape resist.*

Ink resist is an asphalt-based acid-resistant paint or ink. It is supplied as a part of most printed-circuit kits but is also available from many art supply houses. Apply ink resist to the copper foil using a small ruling pen, a small brush, or a "Speedball" pen. Cover all parts of the layout, for only those parts of the copper foil covered by the ink will remain after etching. Allow the ink to dry.

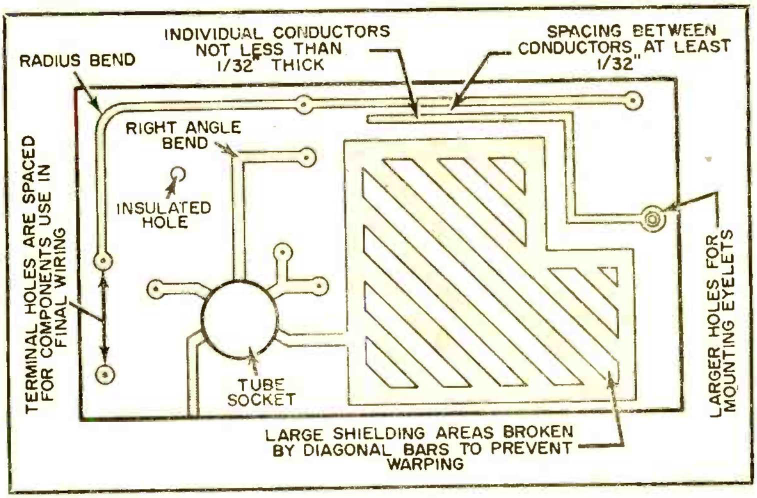
Ordinary plastic-base Scotch electrical tape makes an excellent tape resist. It is furnished in some kits. Narrow strips may

MATERIALS	SUPPLIERS
Complete Kits	KEPRO KITS— Keil Engineering Products 4356 Duncan Ave. St. Louis 10, Mo. TECHNIQUES KITS— Techniques, Inc. 135 Belmont St. Englewood, N. J.
Solder and Fluxes	General Cement Mfg. Co. * Rockford, Ill.
Copper-Clad Laminate ** and Pre-etched Circuits	Harcon Brandywine, Md.

*This firm also manufactures "Silver Print" and a number of special-purpose tools for working with printed circuits.

**Copper-clad laminate and other supplies are also available as individual items from the firms supplying complete "kits."

Fig. 2. A "typical" board which illustrates the important points that you should remember in making up your own printed-circuit layout. It does not represent specific circuit.



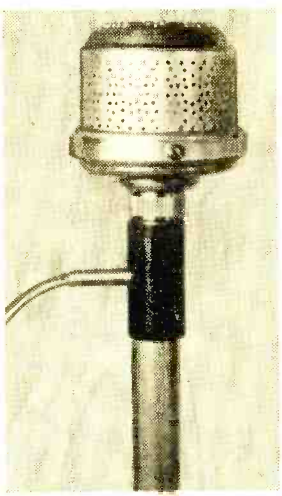
be cut from the standard width using an "Xacto" knife, a razor blade, scalpel, or similar tool. Small circles, for terminal connections, can be punched out with a small hand paper punch. The tape is simply applied to the copper foil to cover the traced layout pattern, then burnished down with a smooth, hard tool. A good burnishing tool can be made quite easily by rounding the end of a wooden dowel peg.

Double-check the circuit board after applying the resist. Compare it to the original layout. If you find you've made an error, correct it. Ink resist may be removed by using a hard (ink) eraser. Tape resist is simply peeled off. Reapply the resist to correct the error.

(To be continued next month)

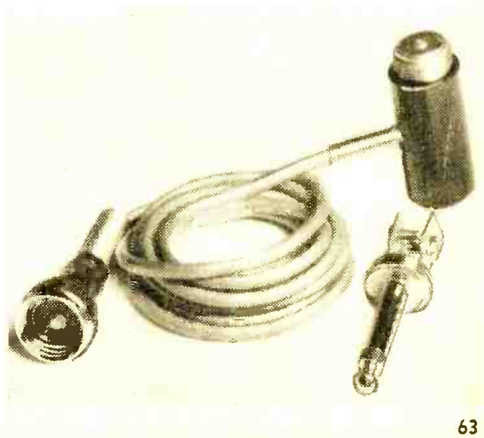
Microphone-to-Stand Adapter

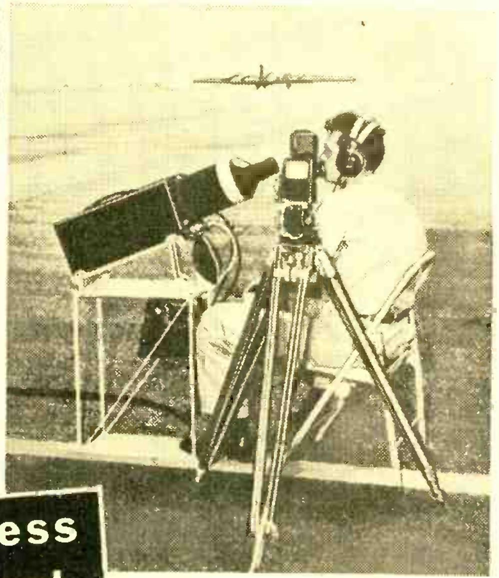
THIS MICROPHONE stand attachment does double duty—it connects a mike through the stand socket when mounted on a solid draw-rod, and it insulates the mike from the stand to reduce danger of shock. The body of the adapter is simply a Bakelite shell removed from a standard phone plug. Such shells have standard ⅝-27 threads on the large opening end, and ⅜"-diameter holes on the smaller end.



Drill a hole in one side of the Bakelite shell for a 1" length of curtain spring, or any other steel spring that will pass your mike cable. The spring should fit the hole snugly, since it serves as a cable protector. Now slip one end of your mike cable through the spring and into the Bakelite shell, slip a hex nut over the cable, and push the end of the cable up and out of the small opening in the end of the Bakelite shell. Then connect the end of the cable to an Amphenol 75-PC1M chassis unit in the usual manner, except that the shield of the cable should be soldered directly to the end of the threaded shank of the chassis unit.

Slip the chassis unit into the hole in the Bakelite shell, tighten the hex nut, and the adapter is complete. A standard Amphenol 75-MC1F female cable connector is used on the other end of the cable. The adapter will fit all American-made mike sockets (except RCA), and standard ⅝-27 desk and floor mike stands. —*Art Trauffer*





Vintage '39 Fortress Now Missile Target

Precision instruments, operated by highly skilled men, are used to land the QB-17 (upper left), as well as have it take off on new flight (upper right).

THE NOW-OBSOLETE "Flying Fortress" B-17 bomber, famous during World War II, is being used to help perfect tomorrow's supersonic guided missiles.

Guided from the ground completely by radio control, these erstwhile bombers, now designated as "QB-17's," are the largest remotely controlled planes in history and serve as targets for ground-to-air and air-to-air missiles.

In a typical mission, the pilotless planes, known as "drones," are launched from the ground with engines running. Signals from ground radio equipment activate the aircraft's controls. Soon the drone is far out to sea. Then, a missile is launched on a course leading to the bomber.

A camera in the drone's nose relays the action to the ground crew via a special television channel. Other equipment records the hit and damage data.

The missiles used in these tests are armed with small explosive charges instead of regular warheads. The charges are enough to cripple the drone. After a hit, the QB-17 plummets seaward, but the cameras and recording gear are parachuted slowly to the water in floatable wing pods. They are then picked up by crash boats. If the missile fails to find its mark, the drone is brought back and landed, also by radio control.

These drones are filling the need for large, bomber-type aircraft that can be tested accurately under fire without hazard to human life.

Computer Goes Aloft

CIRCUITS ARE CHECKED (at left) in the new airborne digital computer developed at North American Aviation, Los Angeles, Calif. Transistors have replaced vacuum tubes in this electronic brain, used for automatically and continuously processing in-flight data.

Etched from sheets of copper-clad plastic, the circuits are designed in the form of standardized panels—which can be pulled out of the equipment like file cards for testing or replacement.

Transistor Topics

By LOU GARNER

BACK AGAIN! This is getting to be a habit . . . a habit which I—and I hope you—like. These monthly visits, through the pages of your favorite magazine, POP'tronics, are becoming real fun . . . something to look forward to. And so far as *your* letters and postcards are concerned . . . every one is given a personal reading, not just glanced at and filed. Need I say more?

Most writers and editors have what they call a "tickler file" . . . notes of things they should remember, or should check on at a later date. With so much happening so fast in the transistor field, a monthly "tickler file" should be of value to every reader. For a start, here are two noteworthy items:

(1) Raytheon's new r.f. transistor, Type CK768. At only $1.50, it's a real buy.

(2) Lafayette's Transistor Brochure No. T4-56 (write to 100 Sixth Ave., New York 13, N. Y.). Free! The most complete offering of transistors and components cataloged anywhere.

Both of these items were mentioned in earlier columns. And from now on we'll try to remind you of special items of real interest each month . . . in a regular transistor *Tickler File*.

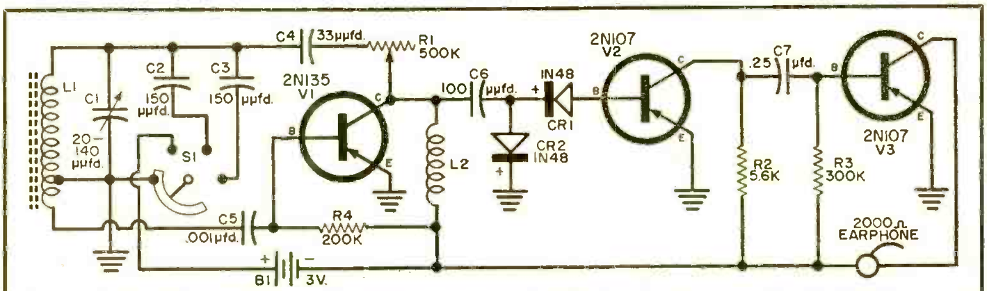
Reader's Circuit. There's only one circuit this month, and it's a lulu! Interest in receiver circuits continues at a high pitch, but there is an increasing shift from simple detector-amplifier arrangements to higher gain regenerative circuits. S. A. Sullivan, W6WXU, of 20565 Fifth E., Sonoma, Calif., sent in the regenerative receiver circuit shown below. He has assembled his model in a small plastic case, making it a "personal portable" receiver.

According to W6WXU, sensitivity is unusually good. He indicates that local stations (up to 30 miles distant) can be received with adequate volume *without an external antenna* . . . and that, at night, he has received clear-channel stations up to 600 miles away! Pretty good for a three-transistor set!

Referring to the schematic diagram, this receiver consists of a regenerative r.f. amplifier followed by a voltage-doubling diode detector (note that *two* crystal diodes are used), followed, in turn, by a two-stage resistance-coupled audio amplifier. Only *p-n-p* transistors are used, and the grounded-emitter configuration is employed in all three stages. The feedback necessary to regenerative action is obtained through *C4* and regeneration control *R1*. As *R1* is reduced in value, the circuit can be thrown into oscillation.

Tuning coil *L1* is a large ferrite core antenna coil (Lafayette No. MS-166). R.f. choke *L2* is determined experimentally from whatever chokes you may have in your junkbox . . . in Sullivan's model, *L2* consists of two TV peaking coils in series.

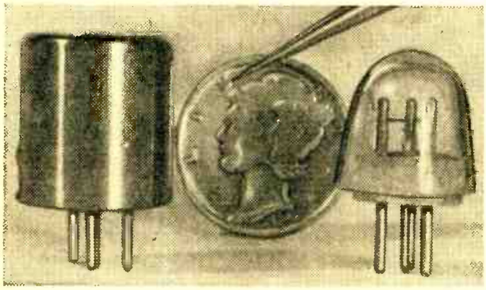
In order to keep his model compact, Sullivan used a compression-type mica trimmer capacitor for *C1*, switching in fixed capacitors *C2* and *C3* with subminiature switch *S1*, in order to cover the complete AM broadcast band. You could use the same arrangement if you want to duplicate his model, but you might prefer one



S. A. Sullivan's regenerative receiver circuit which is described above. Sensitivity of his model is so good that he can receive local stations without an external antenna.

of the new miniature tuning capacitors recently introduced by Lafayette Radio (100 Sixth Ave., New York 13, N. Y.). Two types are available . . . their numbers are MS-274 and MS-215. Use of either in place of *C1* should eliminate the need for *S1* and *C2* and *C3*.

The battery consists of two penlite cells in series to provide three volts. It is controlled by *S1*. If this switch is eliminated by employing a larger variable capacitor in place of *C1* (as suggested above), a small s.p.s.t. slide switch may be used to turn the power supply on and off.



Experimental high-frequency transistors developed by Bell Telephone Laboratories operate up to 500 or 600 mc. Note size in comparison with a dime.

This receiver is operated in much the same manner that any regenerative set is used, whether vacuum-tube or transistor operated. The regeneration control is adjusted just below the point of oscillation for maximum gain. On strong local stations, very little regeneration should be needed.

Tech Talk. Many readers have written to ask about the use of transistors at *very-high* and *ultra-high* frequencies (v.h.f. and u.h.f.) . . . and their possible application in such equipment as television receivers and FM sets. Here's the scoop . . .

The major factor controlling the use of transistors at high frequencies is their *alpha cutoff frequency*. This is the frequency at which their gain, in the common-base configuration, is approximately 70% of their gain at low frequencies. Most transistors can be used as *oscillators* at frequencies far *above* their nominal cutoff frequencies, but must be used *below* their cutoff frequencies in *amplifier* applications.

A typical example is a transistor having an alpha cutoff frequency of, say, 1 megacycle. This unit *would not* make a very good i.f. amplifier at 455 kc., but could probably be used as an oscillator up to 1.5 or even 2 mc.

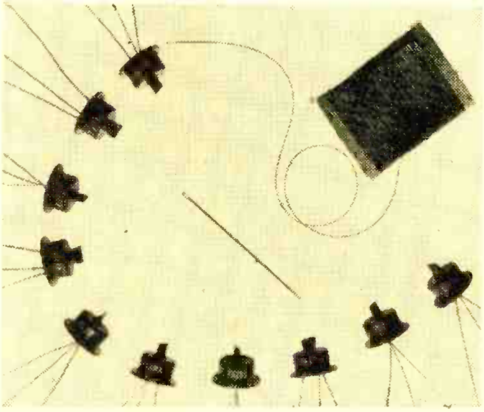
High-frequency transistors have been built! The above photograph shows a unit developed by Bell Telephone Laboratories which can be used at frequencies up to 500 or 600 mc. Motorola has developed units operating up to 1000 mc. Unfortunately, such transistors have been produced in small laboratory quantities only and *are not available* on an "across-the-counter" basis.

As far as available transistors are concerned, Raytheon has *p-n-p* junction triodes with cutoff frequencies up to 20 mc. (Type CK762/2N114), CBS-Hytron has *n-p-n* triodes with cutoff frequencies up to 20 mc. (Type 2N184), and G.E. has recently introduced a 50-mc. *tetrode*. The highest frequency unit presently available on an "across-the-counter" basis with which your columnist is familiar is Germanium Products' Type 3N23C tetrode . . . nominally rated at 60-80 mc., some of these can be selected for operation as oscillators up to 100 mc. As far as triodes are concerned, Philco's SB-100 series of *surface barrier* transistors, rated at 50 mc., are probably the highest frequency units available to the average experimenter.

"In the works" . . . probably for official release later this year . . . are a 110-120 mc. tetrode and a 150-mc. triode transistor. The triode is a "field effect" or "drift" transistor . . . a unit which depends on fairly high voltages for operation.

Unfortunately for the average experimenter, prices on these high-frequency units are relatively high . . . due primarily to the fact that they are in limited production. Prices range from about $10.00 to about $50.00 *each* in small quantities. Many are available direct from the manufacturer only and are not handled by distributors.

Transistor Transformers. Not all transistor transformers are small! On the next page is a photo which shows the range of



Ten new "power output" and "driver" transistors were recently announced by General Electric Company. In the above photograph, their relative size is shown by the needle and spool of thread.

sizes you can encounter if you do much work with transistor circuits. The small transformer, to which the pencil is pointing, is one of Chicago Standard's UM series, designed for hearing-aid and subminiature radio applications. The larger transformer, about the same size as audio output transformers used in moderate-sized p.a. systems, is a unit designed for use with "high-power" transistors such as Sylvania's Types 2N68 and 2N95 . . . it is available from Lafayette Radio, 100 Sixth Ave., New York 13, N. Y.

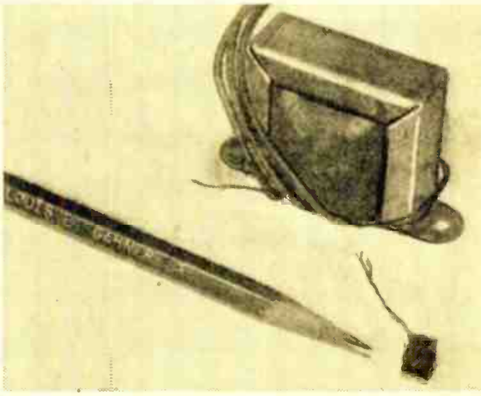
Product News. G.E. has announced ten new inexpensive transistors, designed for use in both high-fidelity amplifiers and broadcast-band receivers. All ten units are *p-n-p* germanium transistors: six are "power output" types, four are "driver" units. The power types have a collector dissipation rating of 180 milliwatts with a pair—in Class B push-pull—supplying up to 750 milliwatts output (¾'s of a watt!) at less than 5% distortion.

Your columnist was recently given the opportunity of examining and testing a transistor radio kit offered by the Superex Electronics Corporation, 4-6 Radford Place, Yonkers, New York. The receiver assembled with the kit uses a diode detector and transistor amplifier, and has about the same gain and selectivity as the usual set employing this type of circuit. But the set has two interesting features. It is designed so that it can be assembled with a *screwdriver only*—no soldering iron is needed! And although it is a low-cost kit and uses an adjustable iron "slug" for tuning, it features a rather unique *slide rule dial.*

The Goldak Company, 1544 West Glenoaks Blvd., Glendale 1, Calif., familiar to POP'tronics readers as a manufacturer of metal detectors and other prospecting instruments, has announced the first in a planned series of transistorized products. Called "Plane-Talk," the new device is a transistorized intercom designed for instructor-student use in light aircraft.

Experimenters will welcome the new *n-p-n* transistor just introduced by G.E. The first low-cost *n-p-n* unit to be offered by a major manufacturer, the 2N170 has a frequency cutoff of 4 mc. Full details are given in a small folder available through all G.E. tube distributors.

Regency, one of the first manufacturers of transistorized "personal portable" receivers, is offering a fully transistorized *amtaeur band converter.* Featuring a surface barrier transistor, the instrument covers the 80, 40, 20, 15 and 10 meter bands. Sensitivity is 5 to 10 microvolts for 6-db signal-to-noise ratio. Features include a drum-type slide rule dial, with only the band in use actually visible, and operation on its own self-contained power supply, consisting of three penlite cells . . . battery life approaches normal "shelf life." Only two connections are needed to install the unit . . . one to an antenna and one to



If you do much work with transistor circuits, you are likely to encounter units as small as the miniature transformer to which the pencil is pointing, or as large as the unit shown in the background.

a broadcast-band receiver. Output frequency is about 1200 kc.

You can add another transistor tester to those described in last month's column. EMC (Electronic Measurement Corporation) is producing a simple *transistor checker* in both "kit" and "assembled" form . . . selling for $7.95 and $10.95, respectively.

On the components front, Thordarson-Meissner offers a whole line of transistor coils and transformers, covering both audio and r.f. applications. The line includes 36 audio transformers, 10 i.f. transformers, 7 antenna coils, 5 oscillator coils, and a miniature tuning capacitor.

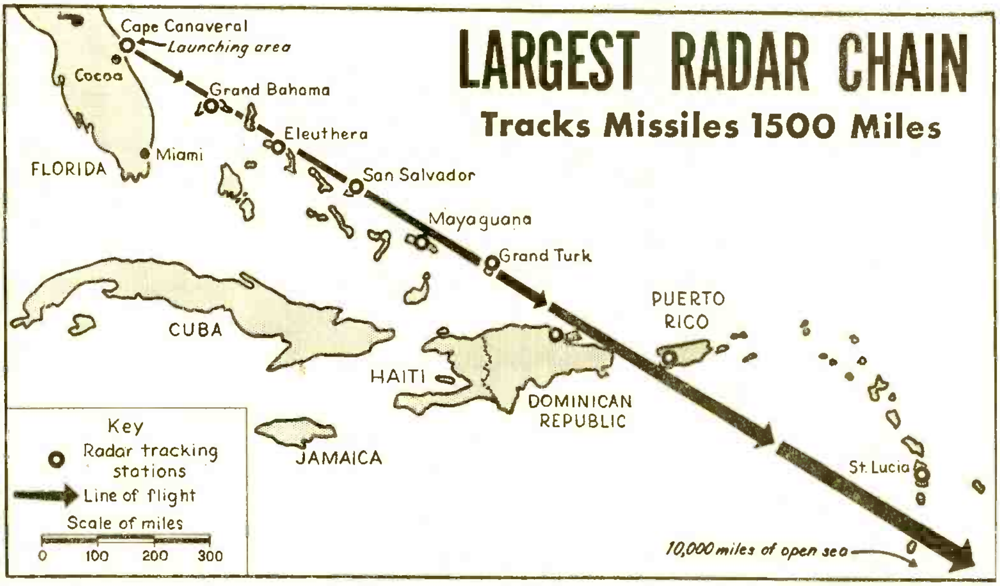
Things to Come. Higher frequency transistors are on the way—watch for 100-mc. tetrodes, 150-mc. "drift" transistors, medium-frequency "power" transistors. . . . Several transistor manufacturers, aware of Sylvania's success with its "kit," have special-purpose transistor "kits" in the works—for the experimenter, this will mean a price break over purchasing the transistors individually, plus valuable circuit information. . . . There are rumors of a portable TV receiver in which four transistors are used in place of tubes—rest of the set uses tubes, however. . . . Several transistorized and "hybrid" (part tube, part transistor) auto receivers are expected to be announced this fall. . . . Watch for a transistorized superhet receiver in a forthcoming issue of POP'tronics!

That's the "show" for now, fellows. See you next month.

Lou

LARGEST RADAR CHAIN

Tracks Missiles 1500 Miles



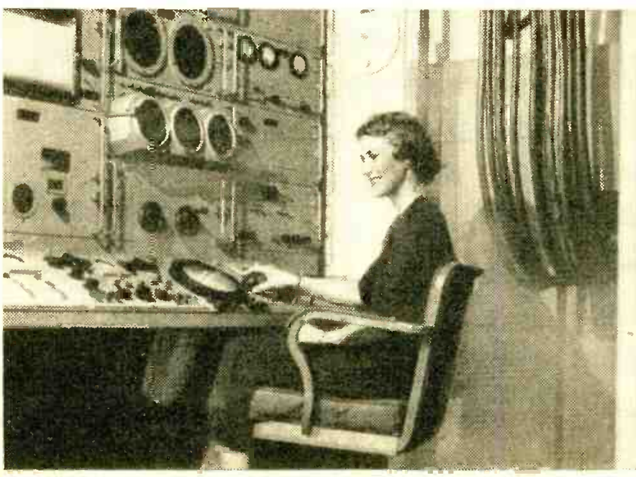
THE WORLD'S LARGEST chain radar tracking system, capable of checking the flights of supersonic rockets and missiles over the full length of the U.S. Air Force Air Research and Development Command's Florida Guided Missile Range, has been announced by Reeves Instrument Corporation, subsidiary of Dynamics Corporation of America.

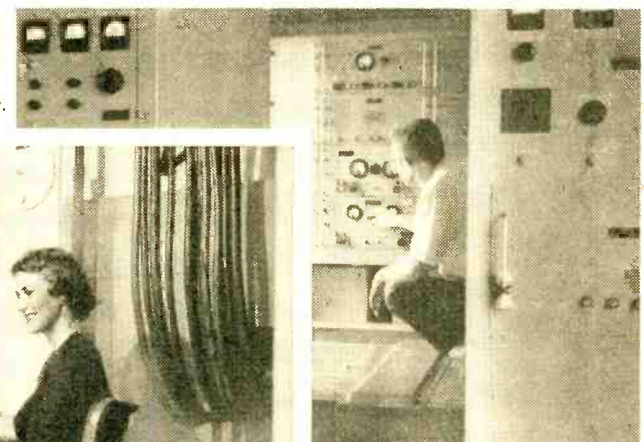
Built at a cost of some $10,000,000, this chain of 21 gigantic radar installations extends from the Florida coast across eight islands to the South Atlantic to provide long-range continuous tracking.

The new system can record and report back to the Flight Control Test Center in the launching area on the missile being tested to an accuracy within .002°. Radars "lock" on the missile the instant it is fired and track its position, course, velocity, and accelerations until the missile hits its target or is, itself, destroyed.

Data from these radars is of vital use to the In-Flight Range Safety Officer who is entrusted with the responsibility of insuring that life and property are not endangered by the missiles being tested. Because of the high precision of the data available through these radars, the Test Range has been completely accident-free. —30—

One operator can handle each unit. Systems are designed to respond at once to push-button control. Once radar "locks" on missile, operation goes on automatically.





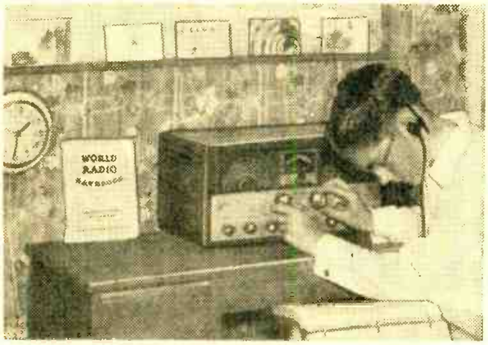
Technician (above) checks part of vast array of equipment that comprises radar system. Each installation weighs five tons, consists of thousands of electronic units.

Tuning the Short-Wave Bands

with Hank Bennett

OUR "POP'tronics short-wave reporter" this month is Gordon Nelson, of 1019 South Fir Ave., Inglewood, Calif. A student at Inglewood High School, Gordon is 14 years old and an avid DX'er on the West Coast.

He is a fairly recent newcomer to the s.w. ranks, having started his DX'ing in early 1955 with a Hallicrafters S-38B receiver. In February of this year, he "graduated" to an SX-99 and is very satisfied with its performance. He uses no other equipment, although he does own a Patterson preselector. To bring signals from faraway places into his shack, he employs three 60′ long-wire antennas.



Gordon Nelson is shown with his SX-99 receiver.

> If anyone is interested in participating in the British Broadcasting Corporation's Audience Research, he should write to the BBC, Overseas Audience Research, 630 Fifth Avenue, New York 20, N. Y.

Gordon has 52 verifications from such stations as *R. Sarawak*, *R. Omroep* (New Guinea), *R. Nigeria*, ELWA (Monrovia, Liberia), and the Windward Islands. In addition to these stations, he lists the following as being among his best DX catches: *Radio Baghdad*; Djeddah, Saudi Arabia; *R. Abidjan; R. Hong Kong;* and *R. Sabah* (Jesselton, British North Borneo). His favorite DX band is 31 meters, and *R. Australia* is his favorite s.w. station (for their excellent DX program), but Gordon is also a fairly steady monitor for *R. Tahiti* at Papeete—their consistently strong signal and programs of Tahitian music command his attention. He adds that he DX'es for the short-wave broadcast stations only—no hams . . . yet.

The photographer for his school, Gordon has had a number of his photographs appear in newspapers in the Los Angeles area. Besides radio, he is interested in anything along scientific lines, especially physics. A member of the International Short Wave League, he sends reports to the League with regularity. He enjoys reading POPULAR ELECTRONICS and thinks that our column is excellent. To which we add, "Thank you!"

Club Notes

The recent Annual Dinner of the Newark News Radio Club, which was held at the Far Hills Inn, Somerville, N. J., was the usual success. Your Editor was especially pleased to meet Lou Marcarelli (our featured DX'er in the May issue). James Hart, of Irvington, N. J., was the recipient of the Peter J. McKenna Memorial Award.

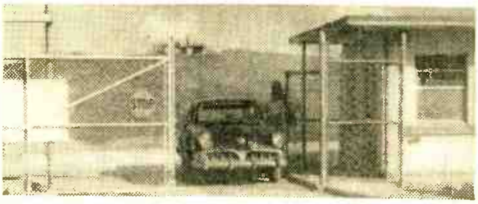
Phil Finkle, Burbank, Calif., has succeeded David Morgan as Western Editor of the Universal Radio DX Club's s.w. section. Mr. Morgan is currently enjoying a stay in Europe.

(*Continued on page* 116)


Eric Bristow, Paris, Ill., at his listening post.

Fish Need Sunlight to Find Way

CAREFULLY lowering a photoelectric cell into Lake Michigan is University of Wisconsin scientist Arthur D. Hasler. Voltages generated by the light intensity beneath the lake's surface have led Dr. Hasler to believe that fish use the sun as a navigational aid. If proven correct, this information will further support the evidence that birds, bees and ants all use the sun to direct their travels. Results of Dr. Hasler's work were recently presented to a group of scientists attending a symposium on marine biology which was held at the Scripps Institute of Oceanography in La Jolla, Calif.



TV Guards the Gate

VISITORS to the Ninemile Point generating plant of the Louisiana Power & Light Co., Inc., just above New Orleans, are stopped at the outer gate and closely examined by a TV camera. Part of a closed-circuit system (see POP'tronics, July, 1956, page 67), the receiving end is mounted near a secretarial desk. Picking up a microphone, the secretary can talk to the visitor through an intercom system. Unless the visitor can state his business and be immediately identified, he is not permitted entry to the generating plant. On holidays, when the office is empty, a second TV receiver is put into operation; this receiver is operated by the main control board personnel of this 319,000-kilowatt station.

Poly Bags Hold Valuable Parts

DOUGLAS Aircraft Co., Inc., has introduced the use of polyethylene bags to store miniature radio subassemblies. These bags were developed by the Polyfab Company, Los Angeles, Calif., and are fitted with a self-locking pressure closure. Edges of the closure are easily pried open and can be relocked again and again. Once locked, a bag is sealed from the effects of moisture, oxidation and dirt. Use of the transparent plastic, which makes contents clearly visible, also facilitates sorting and inventories. Various sizes and shapes are utilized for different parts, and the bags are also made in multiple-pouch form to prevent contact between parts.

Bass Reflex, Jr.

By FRANK H. TOOKER

Small enclosure sounds swell, costs little to build, and uses a "secret tunnel" for better bass response

YOU MAY NOT see the "port" on this bass reflex enclosure, but you certainly can hear it! Hidden under the bottom panel and opening into a wooden tunnel within the enclosure, the all-important cutout for bass notes is neatly tucked out of sight. The result is good bass in a little space. You can build this "Bass Reflex, Junior" (BR, Jr.) with hand tools and use any of several low-priced 12" speakers in it for some fine listening.

The design is based on an idea contained in the article on bass reflex enclosures published in a recent issue of POPULAR ELECTRONICS ("Resonators—Large and Small," March, 1956). Essentially, it involves reducing the over-all dimensions of the enclosure by adding a duct, or interior tunnel for bass notes, directly behind the port.

In the BR, Jr., the port is cut out of the bottom panel. The duct is positioned vertically, right over the port, and the panel is raised off the floor. The critical duct length, plus the air space between the port opening and the floor, combine to enhance the speaker's bass response and provide good acoustical loading at low frequencies. Details on how this is done are given in the "How It Works" box on page 74.

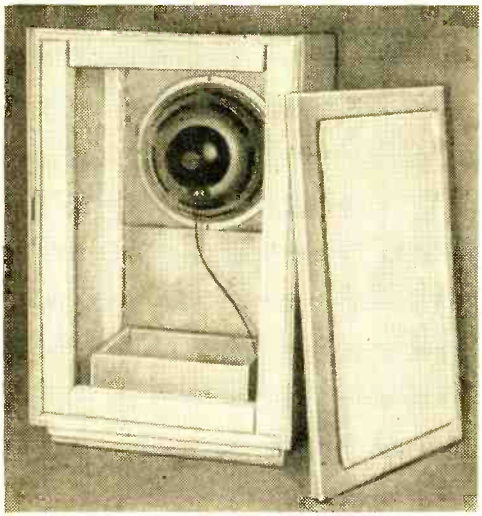
Making the Sides and Duct. Cut the six sides from ¾" plywood. Along the long edges of the left and right side panels, and along the long edges of the top and bottom panels, fit the lengths of 2" x 2" pine. As shown in the photo, each "two-by-two" must be set back from the edge of the plywood by exactly ¾", and centered lengthwise to allow room on either end for the pieces that will butt up against it. These "two-by-twos" act as glue blocks and supports for all adjoining plywood panels. *Note*: the phrase "two-by-two" refers to pieces that are actually 1¾" by 1¾" after planing.

Construct the duct, using the ½" plywood. Cut out the required port opening on the bottom panel, and mount the duct over this opening. A safe method would be to nail a 1" by 1" strip of pine to each side of the duct, around one end. Then glue and screw the entire assembly over the port so that it forms a tunnel which enters the enclosure.

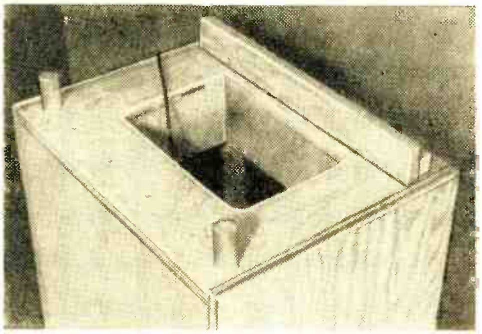
Speaker Cutout. The cutout on the front panel was made octagonal because it was easier to fashion than the conventional round opening. Either type of cutout works equally well, of course. To make the octagonal cutout, bore eight holes at 45° intervals, using a 1" auger bit fitted into a carpenter's brace. Then cut from hole to hole with a compass or keyhole saw.

To prevent the panel from splitting, back it up with a heavier piece during the drilling, or else bore in halfway from one side and then halfway from the other side. When finished, the cutout should measure 10½" between any pair of opposite corners.

Assembling the BR, Jr. Once all panels are cut and planed, and the "two-by-twos"



Two views of the BR, Jr. clarify details of its construction. At left is the completed enclosure with the back removed. Note how the "one-by-one" strips are used for securing proper fit of all panels. Speaker leads trail through duct and emerge under the box's raised bottom. Below, details of underside showing two legs and back panel piece.



have been fitted as required, final assembly is fairly simple.

Remember to "glue and screw" all joinings of all panels—except the back panel. This must be left removable to permit access to the speaker. Therefore, do not glue the back panel—but *screw* it on as snugly as possible.

One way to assure perfect fits of all panels is to check each stage of the construction with a carpenter's square. A trick, often used by professional cabinet makers, is to put the rear panel in place without screwing it. Fit everything else around the snugness of the back panel. To prevent glue from running onto the rear panel during this stage, insert a single thickness of household wax-paper between the panel's four edges and its adjacent panels.

When all other panels have been glued and screwed in place, remove the rear panel. Do not replace it until the next steps are completed.

Acoustic Insulation. The interior padding for the BR, Jr. consists of a layer of heavy undercarpet felt (ozite) plus a layer of ½" thick "extra-fine" fiberglass wool. Fasten the fiberglass to the Ozite with long, loose stitches of heavy thread. Then, cement the felt side to the inner surfaces of the enclosure, using underfelt paste—the kind that's used to cement felt to floors.

Allow this paste to dry 24 hours before installing the speaker. As shown in the photo, the acoustic padding is applied to all interior surfaces except the bottom panel and its duct.

Legs and Back Reflector. The BR, Jr., is raised off the floor by two simple legs at the front, and a strip of plywood at the rear. The legs are made of 1"-diameter round dowels. To fit them to the underside of the bottom panel, first make two holes in this panel with the 1"-diameter auger bit. Locate the holes accurately and bore to a depth of about two inches. This depth should engage the previously attached "two-by-two."

Next, drive a length of dowel as far as it will go into the hole. Cut off the dowel, squarely and accurately, two inches beyond the bottom panel. If the legs do not fit tightly, insert them with a coating of glue.

As shown in the photo, the back plywood strip is first secured to a bracing strip ("one-by-one"). The assembly is then fastened to the bottom panel.

Finishing Touches. While the acoustical felt paste is drying, you can finish the exterior of the cabinet in any desired way. The front panel can be dressed up with a covering of grille cloth. Staple or tack the

Bill of Materials

PLYWOOD

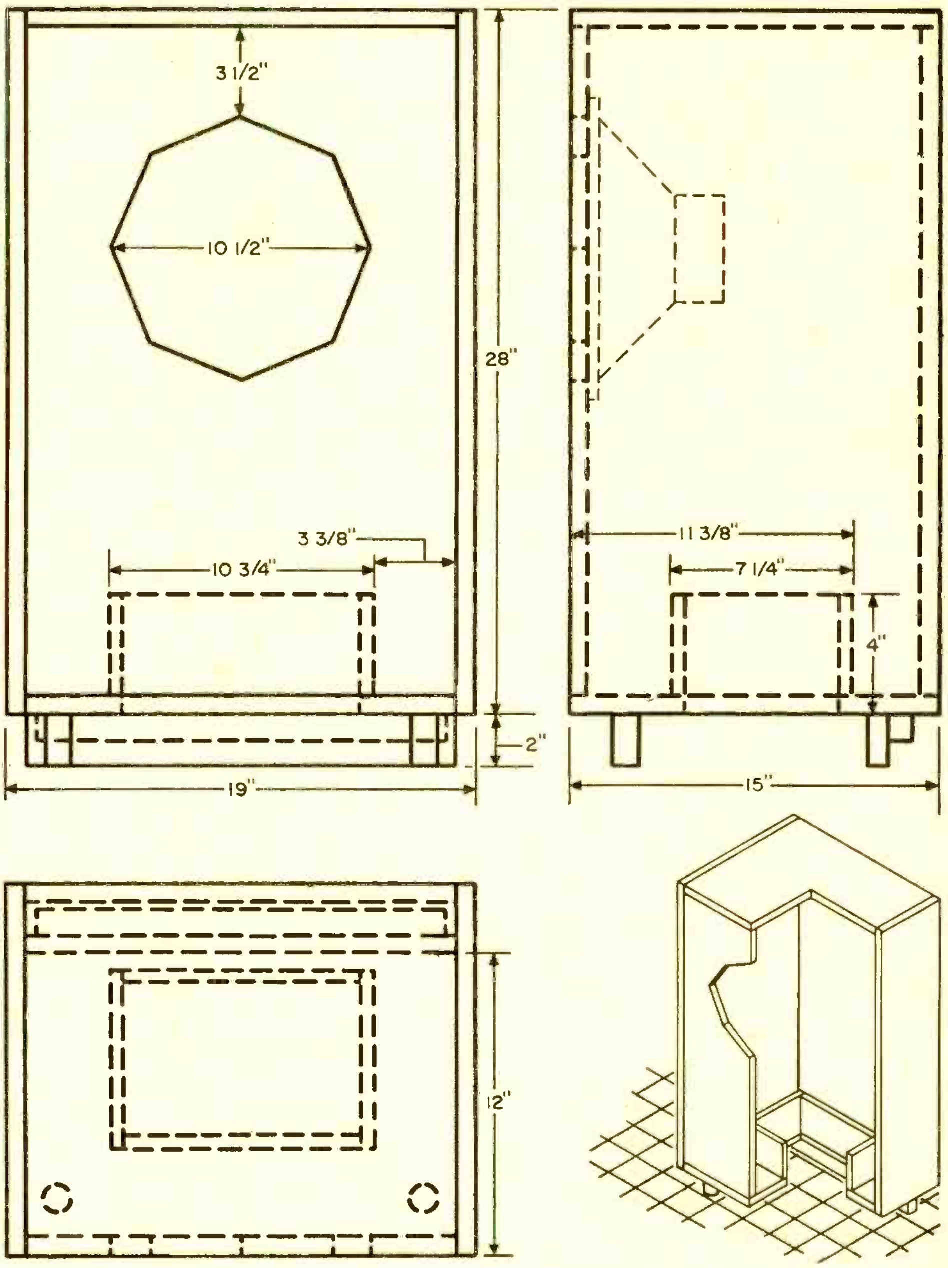
2—17½" x 26½" x ¾" pieces
2—17½" x 15" x ¾" pieces
2—15" x 28" x ¾" pieces
1—2" x 17½" x ¾" piece
2—10¾" x 4" x ½" pieces
2—8¼" x 4" x ½" pieces

WHITE PINE

4—2" x 2" x 26½" pieces
4—2" x 2" x 13½" pieces
1—1" x 1" x 17" piece
2—1" x 1" x 10" pieces
2—1" x 1" x 6" pieces
1—1-foot, 1"-dia. dowel

HARDWARE, ETC.

1—Box of No. 9, 2" wood screws
1—Box of 1½" finishing nails
8—1" wood screws
1—Spool of carpet thread
1—Quart of underfelt paste
Wood glue
Undercarpet felt, ⅜" thick (Ozite or equal)
Glass wool insulation, ½" thick



Resonant Frequency (cps)	Duct Length (inches)
80	2
75	4
70	6
65	10
60	14

Construction data for building the BR, Jr. One-by-one bracing strips are omitted for sake of clarity, but their positions and use are shown in photos on opposite page. Lower right-hand drawing is cutaway view showing how duct extends into interior of cabinet, and how cabinet is raised off floor to provide correct total duct length. Chart at left lists correct total duct lengths to use with speakers of different resonant frequencies. Lengths shown include the two inches gained by raising box off floor. Thus, in dimensional drawings, above, the resonance indicated is 70 cps; the 6" duct length is obtained by 4" of tunnel plus a 2" space to floor.

cloth's edges into the plywood edges. Then cover the edges with strips of decorative wood molding to provide a really professional touch.

Paste dried and finishing accomplished, you can now install the speaker. Mount it on the inside of the front panel, using 1" wood screws. These are long enough to hold the speaker securely without breaking through the front of the panel. Tighten the screws enough to hold the speaker fast, but not so much that the speaker frame will become warped.

Run the voice-coil leads through the duct and out of the bottom of the enclosure. Now replace the back panel. Do not use glue, but screw it firmly to the "two-by-twos" along all four edges. The BR, Jr. is now ready for use.

Which Speaker to Use? The BR, Jr., built to dimensions given here, was designed to house a particular speaker the author owned and wanted to use. It happens to be the General Electric S1201D. This is a single-cone unit with a response from 50 to 13,000 cps, and a resonant frequency of 70 cps. Net price is about $20.

This speaker, however, is not the only type available with similar characteristics at a similar price. Other likely candidates for this project are made by such companies as Electro-Voice, Jensen, Oxford, Quam, RCA, University, Utah, and others. A visit to your local parts jobber, or a study of an audio catalog, can turn up any number of similar speakers.

The important thing to remember here is the resonant frequency of the speaker used. This resonance must be matched by the enclosure's own resonance if decent bass response is expected. When both resonances are matched, the enclosure is said to be "tuned" to the speaker. Then, the speaker's bass peak is pulled down and broadened. This action eliminates the one-note bass-boom effect and actually extends bass response below resonance.

When the enclosure is not tuned correctly to the speaker in it, the resultant mismatch can cause boom, distortion, and loss of bass notes. This principle applies to any bass reflex enclosure. The BR, Jr. is no exception.

For Best Sound. This is all by way of pointing out that a speaker whose resonant frequency is much higher or lower than 70 cps would not sound its best in this enclosure. The present duct is six inches in length—from floor to top of the tunnel. At this length, in this size of enclosure, the enclosed air will resonate at about 70 cps. To use a speaker with a higher resonant frequency, you must shorten the duct. To use a speaker with a lower resonance, you must lengthen the duct.

The chart on page 73 shows total duct lengths for different resonant frequencies most often encountered in modestly priced speakers. Note that the duct length increases very rapidly for only small decreases in resonance. Consequently, a speaker whose resonance is much below 60 cycles would be wasted in the BR, Jr. To resonate at 55 cycles, the duct would have to be 26" long. In a cabinet whose total height is only 28", such a duct would be utterly impossible for purely physical reasons.

In other words, a speaker with a lower resonant frequency actually requires a larger enclosure. As is the case with most hi-fi "short-cuts" or scaled-down versions of larger units, the BR, Jr. is no substitute for the very deep bass possible with a high-quality speaker in a full-sized enclosure. But if you want to use a low-priced speaker, whose resonance is somewhere between 60 and 80 cps, the BR, Jr. will provide "near-senior" performance with it. —30—

HOW IT WORKS

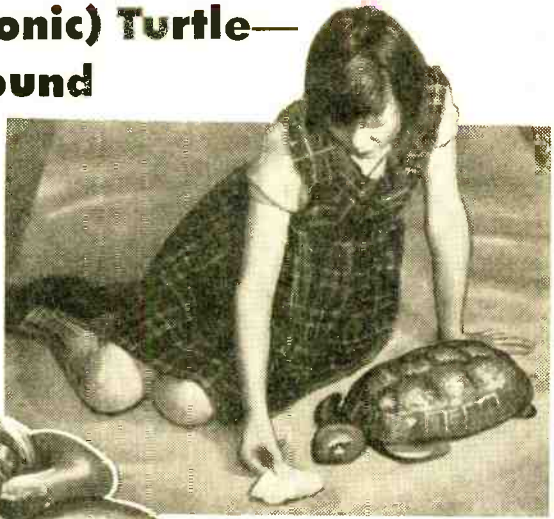
The conventional bass reflex enclosure for a 12" speaker requires an internal volume, or "air cavity," of about 10,000 cubic inches (6 cubic feet). An auxiliary opening below the speaker cutout (the "port") permits the cavity to be "tuned" to the speaker mounted within it. This means that the cavity's own resonance will match that of the speaker's. The resonant point is, of necessity, a bass frequency. When both cavity and speaker so resonate, their respective peaks buck each other. As a result, the over-all response is "pulled down" from a sharp peak, and broadened. This action (lowering the Q of the speaker system) reduces "one-note" bass, and boom effects. It permits the speaker to respond to bass notes well below its resonant frequency.

At the same time, the port provides a passageway for the resonating cavity to release its sound energy. Stimulated by the speaker's back wave, the cavity energy emerges from the port in phase with the speaker's front wave. Thus the bass notes are not only smoothed and extended, but actually reinforced in strength by the port action. A similar effect can be obtained using a smaller enclosure (smaller air cavity) if a duct, or tunnel, is added directly behind the port. The cavity of the enclosure combines with the air confined to the duct to provide optimum loading on the speaker cone.

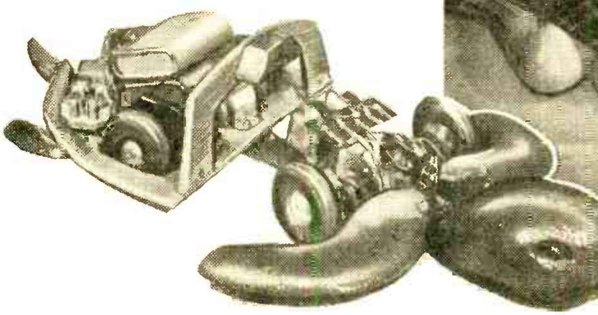
In the BR, Jr., total duct length is obtained by the interior tunnel plus the space provided by raising the box off the floor. The area thus created is backed by a panel which holds the enclosure upright and—at the same time—acts as a critical part of the total duct. A 12" speaker was planned for use in this system. Consequently, a duct was needed whose cross-sectional area came to 78 inches. Such a duct —of the length used here—placed in a cavity of 5000 cubic inches (the interior volume of the BR, Jr.) produces resonance at about 70 cps.

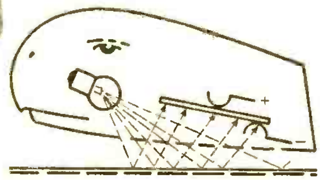
As shown in the chart on page 73, speakers whose resonant frequencies vary from 60 to 80 cps may also be used in the BR, Jr. with small changes in duct length. These changes are feasible within the over-all dimensions. Resonant frequencies beyond the 60 to 80 cycle limits could not be obtained because the length of the duct increases rapidly for only small decreases in cavity volume, as well as in resonant frequencies required. Similarly, speakers other than 12" units are not recommended for use in the BR, Jr.

Myrtle—the (Electronic) Turtle—Knows Its Way Around



MYRTLE is the second turtle at the Hildebrand household in Berlin. Her predecessor was a flesh-and-blood model who, after a winter's hibernation, never woke up again. To soothe his children's grief, Herr Hildebrand, by electronic experiments, begat Myrtle II, who never hibernates and whose life is renewable with fresh batteries.





Reflected light from paper "lettuce" laid out on floor acts on selenium photocell to guide Myrtle in her explorations. An outgoing personality, Myrtle sometimes sheds her hard shell (left) to show what makes her tick.

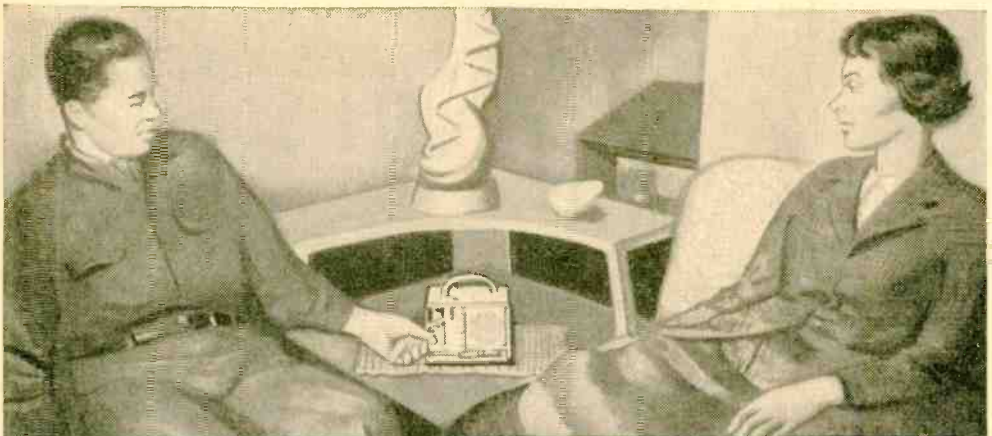
Myrtle's tail literally "switches" and turns on a motor and brake system governed by the action of a photocell. She goes after paper "lettuce," which reflects her "headlight" against the cell. If the paper is arranged in a strip, Myrtle waddles down the line in a searching zigzag, swinging head and shoulders sagely from side to side. Every time she walks off the paper path, her electronic eye—blinded by the darker surface—pulls the front-wheel brake on the opposite side. Result: head and shoulders swing back on the track. As soon as the light track is "seen" again, transistors and relays release the brake, and Myrtle rolls off the track on the other side. The process then repeats itself in reverse until, in this halting seesaw gait, Myrtle finally reaches her goal.

For this kind of rock-and-roll locomotion, one naturally needs a swivel-jointed hip. Myrtle has just that. But since that lively joint is normally hidden beneath her shell, no proprieties are compromised.

Print-Out Voltmeter Keeps Triple Record

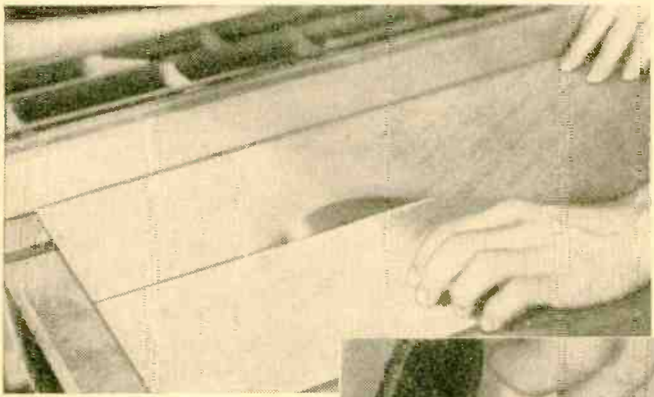
A VOLTMETER produced for Hycon Electronics, Inc., of Pasadena, Calif., prints a permanent record of measured voltages on adding machine tape. Any variation in line voltage or resistance is permanently noted down. Uses of the new print-out system are virtually endless. Principal applications are seen in the fields of temperature and pressure controls, liquid level recording, preservation of telemetered information from airborne sources, and control of chemical processes.

The print-out device, looking like an ordinary adding machine, sits astride the digital counter shown in the accompanying photograph.

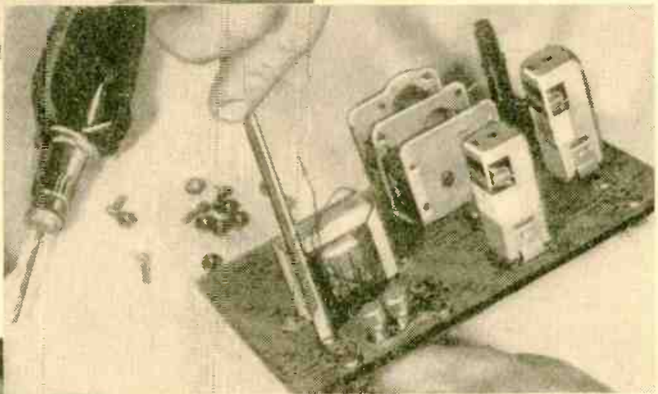


Building a "See-Thru" Radio

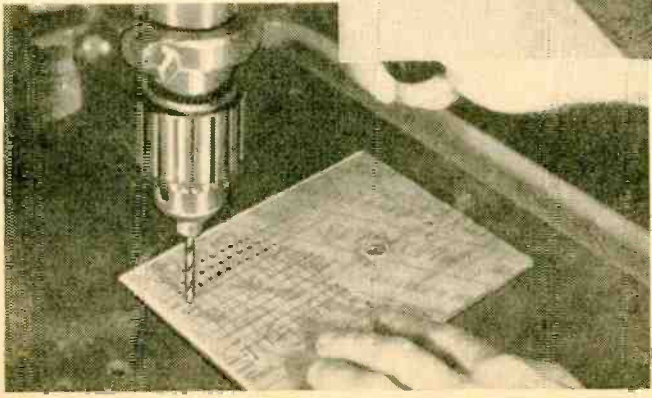
By
PHIL McCAFFERTY



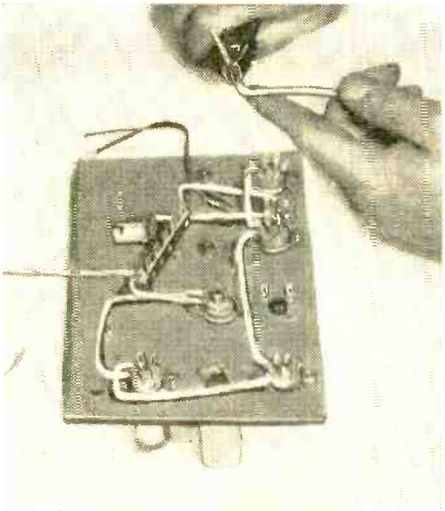
Lay out case parts on paper covering of plastic sheet (left). A sheet of 1/8"-thick Lucite or Plexiglass 12 1/2" x 18" is ample for building a 5" x 7" x 5" case—which is big enough to house a five-tube superhet radio. Cut parts to size and groove the edges of the mating parts.



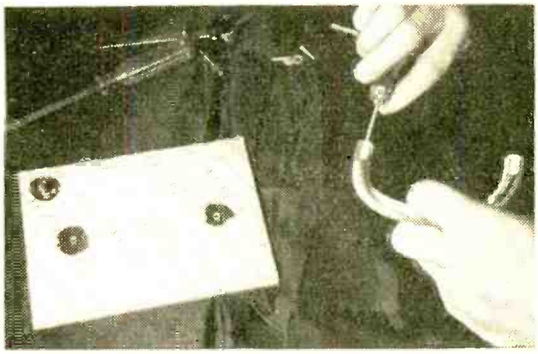
Find logical position for the components on the plastic chassis, then drill holes and mount the parts (see photo at right). Leave the paper on the plastic until wiring is done. When wiring, note that the wires which go to the chassis in normal construction should all be connected together to form a common ground.



Locate speaker on the case front, and also the tuning capacitor drive and volume control potentiometer. Drill rows of 1/8" holes to form speaker grille (left). Model follows design of a.c.-d.c. superhet with all miniature tubes found in the RCA Receiving Tube Manual. When set is finally turned on, light from the tubes and pilot give whole case a warm glow.



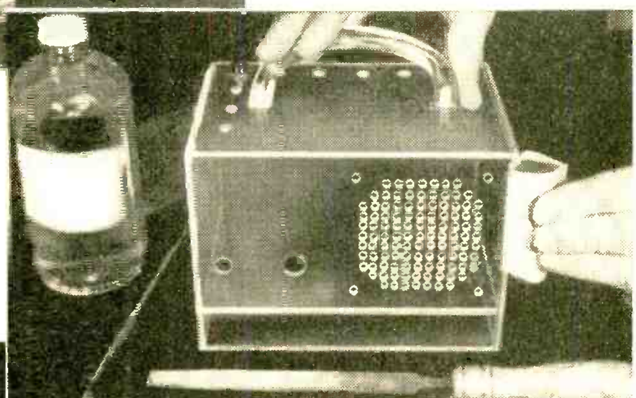
Wire up the components (left). Start with the filament wiring and power supply. Keep the wiring neat—it will be seen. Heat a suitable portion of a 1'-long, $\frac{1}{2}$"-diameter clear plastic rod until it becomes pliable (about 10 minutes in an oven set at 300°), then bend softened rod into a handle and let it cool.

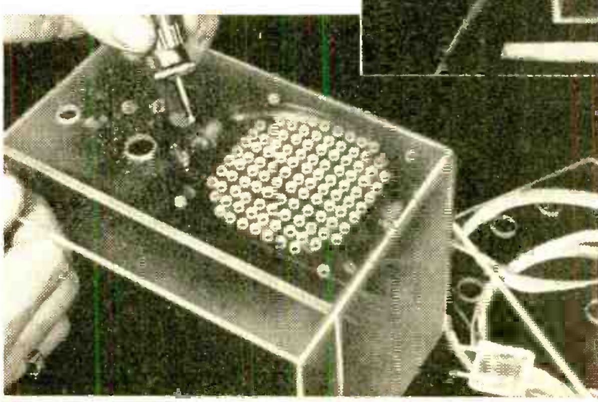


Drill holes in case cover, then drill and tap holes in handle for mounting with small cap screws (above). Mount a socket on top of case for extra antenna if you intend to use one. Drill holes for ventilation where necessary.

Check to make sure that the parts will fit before gluing (left). Now is the time to remove the paper from the plastic parts. If the plastic becomes dirty as you work, it can be quickly cleaned with a little alcohol.

Glue parts of case together with plastic cement (right). Both plastic and cement are available at hobby shops. Round the edges smooth with sandpaper backed up with a pliable sponge, then polish sanded surfaces by hand or with buffing wheel. Use a fine abrasive such as jeweler's rouge; toothpowder made into a paste with water works well.





Cut the dial markings into the front of the case. Knobs are made from ends of plastic rod; dial pointer can be made from a scrap of plastic. Note how the chassis slides into the grooves —for removal if servicing is needed. Back of case is secured with screws threaded into short rod ends. And your "see-thru" radio is complete . . . even to the transparent power cord which consists of 300-ohm TV lead.

THE TRANSMITTING TOWER

Herb S. Brier, W9EGQ

BESIDES GRANTING the privilege of operating an amateur station, the possession of an amateur license imposes a few obligations, too. Among them is the obligation to operate within the authorized frequency bands and not to interfere unnecessarily with other services.

No conscientious amateur does either intentionally. Unfortunately, good intentions alone are not enough. When signals from distances up to 1000 miles or so are strong on the 7000 to 7300 kc. band, listen between 7300 and 8000 kc., concentrating on the 7400 to 7500 kc. region. The number of amateur signals you will hear may almost make you believe that the FCC has authorized a new amateur band.

Actually, these signals are the second harmonics generated in transmitters operating in the 3500 to 4000 kc. band. You could also hear them down to 7000 kc. if it were possible to tell a harmonic from a fundamental signal in this region. Second harmonics of 1800 to 2000 kc. phone signals are frequently heard in the 3500-kc. band, too.

More rarely, third harmonics of 3500-kc. signals may be heard between 10,500 and 12,000 kc., and second harmonics of 7000-kc. signals may be heard in the 14,000-kc. region. Furthermore, you can probably hear harmonics from your own transmitter in your receiver to as high a frequency as the receiver will tune, with the higher harmonics gradually getting weaker.

That you can hear harmonics from your own transmitter is not necessarily any cause to worry. All transmitters generate them. It is only when they get out in public that they disgrace us.

Harmonic Energy. In the April and May, 1956, *Transmitting Towers,* we discovered that a radio-frequency power amplifier tube usually delivered power to its associated tuned circuit in the form of pulses, full of harmonic energy. This is because the tube is normally operated at a high negative grid bias and driven into the grid-current region to produce maximum power output.

The tuned plate circuit then smooths out the pulses into virtually undistorted sine waves, before they reach the antenna. It does this by converting the pulses into circulating tank current, which oscillates between the coil and the capacitor. In this manner, the tube and tuned circuit work together much like a one-cylinder engine with a flywheel on its drive shaft. The engine delivers a power thrust during only a small part of each cycle, but the flywheel absorbs the thrust and releases the energy contained in it uniformly over the complete cycle.

In a tuned circuit, "flywheel" action is obtained when its circulating current is large compared to the exciting current.* A ratio between the two of 10:1 to 15:1 usually represents the best compromise be-

*This is not a something-for-nothing proposition. The tube supplies low current at high voltage, while the high circulating current is at low voltage; thus, the power involved is the same.

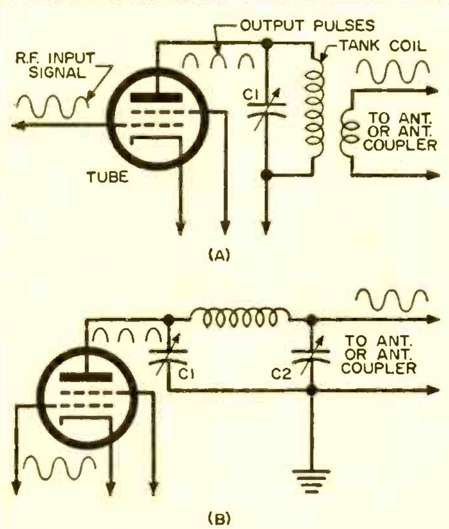


Fig. 1. Skeleton diagrams of typical amateur transmitter output circuits, showing their importance in converting the distorted pulses delivered by the tube plate to sine waves before they reach the transmitting antenna. (A) is a parallel-tuned circuit; (B) is a pi-network output tank circuit. See text for details.

tween high harmonic attenuation and low losses.

Such a tank circuit is said to have a *Q* (quality factor) of 10 to 15. It will attenuate second-harmonic energy fed into it 30 to 40 db (5 to 7 "S" units), compared to an untuned coupling device, and it will deliver about 95% of the power it receives to a load. A higher *Q* would increase harmonic attenuation only slightly, but would increase losses rapidly. Conversely, reducing the *Q* below 10 decreases harmonic attenuation rapidly.

Calculating Tank Circuit Q. Three things determine the *Q* of a transmitter tank circuit. They are the tube plate voltage and current and the size of the tuning capacitor (*C1* in Fig. 1). Both the *ARRL* and the *Radio Amateur Handbooks* contain charts showing the capacitance to be used in different circuit arrangements to obtain a *Q* of 12 to 15 at different voltages and currents. But a simplified method for use in the circuits of Fig. 1 follows:

Divide the plate voltage by the plate current in milliamperes. If the answer is approximately 5, *C1* should have a capacitance of approximately 250 μμfd. for 3.5-mc. operation, 125 μμfd. for 7 mc., 62 μμfd. for 14 mc., 42 μμfd. for 21 mc., and 30 μμfd. for 28 mc.

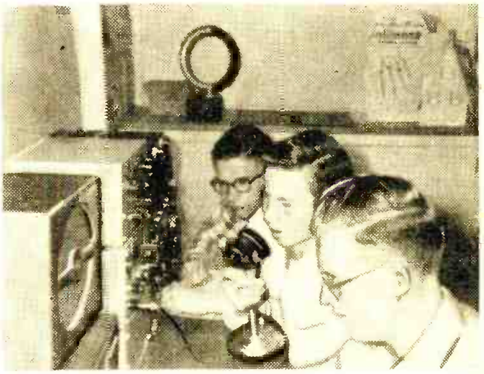
If the answer obtained by the division differs from 5 by more than about 20%, divide 5 by the number obtained and multiply the capacitance values given above by the result. For example, a plate voltage of 750 divided by a plate current of 100 ma. equals 7.5. And $5/7.5 \times 250 = 167$ μμfd. Optimum capacitance for 75-watts input on 80 meters at a plate voltage of 750 volts is, therefore, about 165 μμfd. A voltage of 600 at 300 ma. gives a ratio of 2. And $5/2 \times 250 = 625$ μμfd. So, optimum capacitance for 180-watts input on 80 meters at 600 volts is approximately 625 μμfd.

The inductance of the coil is adjusted to achieve resonance on the desired frequencies with the calculated capacitance values.

Unfortunately, high-quality capacitors with capacitance values above about 200 μμfd. are fairly expensive and sometimes a bit difficult to come by. Also, high values of capacitance make tuning rather critical on the higher frequency bands. Consequently, some designers skimp a bit on capacitance on the 3.5-mc. band. This is one big reason why most troubles from second-harmonic output stem from 80-meter (or 160-meter) transmitters.

Checking for Radiation. Determining if a transmitter radiates excessive harmonics is not difficult. A harmonic-reception report from the FCC is the most convincing evidence. But it is advisable to avoid this method. It jangles the nerves. A well-shielded communications receiver can be used instead.

Remove the antenna from the receiver and tune in the transmitter signal. Adjust the receiver sensitivity control for a comfortably strong signal from the loudspeaker or phones. Now, tune the receiver to the second-harmonic frequency of the transmitter. It should be very weak or completely inaudible, until the receiver



Three of the 12 members of the Roosevelt High School Amateur Radio Club, in Fresno, Calif., are operating the club station, W6PMW. Shown are KN6RPM, KN6RPN, and Jim Ratzliff. The president of the club is K6KLQ, and the sponsor is W6HYR.

sensitivity control is advanced considerably. Measured on the receiver "S"-meter, the difference in strength between the fundamental and harmonic signal should be at least 50 db (8 or 9 "S" units).

An inexpensive receiver may not be satisfactory for this test because of excessive signal pickup, even with the antenna removed, unless it can be removed a distance from the transmitter and powered from a power line separate from that powering the transmitter.

You can also enlist the aid of another amateur within a mile of you. If he hears your harmonic at all, it should be at least 50 db weaker than your fundamental signal.

Reducing Harmonic Output. Should your tests indicate that you are radiating a strong harmonic, the first step is to check your tuning procedures carefully. With many transmitters, it is possible to tune the output circuit to 80 meters with the tank capacitor plates well meshed and to the second harmonic frequency with them well open. Too, with a pi-network output circuit, decreasing the output capacitance (*C2*) too much in order to put power into a high-impedance antenna may make it impossible to tune the circuit to 80 meters at all.

In any event, do not load the transmit-

HELP US OBTAIN HAM LICENSES

In this section of the Transmitting Tower, the names of persons requesting help and encouragement in obtaining their amateur licenses are listed. To have your name listed, write to Herb S. Brier, W9EGQ, % POPULAR ELECTRONICS, 366 Madison Ave., New York 17, N. Y. Names are grouped geographically by amateur call areas.

W1/K1 CALL AREA

Arthur McDonald (14), 29 Robinson St., S. Portland, Maine. (Code and theory)

Taylor Washburn, 70 School St., Lisbon, N. H.

Arthur R. Taylor, R.F.D. #1, Lyndonville, Vt. (Code)

Laurence Jaffe, 47 Hadwen Rd., Worcester 2, Mass. (Code and theory)

Doug Moody, 45 Sylvan Rd., Rumford 16, R. I. (Code and theory)

David Duncan, 127 Blue Hill Ave., Milton 87, Mass.

Norman Finkelstein, 71 Bellingham St., Chelsea 50, Mass.

W2/K2 CALL AREA

D. F. Aldridge, 108-23 63rd Ave., Forest Hills, N. Y. (Information on clubs or other groups in the New York area giving instructions to prospective amateurs)

David L. Bergdall, 113 Elmwood St., Valley Stream, L. I., N. Y. (Pen pals)

Ronnie Tobin (13), 640 West 231 St., Riverdale 63, N. Y.

Freddie Childs (14), 20 Redoubt St., Highland Falls, N. Y.

David F. Kovach, KN2RSM (12), 161 LaGrange St., Vestal, N. Y. (Theory)

John H. Ryan, Tonawanda Creek Rd., East Amherst, N. Y. (Code and theory)

Harold Pietrucha, 3 Summit St., Newark, N. J. (Code and theory)

George Kerr, 5 10th St., Beach Haven, N. J. (Code)

Robert Shea, Indian Rd., Milton, N. Y. (Novice theory and regulations)

Roy Krause (14), 6 Sparrow Lane, Huntington, N. Y. (Code)

Emil Vandevelde, Oswego St., Oakland, N. J.

Martin Ewing, 1656 Lenox Rd., Schenectady 8, N. Y. (Code)

O. J. Demarest, 89 West St., Green Island, N. Y.

Robert Selkowitz, 114 Old Commack Rd., Kings Park, N. Y.

Frank Ryon (17), 49 Mitchell St., Norwich, N. Y.

George Kimal, % Kambu, 293 Saw Mill R. Rd., Yonkers, N. Y.

George DeSalvo, 1097 East 3rd St., Brooklyn 30, N. Y. (Code and theory)

Louis Winkler, 100 Catherine St., Valley Stream, N. Y. (Code and theory)

Dick Kohler, 151 East 80th St., New York 21, N. Y. (Code and theory)

John Wasylyk, 333 Semel Ave., Garfield, N. J.

Earl Kohn, 63-60 102 St., Forest Hills 74, N. Y. (Code and theory)

Hermann Beck, 78-28 65th St., Brooklyn 27, N. Y.

Robert Makuh, 60-27 80th Ave., Brooklyn 26, N. Y.

Thomas Walsh, Bethel Cem. Cypress Hills St., Brooklyn 27, N. Y.

Carolee Atkins, 302 N. Union St., Lambertville, N. J. (Theory)

K3/W3 CALL AREA

Joseph W. Smith, 2990 York Way, Dundalk 22, Md.

Howard A. Lurkins, Mission Road 199, Jessups, Md.

K4/W4 CALL AREA

Bruce Tuten, 433 East 49th St., Savannah, Ga. (Help in getting his license and in starting an SWL club)

Stuart Looney, Grundy, Va.

Tom Creech, Box 497, Cumberland, Ky. (Code and theory)

Harold Schwarz (13), 2225 Meridian Ave., Miami Beach, Fla. (Code and theory)

Larry Beufield (16), Route #1, Mount Ulla, N. C.

Ronnie Chase, 7009 Jahnke Rd., Richmond 25, Va. (Code)

Noel Edwards (18), P. O. Box 3, Marble, N. C. (Code)

Mike Fletcher (18), 300 West Redbud Drive, Knoxville, Tenn.

Isaiah Singletary (17), 1770 Bridger St., Fayetteville, N. C.

K5/W5 CALL AREA

Don Blackburn (12), 4132 Travis St., Dallas, Texas. (Help on choosing equipment; would also like to receive QSL cards)

Jim Pickett (14), 611 N. Main St., Sand Springs, Okla.

Paul Alexander (15), P.O. Box 1, Conroe, Texas.

Bill O'Brien, Jr., Box 367, Pilot Point, Texas. (Code)

Freddy Frost, 121 Tarrant St., San Antonio 4, Texas. (Code)

K6/W6 CALL AREA

Steve Dubnoff, 1930 N. Normandie, Los Angeles 27, Calif. (Interested in radio clubs around Los Angeles that extend help and welcome to prospective Novices)

Robert Sanders (13), 2749 10th Ave., Sacramento, Calif. (Code)

Dennis Carter, 510 Terraceway, Bakersfield, Calif. (Code)

Mike Miller, P. O. Box 368, Rancho Mirage, Calif.

John C. Pennington, 5540 S. 2200 West, Roy, Utah.

K7/W7 CALL AREA

Thomas D. Wurth, 7310 E. 8th Ave., Spokane 63, Wash.

Roger Hatton (15), Route #4 East, Missoula, Montana.

Dick Quam, 4209 Eastern Ave., Seattle 3, Wash. (Code and theory)

K8/W8 CALL AREA

Michael P. Solomon (13), 2441 Laurelhurst Drive, University Heights 18, Ohio. (Code)

Pat Vosburg, Box 308, 3040 Avalon St., Auburn Heights, Mich.

Charlie Parker, Jr., 6401 Quimby Ave., Cleveland 3, Ohio. (Wants to get started right; had a minimum of radio experience in Army)

Edward Gansen, 203 N. Rosevere, Dearborn, Mich. (Code)

Paul Saplak, Box 84, Glen White, W. Va. (Code and theory)

Robert Craft, Box 116, Kilsythe, W. Va. (Code and theory)

K9/W9 CALL AREA

I. A. Smith, 3146 West 15th St., Chicago, Ill.

Carl Mattson, RR1, Sand Lake, Phelps, Wis. (Code and theory)

Tom Bertrand (15), 729 E. Central Ave., Greensburg, Ind. (Theory)

K0/W0 CALL AREA

David J. Zimmer (13), 225 Dessa Lane, S. St. Paul, Minn.

John Young (12), Box 716, Waynesville, Mo. (Code)

David Waite (14½), 810 S. Maguire, Warrensburg, Mo. (Code and theory)

Lynn Yecum (13), Route #2, Nankato, Kansas. (Code and theory; would like pen pals)

Lawson Hart (13), 5332 Willow, Kansas City 29, Mo.

Byron Nordby, Edinburg, N. Dakota. (Code)

Larry Peacock, 1608 S. Steel St., Denver, Colo. (Code and theory)

Charles O'Rear, 303 W. Ft. Scott, Butler, Mo.

Dick Carochi, 606 East 2nd St., Florence, Colo. (Code and theory)

Thomas E. Storm, 527 Pott, Leavenworth, Kansas. (Code and theory).

VE, AND OTHERS

Donald Knight (14), Box 209, Medford, Ontario, Canada.

Duncan MacAdams, R.R. #1, Maple Bag Rd., Duncan, B.C., Canada.

Peter Norton, 4634 W. 2nd Ave., Vancouver, B.C., Canada.

Rolf Strömberg, Box 514, Vindeln, Sweden. (Pen pals, SWL's)

Alfred Celestin, Jr., 151 Grand'Rue, 151, Port-au-Prince, Haiti, W.I. (Code and theory)

To help prospective amateurs obtain their Novice licenses, the Radio-Electronics-Television Manufacturers Association offers a set of code records (recorded at a speed of 33⅓ rpm) and a Novice Theory Course for $10.00, postpaid. The complete course or more information on it is available from RETMA, Suite 800, Wyatt Bldg., 777 Fourteenth St., N. W., Washington 5, D. C.

ter to a power input in excess of the manufacturer's recommendations. As we saw above, the ability of a tuned circuit to discriminate against harmonics depends largely on how heavily it is loaded. Excessive loading can easily push harmonic output above the danger line.

Next, check the grid current to the final amplifier tube. Most low-power transmitters require only two or three milliamperes of grid current to the final amplifier tube for maximum output. But the preceding stage is usually capable of delivering several times this amount on the lower frequency bands at least. The extra grid drive simply increases harmonic output, without increasing fundamental output. Reduce the excitation to the point where the output from the transmitter just begins to decrease. In the future, do not exceed the amount of grid current which is then flowing.

Many small transmitters incorporate no means of varying excitation to the final stage, except by detuning the preceding stage. A much better method is to install a variable resistance in series with the screen lead of the preceding stage as an excitation control.

If harmonic output is still excessive, check the amount of capacitance actually used to tune the output tank circuit to resonance at the operating frequency. If it is appreciably less than the values indicated earlier, short out or remove turns from the coil, so that more of the available capacitance is used to tune the circuit to resonance. If the capacitor is too small, it may be desirable to replace it with one of greater capacitance.

When it is not desirable to make such modifications in the transmitter, and an antenna coupler is not already in use, an antenna coupler may be installed between the antenna and the transmitter. It will reduce the strength of harmonics reaching the antenna. See recent *Handbooks* for constructional details.

Taped Code Course

An interesting new code course just received for review is the *Tapedcode Course*. The complete course consists of one 7" reel and five 5" reels of magnetic recording tape, dual-track recorded at a speed of 3¾" per second. The 7" tape gives two hours of basic code instruction and practice, and each of the 5" ones gives an hour of practice material. Speed on the last tape is about 17 wpm.

Every effort has apparently been made in this course to teach the code by the most modern methods. After carefully listening to it—I heard only one error, a

(*Continued on page* 114)

Portable Detector Spots Deadly "Nerve" Gas

SELF-CONTAINED and portable, an electronic device developed by RCA detects "nerve" gas. This toxic agent is said to be the deadliest gas developed in recent years. It is over a thousand times more effective than any gas previously in use. "Nerve" gas is so lethal and quick-acting that it will produce fatal spasms and convulsions within 45 seconds after contact or inhalation unless the proper antidote can be administered immediately.

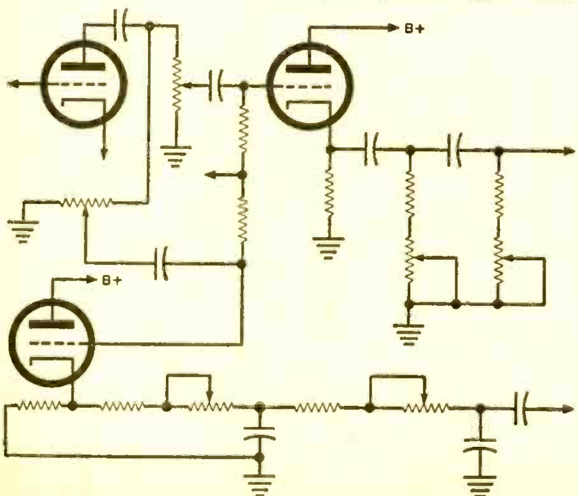
Classified as secret until very recently, RCA's device for spotting the odorless, colorless gas weighs only 24 pounds and, as shown in the photo, can be carried in the field. Upon contacting the gas, the unit triggers a built-in audible alarm. At the same time, it activates a flashing red warning light.

In civilian applications, in industrial or population centers, the audio alarm can be rigged to sound through a public address system, or an air raid siren. The device works by passing air over a special detector tape constantly scanned by a photo-tube.

Automation Idea Used in Tube Tester

CONVENIENT and speedy testing of tubes is expedited by the use of automation techniques in a uniquely designed tube checker. Introduced by the TeleTest Instrument Co., Flushing, N.Y., and known as the "Dynamic Mutual Conductance Tube Tester, Model DM-456," the instrument uses pre-punched cards to adjust its internal circuitry for running tube tests. This technique eliminates the conventional roll chart and multiple-socket panels.

Among the tests performed are mutual conductance, gas content, grid emission, life expectancy, shorts, and leakage. New cards are issued as new tube types are announced. The DM-456 nets for $125.00.



WHERE ARE YOU?

This is the first of a new series of monthly puzzlers. The idea is to guess (or if you are really good—diagnose) the type of circuit shown in the accompanying schematic. The answer will be found on page 125.

The circuit is an application of several well-known theories. Do you think it is practical? What type of signal would you put into this circuit? What would you expect to get out of it? Where would you be most likely to see this circuit in operation—if it is practical?

We will welcome suggestions on circuits to puzzle our readers. Such circuits should not be overly complicated and should be operative. Usable circuits will be paid for at our usual editorial rates.

THE JUNKBOX has long played a traditional role in the hobby of electronic experimenting. But if your junkbox is anything like the writer's, it contains a rather large proportion of parts for which capacitance, inductance or resistance values cannot be identified. This state of affairs stems partly from the fact that many manufacturers of mass-produced equipment purchase parts to their special order, in which the value is never stated except through a company part number. And we seem to be "unable" to throw these parts away.

Here is a solution to this chaotic situation. The instrument to be described is about as simple as any instrument can get, but its range encompasses the most commonly encountered values of inductance, capacitance and resistance. It will measure capacities from 500 μμfd. to slightly over 1.0 μfd., inductance from 1.0 millihenry to 2.0 henrys, and resistance from 200 ohms to 2.0 megohms.

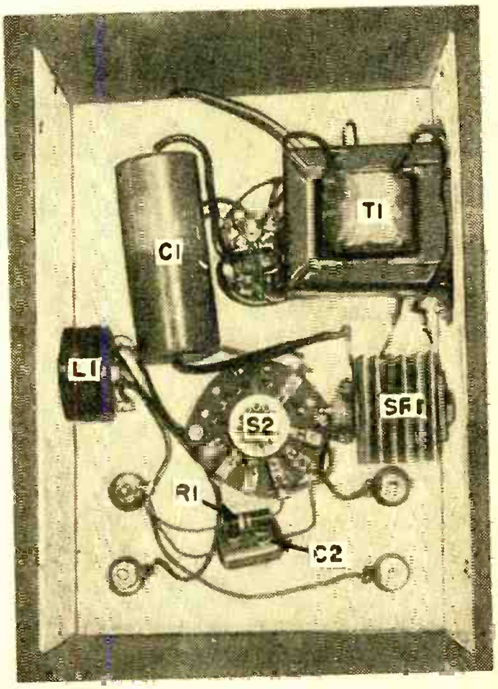
Junkbox Parts Checker

By RICHARD GRAHAM

Cost of this device should be on the order of six dollars; depending on what parts you already have available, the cost will be proportionately less. No special precision parts are used, nor is there any loss in accuracy because of this, since each model is calibrated to the parts used.

Calibration is quite simple. If the procedure below is followed, excellent accuracy plus all the intermediate calibration points can be obtained with only a few known components. The classical method of calibrating devices of this sort cannot be employed. Such a method would dictate that components of known electrical value be used for every calibration point. Fortunately, this instrument can be calibrated—including all the intermediate points—with only four known parts per scale, i.e., 4 capacitors, 4 inductances, and 4 resistors. Later checks with additional known components will verify its accuracy.

Basically, the method is to plot the known calibration points on a graph in order to obtain a curve from which all the intermediate points can be determined. The first step is to make a blank dial scale calibrated from 0 to 10. Then obtain a sheet of graph paper. Mark off one edge of the graph paper from 0 to 10 to correspond to the dial calibration. Mark off the other edge with the values of capacity, inductance, and resistance. For example, one edge will have three scales marked off in capacity from 500 μμfd. to



Front and rear (open) views of the model, built in a 7" x 5" x 3" aluminum case. As parts layout is not critical, any available housing may be used.

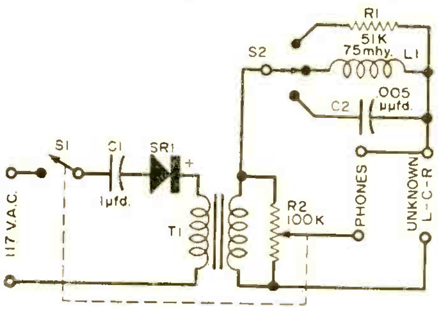
HOW IT WORKS

This is basically a bridge circuit in which the unknown component is balanced by adjusting potentiometer *R2* for an audio null or minimum sound in the earphones. The bridge consists of four arms. *R2* forms the two resistance arms of the bridge. The unknown *R*, *L*, or *C* forms the third arm; and an internal *R1*, *L1*, or *C2*, which is selected by the switch *S2*, forms the fourth arm of the bridge.

Balanced condition of the bridge occurs for a different setting of *R2* for each different value of an unknown component. That is, a minimum sound or null will be heard in the earphones when the voltage at the tap point of *R2* is equal to the voltage at the junction of the unknown part and the internal *R*, *L* or *C*. If the voltage at these two points is the same (with respect to either end of the transformer), no current can flow through the headphones, and thus there is no sound.

The remainder of the circuit (*C1*, *SR1*, and *T1*) consists of a 60-cycle harmonic generator. A straight 60 cycles is unsuitable for powering the bridge. If this 60-cycle sine wave is severely distorted, then the higher frequency harmonics of 60 cycles can be heard quite plainly. This is important if one expects to find the audio null easily and reliably.

The 60-cycle harmonic generator uses a selenium rectifier which serves to distort the 60-cycle 117 volts severely before it is applied to the transformer. The 1.0-µfd. capacitor serves as an additional distortion-producing element so that a clearly audible tone can be heard in the earphones when connected to the appropriate terminals.

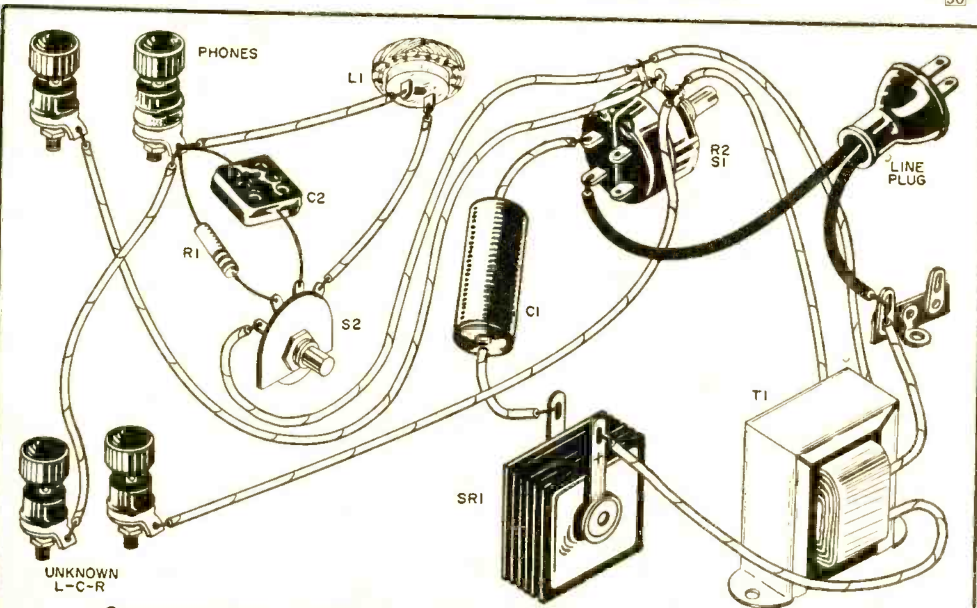


C1—1-µfd., 400-volt capacitor
C2—.005-µfd., 400-volt capacitor
L1—75-mh., 100-ma. r.f. choke
R1—51,000-ohm, 1-watt resistor
R2—100,000-ohm potentiometer with switch
S1—S.p.s.t. switch (on R2)
S2—S.p., 3-pos. rotary switch
SR1—150-ma. selenium rectifier
T1—6.3-volt, 2-amp. filament transformer

1.0 µfd., inductance from 1 millihenry to 2 henrys, and resistance from 200 ohms to 2 megohms.

Now, obtain four known values each of capacitance, inductance and resistance, spread as uniformly as possible over the range of the instrument. Attach them to the "unknown" binding posts, and find the number on the dial (between 0 and 10) of the null. Plot these number and component values on the graph paper. Then, preferably with a French curve, draw a smooth curve through the points obtained on the graph paper for the capacity, then the inductance, and finally the resistance.

From the curves so obtained, all the intermediate points (for example, .01, .02, .03, .04 µfd., etc.), can be found in terms of numbers from 0 to 10, which corresponds to the 0-to-10 calibration on the dial. These values can now be transferred to the dial with India ink, making the calibration permanent, and the penciled-in scale from 0 to 10 can be erased. —30—



Components of the junkbox parts checker should be connected as shown above.

AFTER CLASS

SOME FACTS ABOUT ELECTRETS

SOME TIME during the opening phase of World War II, a detachment of American soldiers captured a complete mobile communications system at an advanced Japanese post. Although much of the equipment had been unimaginatively copied from standard Allied gear, one item in particular was apparently new in concept. It was a capacitor microphone with no perceptible source of polarizing voltage! Included in the mike case was a resinous mass of wax whose function eluded our scientists for some time. This was the way the electret was first introduced to the Western world.

Let's brush up a bit on static electricity before tackling the electret, since its construction and performance are based upon static electric fields.

Electrification. The classic demonstration in which a hard rubber rod is electrified by stroking it with fur or flannel is performed at least twice a year in over 20,000 secondary schools and colleges throughout the world. If you have never witnessed it, you can duplicate it by rubbing a good vulcanite comb or fountain pen on any rough cloth. The electrified object then attracts bits of paper or thread by inducing opposite charges in these small bits of matter.

Stroke an inflated balloon on your suitcoat, then gently place it against a wall; it will hang there as though glued. Shuffle your feet on a high-nap wool rug when the weather is cold and clear, then bring your fingertip close to a grounded pipe or radiator . . . you can sometimes get a half-inch spark to leap between them. The Van der Graaf high-tension generator used for atom-smashing, the famous voltaic electrophorus, and the whirling Wimshurst static machine are all based on the same fundamental principle: the generation of static electricity by friction.

This kind of electrification is termed "superficial" because the charge produced by friction quickly decays and disappears, particularly when the air is humid. It results from the transfer of free electrons from one substance to another, leaving one with a deficiency of these negative particles and the other with an excess. For this reason, objects charged by friction

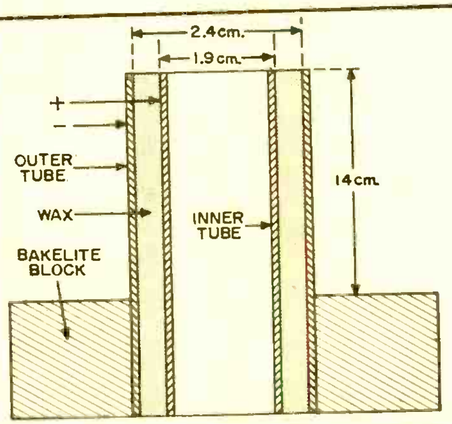


Fig. 1. In the forming method used by Edwin P. Adams of Princeton University, wax is poured between two concentric tubes held in a Bakelite block. The tubes are then connected to a source of 4000 volts d.c. as the wax solidifies. Solidification is retarded by placing the assembly in a thermostatically controlled oven. When the concentric tubes are removed, a hollow cylindrical electret is obtained.

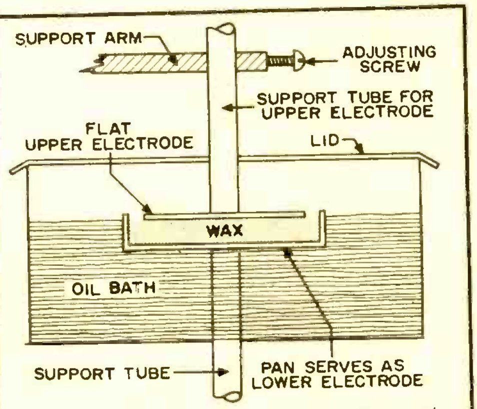


Fig. 2. In the Good-Stranathan forming method used at the University of Kansas, the temperature of the oil bath is thermostatically controlled. This method is considered highly efficient and permits the forming of electrets of various shapes and thicknesses for experimental purposes. The forming potential is regulated to about 8000 volts per centimeter of electret thickness for effective charging.

take on opposite charges which last for a short time.

Before 1919, no device was known which could be electrified permanently; but in that year a Japanese scientist, Motoaro Eguchi, is reported to have been successful for the first time. He melted together a 50-50 mixture of rosin and carnauba wax. Then he allowed it to solidify between two electrodes across which a high d.c. voltage was applied. After hardening was complete, the waxy mass was kept between the activated electrodes for an additional period of 12 hours. After removal, it was found to have a permanent charge; that is, one side was charged positively and the other side negatively, so that it was surrounded by an external electrostatic field that showed little or no tendency towards decaying.

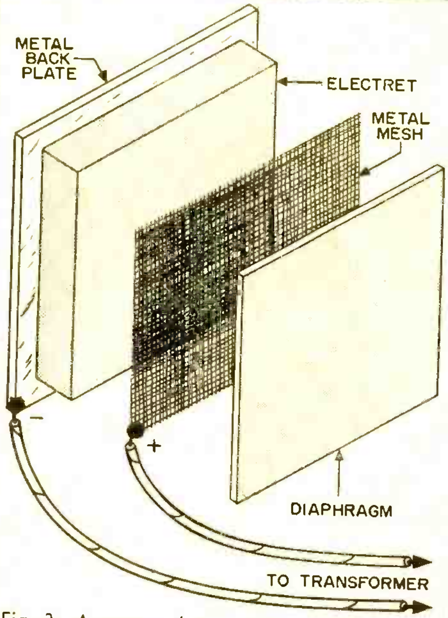


Fig. 3. A proposed capacitor electret microphone. The charge which appears on the metal mesh depends upon the capacitance between the mesh and the electret surface and upon the potential of the electret. As sound waves cause the diaphragm to vibrate, the capacitance changes, causing a corresponding alternating voltage waveform to appear at the terminals of the transformer.

Methods for manufacturing electrets have undergone very little change in the 37 years that have passed since Eguchi's initial experiments. Improvements have been made in dielectric materials by using various combinations of waxes and applying higher forming potentials to thermosetting plastics and ceramics. (For forming methods, see Figs. 1 and 2.) When properly stored, an electret made by these simple methods can retain its charge for *20 years or more.*

Electret Formation. One currently popular theory which attempts to explain electret formation may be outlined in the following way:

(a) A material mass contains neutral atoms and charged atoms (ions). In a dielectric material, the ions cannot move about readily because of the nature of the substance. Since positive and negative free ions are usually approximately equal in number, a dielectric containing scattered ions displays zero net charge because the individual little electric fields effectively cancel each other.

(b) When a molten dielectric is situated between two highly charged electrodes, the free ions migrate toward the electrode bearing a charge opposite from theirs. This accumulation of a positive charge on the negative face of the electret and a negative charge on the positive face is called the *heterocharge* (meaning charge that is different from the electrode polarity). The heterocharge is a temporary manifestation which disappears within a day or two.

(c) During the forming period, it is believed that "sprays" of electric charges enter the molten mass and are frozen there when the dielectric hardens. As these charges have the same polarity as the electrodes near the surface at the point of entry, they produce the *homocharge.* This is the electret's permanent charge.

(d) For the first day or two, the heterocharge is very strong and the net charge on the electret at this time is the reverse of what it will finally be. As ions carried by the air come in contact with the electret surfaces, the heterocharge ions are quickly neutralized. Thus, the heterocharge disappears altogether in a relatively short time.

(e) The homocharge, consisting of elementary electric charges rather than ions, penetrates the surface more deeply, becomes embedded, and is thereby protected from ionic assault. Once the dielectric has hardened, the charges are further guaranteed long life by the fact that ions move through solids only with great difficulty.

Properties and Applications. Some of the properties of electrets are quite interesting. They tend to lose their charge tem-

Ed. Note: Your comments on the above type of material, currently appearing in this department, are earnestly solicited. As pointed out a couple of months ago, "After Class" has been redesigned to incorporate subjects felt to be of interest, but which do not appear in the usual radio textbooks—how do you like our new subject matter?

porarily under the action of certain solvents, surface planing, high humidity, x-rays, and gamma rays; but the charge is self-restoring after the depolarizing agent is removed. And the larger an electret is made, the greater its total charge and external electric field. The charge pattern on the electret faces may be controlled by suitably shaped forming electrodes. When heated above certain critical temperatures, electrets emit electrical pulses having a definite frequency range, peaking at about 500 pulses per minute. Wrapping stored electrets in metallic foil retards homocharge deterioration so much that very little charge decay occurs for many years.

Thus far, electrical devices based upon other phenomena perform better and for longer periods than those which involve the electret principle. For example, a standard capacitor microphone which requires a source of polarizing potential has been constructed using an electret (Fig. 3). Unless foil-shorting provisions are made, however, the electret charge decays quickly, and the microphone fails after six months.

Electrets have been tried without encouraging results as x-ray dosimeters. The dosage of x-rays, as you have probably discovered in your dentist's chair, must be precisely controlled to avoid damaging body tissue. X-ray machines therefore contain integral timers of high accuracy. Since an electret is temporarily discharged by x-rays, it seems to afford a method of timing exposure based upon both ray intensity and period of application. Unfortunately, the reaction of the electret is not sufficiently precise for safety.

Patents have been issued for electret dust-filters, sparking devices, and electrostatic generators; but none of these competes seriously with existing units based upon older principles.

Yet, this is a very familiar pattern in scientific research. Some day—perhaps very soon—a specialized job will be found for electrets, a job that will elevate them to the same proud status that quartz crystals and transistors now occupy.

TRANSFORMER QUIZ

THE FOLLOWING QUIZ will test your knowledge of transformers and their applications. A score of 100 is excellent, 90 is very good, 80 is good, 70 is fair, and 60 or less is poor.

1. **If the secondary of a transformer has three times as many turns as the primary:**
(a) the secondary voltage will equal the voltage applied to the primary; (b) the secondary voltage will be three times as great as the voltage applied to the primary; (c) the secondary voltage will be nine times as great as the voltage applied to the primary.

2. **The transformer shown in Fig. A is:**
(a) an output transformer; (b) an i.f. transformer; (c) a push-pull transformer; (d) a power transformer.

3. **The transformer shown in Fig. B is:**
(a) an autotransformer; (b) a push-pull transformer; (c) an output transformer; (d) a power transformer.

4. **The transformer shown in Fig. C is:**
(a) a push-pull transformer; (b) a power transformer; (c) an output transformer; (d) an i.f. transformer.

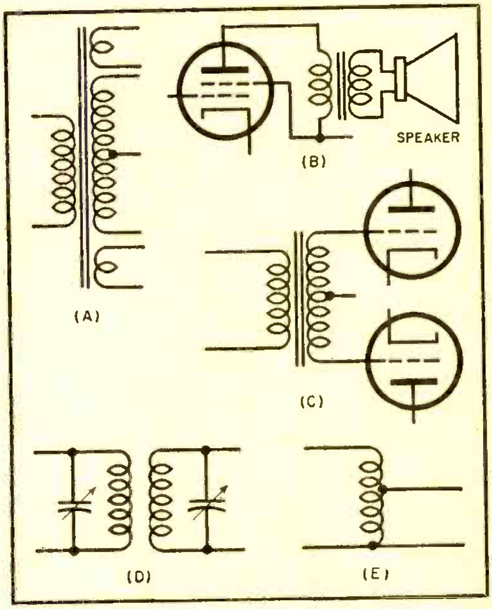
5. **The transformer shown in Fig. D is:**
(a) an autotransformer; (b) an i.f. transformer; (c) a power transformer; (d) an output transformer.

6. **The transformer shown in Fig. E is:**
(a) an i.f. transformer; (b) an output transformer; (c) push-pull transformer; (d) autotransformer.

7. **If the primary of a filament transformer is connected to a 110-volt power line and the 6.3-volt secondary is connected to a 0.3-ampere filament, the primary current will be approximately:**
(a) 5.2 amperes; (b) 0.3 amperes; (c) 17 milliamperes; (d) 30 milliamperes.

8. **Laminated rather than solid iron cores are used in transformers in order to:**
(a) increase eddy currents; (b) reduce power losses in the core; (c) facilitate removal of burned-out windings.

9. **A Faraday shield is used to:**
(a) reduce the capacitive coupling between the windings of a transformer; (b) decrease core losses; (c) prevent mutual inductance.

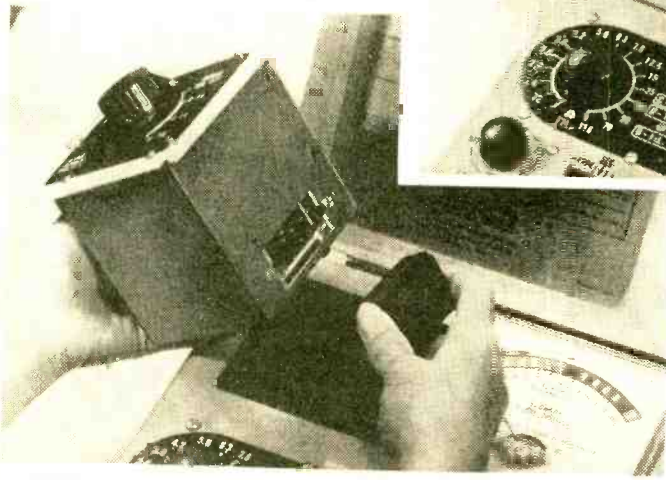


10. **A filament transformer has two 6.3-volt windings each rated at 4 amperes. If these two windings are connected in parallel, the combination will have a rating of:**
(a) 6.3 volts at 4 amperes; (b) 6.3 volts at 8 amperes; (c) 12.6 volts at 8 amperes.

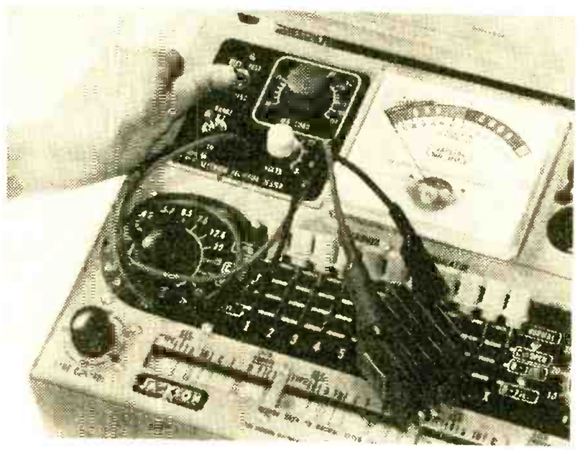
(Answers appear on page 123)

Tube Tester Plug-In Accessories Double Value and Quadruple Versatility

Blank panel, in upper left-hand corner of tube checker, is removed to permit installation of accessory—in this case, a filament current tester. Other accessories are installed in a similar manner.



Accessory is fitted into space provided on chassis. Connection to power supply and meter is made by means of the 10-connector plug shown. Accessory does not interfere with normal tube check operations.



Test of a selenium rectifier is made with special accessory fitted into place. Hookup is made with the 10-connector plug. Right-hand side of instrument contains tube sockets; a special adapter plate permits checking of subminiature and older tubes. Tube test data is listed on roll chart. Same 4½" meter is used for all tests.

APPLYING THE MODULE idea to test instruments, the Jackson Electrical Instrument Co., Dayton, Ohio, has come up with a low-cost tube checker which becomes a versatile test instrument with many other applications by adding plug-in accessories.

The basic tube tester, which sells for $49.95, furnishes regular tests on most standard tubes. Sockets for older types as well as subminiatures are provided on an accessory panel. Accessory units include: a high-resistance shorts tester for measuring interelement leakage to 2 megohms; a heater current tester; and a selenium rectifier checker.

Other accessories, expected to become available in the future, include a signal tracer, r.f. oscillator, and a capacitor checker. Use of accessories such as these is made possible by adapting the tube tester's meter and power supply for purposes other than simply testing the emission of standard tubes. The accessory units accomplish this without interfering with the checker's main function of testing tube quality. A special connector is plugged into the desired accessory, which is then slipped into the instrument's "accessory port." For additional information, contact the manufacturer at 16-18 S. Patterson Blvd., Dayton 2, Ohio. —30—

Electronic Phono Speed Changer

By

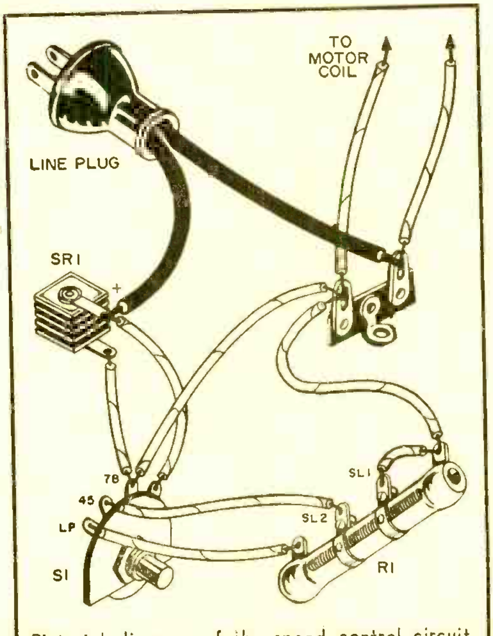
H. J. CARTER

Would you like to convert your old 78-rpm phonograph to a 3-speed model? Here's how—

YOU CAN EASILY convert a 78-rpm electric phonograph to a three-speed phonograph with the simple control circuit described in this article. Any *shaded-pole* electric motor can be run at reduced speed by adding three inexpensive parts: a switch, a rectifier, and an adjustable resistor. The parts cost less than a new three-speed motor, and take about half an hour to install.

Before adding this speed control circuit to an old phonograph, you should inspect the motor. If it runs noisily, uneven, or at low speed, dismantle it and clean the parts in grease solvent. Reassemble the motor carefully and oil sparingly with a good grade of thin sewing-machine oil.

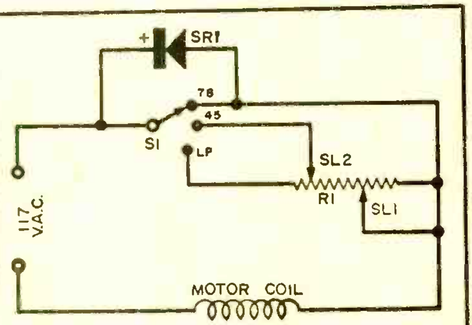
A shaded-pole motor can be slowed by simply inserting series resistance in the field coil circuit, but the rapid drop of torque in this method of speed control makes the motor useless for record players where good speed regulation is essential. The torque developed by the phono motor running at the reduced speed in this circuit decreases very little, inasmuch as full power a.c. pulses are present on alternate half-cycles.



Pictorial diagram of the speed control circuit.

The resistance of *R1* is not critical; any value from 300 to 500 ohms will work. An extra slider must be added to tap the resistor at the value required to run the motor at 45 rpm. All of the parts can be mounted easily on the bottom side of the motor board. The selenium rectifier may be polarized either way. If the motor board is wood, keep *R1* at least ¾" away to allow for heat dissipation.

Adjustment. It is easy to correct the speed if a stroboscopic disc is used (see POPULAR ELECTRONICS, October, 1954, page 71). Be sure to be playing a record while making the speed adjustment in order to include the effect of needle drag on turntable speed. *Before adjusting* the sliders *SL1* and



Schematic wiring diagram and necessary parts.

R1—300-500 ohm, 10-watt adjustable wire-wound resistor with two sliders (RL1 and RL2)
S1—Centralab No. 1461 switch
SR1—115-volt, 100-ma. selenium rectifier

SL2, always be sure to disconnect the power line cord!

Switch the selector to the 33⅓-rpm (LP) position and check the speed. If the turntable is slow, move *SL1* toward *SL2*, tighten the clamp screw, and check the speed again. Continue adjusting the slider until the speed is correct, then switch to the 45-rpm position and repeat the adjustment procedure, moving *SL2* toward *SL1* if the turntable speed is slow. Remember to readjust *SL2* if you have to readjust *SL1*. The position of *SL2* does not affect the LP speed adjustment.

Precautions. When starting the motor, switch to the 78-rpm position before selecting a slower speed. If the motor is started in a slow speed position, it generally will not run at the correct speed.

There is nothing critical about the mounting of the parts, but you should locate them away from the pickup in order to avoid hum trouble. —30—

HOW IT WORKS

In this circuit, selenium rectifier *SR1* blocks on alternate a.c. half-cycles, switching resistor *R1* in series with the motor field; on the other a.c. half-cycle, it shorts *R1*, leaving the field coil directly connected to the line. The reduced current pulse on alternate 60-cycle a.c. half-cycles is equivalent to a direct current level superimposed on the a.c. waveform.

In normal motor operation, the rotor does not quite keep up with the rotating stator field, but lags behind by what is known as the *slip angle*. Motor speed is varied by varying the slip angle—either by varying the motor load or slowing the rotating magnetic field by electrical means.

The rotor activated in this circuit is subject to current pulses which tend to rotate it with the stator field, and to pulses which tend to let it slip further behind the field. These opposite effects are smoothed by the turntable and rotor inertia so that the average slip angle is increased, thus reducing the motor speed.

Magnifying Sun Battery Power

THIS IDEA should interest electronics experimenters who must do most of their experimenting indoors during the evening hours. You can practically double the output of a single B2M "Sun Battery" under the workbench lamp by the addition of a cheap magnifying glass mounted on a simple stand.

Take a magnifying glass having a 2"-diameter lens with a focal length of 4" (which costs about 98 cents), and set it up on a stand made from a block of wood, a piece of clothes-hanger wire, and an ink eraser. Two holes are punched in the eraser, as shown (below, right), so that the reading glass may be adjusted at any height.

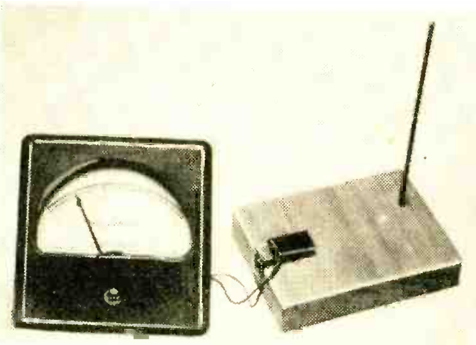
A "Sun Battery" mounted to a wood block directly under the lens and connected to a 0-1 d.c. milliammeter should provide a reading around 0.4 milliampere—using a 100-watt lamp in a reflector about 20" above the lens. Without the magnifying lens, the reading will be slightly over 0.2 milliampere, or about one-half the output obtained when the lens is used.

Of course, the output could be increased by simply moving the lamp closer to the B2M, but 20" is a safe distance since the temperature under the author's lens did not rise over 100°. When the lamp was placed 12" above the lens, a reading of over 140° was obtained with the bulb of the thermometer placed directly under the lens.

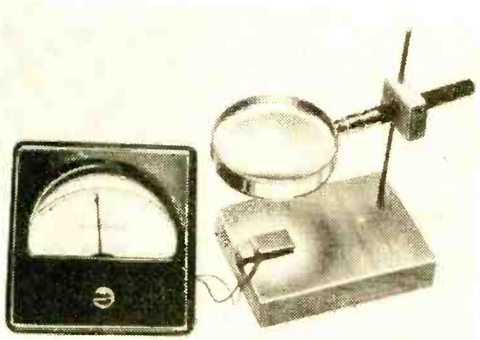
It goes without saying that the lens should not be used on the B2M in direct sunlight, as the intense heat would ruin the selenium cell—which should not be exposed to temperatures over 185°.

While an increase from 0.2 milliampere to 0.4 milliampere doesn't look like much on the meter, it produced a substantial increase in volume when the author used the "Sun Battery" to power a transistorized crystal radio.

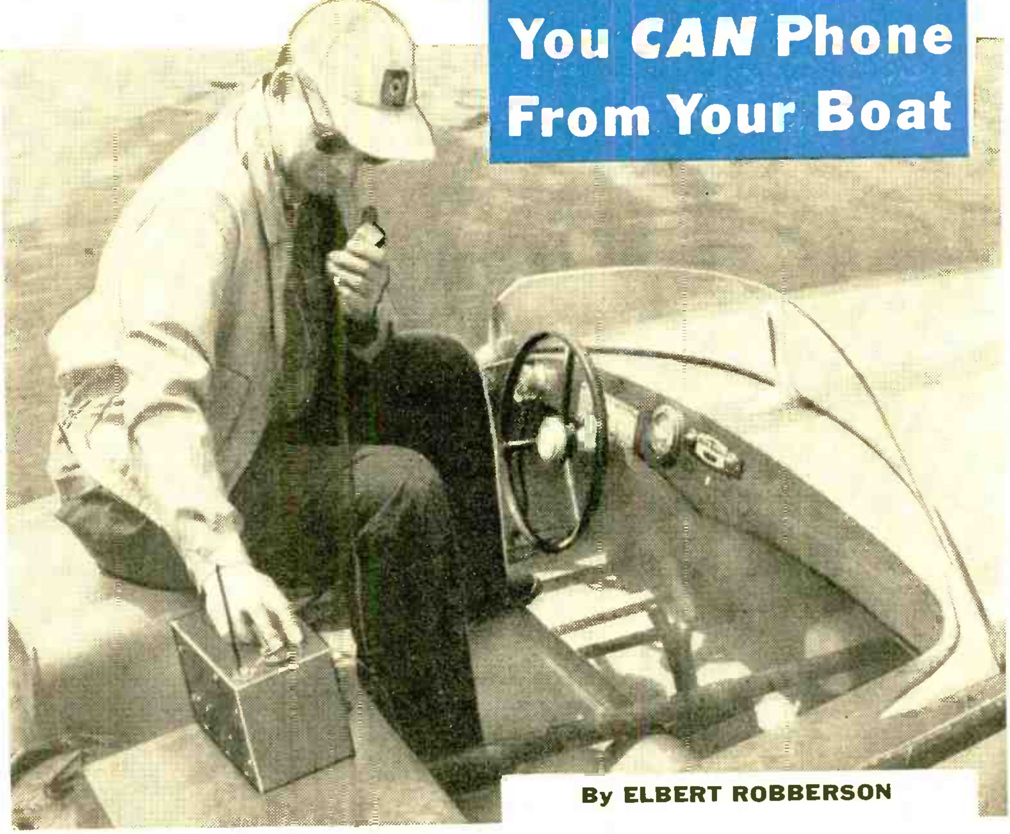
—*Art Trauffer*



Without magnifying glass, the "Sun Battery"—mounted on a wood block and connected to a 0-1 d.c. milliammeter—provides a reading of about 0.2 milliampere when a 100-watt lamp is used.



With the magnifying glass, the "Sun Battery" should give a reading of about 0.4 milliampere—twice that obtainable without the lens. Two holes are punched in eraser for adjusting height of lens.



You *CAN* Phone From Your Boat

By ELBERT ROBBERSON

Marine radiotelephones make communication possible over u.h.f. and medium frequencies

THE FIRST sea-going two-way radio station I ever saw was a room full of wire on a bucket sailing out of Seattle for Alaska. To operate "the wireless," you needed a "Junior Marconi" button; and to raise another ship, your best bet was to maneuver alongside them before calling. Then, without turning on their receiver, they could hear the buzz of the rotary spark gap.

But things have happened in this field! For example, today I was out zipping around Manhasset Bay (off Long Island Sound) in an open 14-foot outboard speedboat. I picked up a microphone, pressed a button on a little grey box alongside me, and said: "2A1499 calling home station—come in please."

My wife's voice came blasting out of a speaker in the little box: "Home station back to 2A1499."

"Come down and meet me at the dock in ten minutes," I told her. "I'm going to tie up for the day."

"Okay," she said. "2A1499 home station off."

The process of evolution from the ship's "wireless" I first saw to the neat grey box has taken more years than I like to recall. But now that manufacturers have developed such small and efficient equipment, a new era is waiting to be enjoyed. While small boatmen used to brave the briny deep in magnificent isolation, sometimes out of sight and always out of touch with land, today anyone—in any size of boat—can take a radiotelephone along.

The kind of radiotelephone you have on your boat depends upon the boat's size, the motive power, and your budget. Among the equipment to be described, there is a radiotelephone for just about everybody. Some of them are portable, operating from their own batteries. Others can be permanently installed and operated from a boat's engine battery.

The smallest radiotelephones have their own antenna systems built on as a part of the equipment. Larger units are designed

This bag totes a medium-frequency radiotelephone good for a hundred miles under favorable conditions. The "center-loaded" whip antenna telescopes into a socket on the side of the equipment, which is made by Sonar Radio Corporation. Unzip the cover, extend the antenna, connect ground, and you're ready to operate the portable six-channel unit.

to connect to a wire in the boat's rigging, or to a specially engineered whip antenna.

More people have outboards than any other kind of boat. Even if you don't own one, you're likely to ride in one before the year is out—just about everyone heads for the water on a hot day, and about one out of five piles into a small boat. If you are in this group, look into the portable u.h.f. radiotelephones which have recently been developed for the 465-mc. Citizens band.

A good example of this gear is the Vocaline radio transceiver (see also the June, 1956, issue of POPULAR ELECTRONICS, page 40) which is priced at $69.75. Licensing is the simplest and easiest formality you can imagine. Just send FCC Form #505—stating your name and address, and giving the identification and type-approval numbers on your equipment—to the nearest FCC district office. Applicants must be over 18 and citizens of the United States.

The transceiver and power supply are contained in one cabinet, complete with loudspeaker and a plug-in quarter-wave antenna rod. One tube is used as the transmitting oscillator, with a two-tube speech amplifier and modulator.

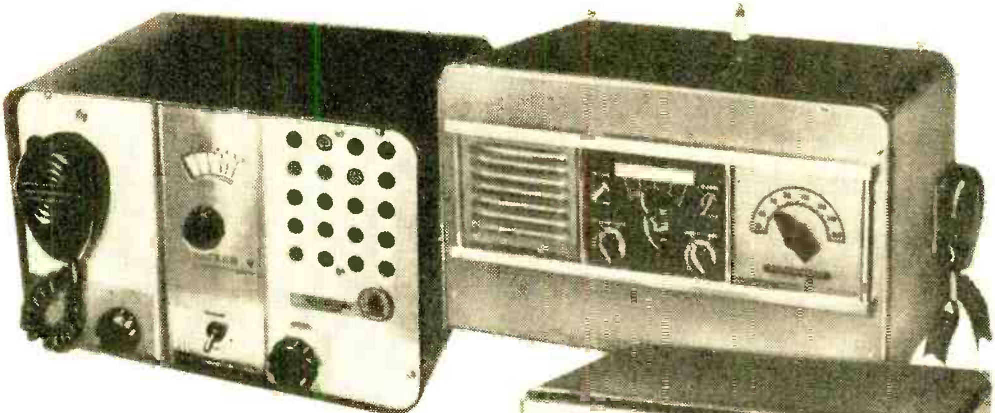
For reception, the same tubes are used. The oscillator turns into a superregenerative detector, and the other tubes make up the audio amplifier to feed the loudspeaker. Pressing a button on top of the cabinet performs all the switching necessary to go from "receive" to "transmit."

The Vocaline transceiver has a dual-purpose power supply. It is hooked up for standard a.c. operation in which a conventional transformer, selenium rectifier and *RC* filter are used. To operate from 6 volts d.c. for portable use, an internal vibrator chops input current into a.c. and applies it to a tap on the same transformer. The switching from 117-volts a.c. to 6-volts d.c. input is automatically accomplished by a system of jumpers in the power cord plugs.

Normally, the station on shore uses a.c. power, while on the boat a small 6-volt battery is all that is required. Current drain at 6 volts is only 3 amperes, so the very smallest storage batteries will serve very well.

Transmission range is line-of-sight, and may extend as far as ten miles "in-the-clear." Through trees and buildings, you can talk over a distance of ½ to 1 mile, depending on how high the sets are from ground (or water) level. Plug-in antennas are available which extend ten feet in the air to improve the working range.

Although u.h.f. telephony is entirely practical for limited-range operation, users must set up their own communication networks, which may be inconvenient. If this is the case, equipment for the medium-



Available commercial radiotelephones include: a Hudson American "Privateer V" low-powered unit (above); Ray Jefferson 'phone (above, right); a Pearce-Simpson "Islander 30" radiotelephone (right); and Raytheon's newest small telephone.

frequency marine channels is the answer.

Let out a yawp on the radiotelephone International Distress frequency of 2182 kc. that you're stuck on a rock or out of gas, and you can be sure that somewhere ears perk up.

And you can do more than just call the Coast Guard or other boats. Shoreside telephone companies maintain ship-to-shore stations in all the large ports; so you can place a call over the land lines just as easily as at the corner soda fountain, for about a dollar more per call.

Until very recently, equipment for these frequencies was not only costly, but inefficient, large, heavy and hungry for amperes. There was no use thinking about a marine 'phone unless your boat carried a husky battery that could be charged fairly continuously by the engine. In addition, you'd have to shinny up the mast with an antenna wire, or mount a long whip antenna somewhere on the superstructure. Naturally, if you didn't have a battery-equipped engine, or a mast or substantial superstructure for supporting a whip, you just didn't think about radio.

But, here again, things are different today. For example, the Sonar Radio Corp. builds a portable six-channel 2 to 3.5 mc. radiotelephone that takes up less than a cubic foot of space. Besides an 8-tube superheterodyne receiver and a 35-watt input crystal-controlled phone transmitter, the unit includes a vibrator power supply, and a 6-volt rechargeable battery. It is completely pre-tuned and will communicate on any of five channels selected by a panel switch. In addition, it can be used to receive the regular AM broadcast band.

A "center-loaded" whip antenna telescopes into a socket on the side of the equipment. To transmit, you just extend the antenna full length, connect the ground terminal to the motor (or some other metal in contact with the water—the larger the better), turn the bandswitch to the desired channel, and go on the air. Talking range is from about 10 to 100 miles, depending upon conditions.

Cost of this radiotelephone is $339.50, ready to operate. A license to use it on a particular boat, or on any boat you may go aboard, is obtained by filling out FCC application Form #501A.

In addition to the station license, a Restricted Radiotelephone Operator's Permit must be obtained to operate a marine radiotelephone in the medium-frequency band. No examination is required.

A small 'phone installation can be made if your boat has any kind of cabin or shelter to protect the equipment. You don't need an engine electrical system. In fact, boats as small as a 16-foot racing sloop have had telephones installed with an 80-ampere car battery for power. By using the telephone sparingly, the battery will last several weeks between charges—and you can either lug it home for a boost whenever needed, or carry a small charger aboard which can be hooked up occasionally to shore current. (*Caution:* In case the charger does not have completely isolated input and output circuits, be sure to disconnect the battery from the radio equipment and the ground connection before charging. Otherwise, harmful electrolysis might attack underwater metal fittings.)

But, of course, if there is an engine storage battery aboard, it is simplest to connect the radiotelephone to this battery. There is nothing tricky about installing a permanent-type radiotelephone—just follow the manufacturer's instructions on input polarity and the size of power wiring and the antenna and ground conductors. However, the final tuning and testing must be performed by an FCC-licensed marine-radio technician. The people who sell the equipment can take care of this.

On powerboats, a telescoping or folding whip antenna mounted to the cabin or windshield framing by heavy stand-off insulators can be used. There are several coil-loaded models designed for this purpose. The higher the antenna, the better the transmitting efficiency and range.

On sailboats, a length of rigging—such as a permanent backstay—can be insulated and used for the antenna. If this is not possible, a satisfactory "skyhook" can often be made by hoisting a wire on the signal halliard, or cleating it to the mast.

Medium-frequency radiotelephones require a ground connection. A twelve-foot or greater area of metal in contact with the water will suffice, although larger surfaces give better efficiency. Metal keels, rudders, or the engine (grounded through shaft and propeller) are often used.

The ignition system of a boat's engine will interfere with reception on the medium frequencies. Usually, the noise can be reduced to a satisfactory level through use of suppressors (or special suppressor spark plugs) and the same kind of capacitors used in silencing auto engines.

Prices of the smallest permanent-type telephones start at just under $300. An idea of the features available can be gained from the accompanying summary of the smallest models in the leading makes. In addition to the 'phone channels enumerated, all of them include broadcast reception—unless otherwise noted—and have press-to-talk hand microphones. To convert the drain wattages given in the table to current consumption at the various input voltages, divide the watts figure by battery voltage.

Your "yacht" doesn't have to be a 60-footer to carry two-way radio today. You can phone from your boat even if the only spare space is on your lap. —30—

Manufacturer and Model	Channels	Frequencies (mc.)	Carrier Output (watts)	D.C. Input Voltages	Approx. Standby Drain (watts)	Approx. Transmitting Drain (watts)
APELCO: AE-18-A	6	2-6	11	6, 12	36	84
BENDIX: "Skipper 28"	6	2-5	15	6, 12	33	84
BLUDWORTH: BRT-1025	4	2-3	10	6, 12	39	90
HUDSON AMERICAN: "Privateer V"	4	2-3	8	6, 12	42	90
RAY JEFFERSON: Model 535	4	1.6-3.5	20	6, 12, 32	54	84
KAAR: Model 37	5	2-4.5	27	6, 12	30	150
MUNSTON: MRT-15	5	2-4.5 (no broadcast)	15	6, 12	60	120
PIERCE-SIMPSON: "Islander 30"	5	2-4.5	14	6, 12	23	108
RADIOMARINE: "Golden Sentry"	5	2-3	12	6, 12	33	102
RAYTHEON: RAY 10A	5	2-6	10	6, 12	39	84
SONAR: M35W	5	2-3.5	25	6, 12	15	90

Super-Safe Testing Assures Survival at Supersonic Speeds

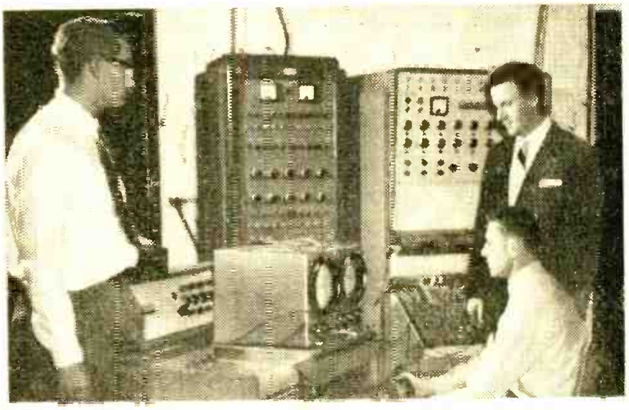
HELPING human beings keep pace with the stepped-up tempo of machines in a supersonic age is one of the really big jobs being tackled by the experts using electronics.

The problem is many-sided, involving the obvious factor of safety to personnel within the framework of constantly rising hazards. A more subtle problem is the one which involves man's psychological reactions to machinery that literally moves faster—and has things going on at greater speeds—than most people are accustomed to. How can you be sure that a man's body will react to strain in time to make certain adjustments, when the strain might hit at supersonic speed?

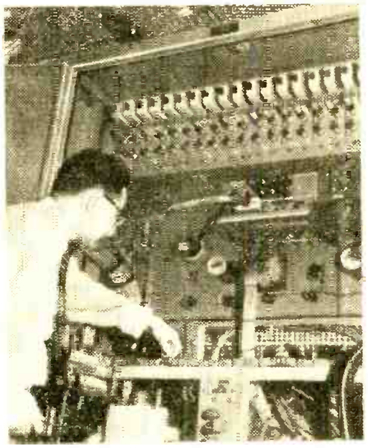
In line with this safety factor is the question of developing better survival equipment, pressure suits, etc. The entire problem is a complex one, impinging on such former widely separated areas of study as physics and psychology.

Helping scientists bridge the gap between man and the new machines he is creating, and must learn to live with, are new and ingenious computers. For example, the Psychology Branch of the Wright Air Development Center's Aero Medical Laboratory has developed a machine that electronically computes various factors to permit an operator to control an airplane or missile traveling at Mach 2 (twice the speed of sound, or roughly, 1500 mph).

On another front in the battle for safety is a giant computing machine that enables engineers to "fly" jet planes before they are actually built. Control tests, performed behind the safety of a data processing board, can predict performance characteristics and smooth over "bugs" that could otherwise cost lives, dollars, and valuable time. This instrument was built for the Air Research and Development Command by General Electric. —30—

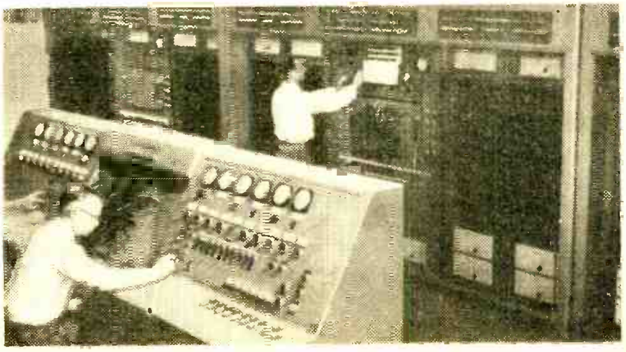


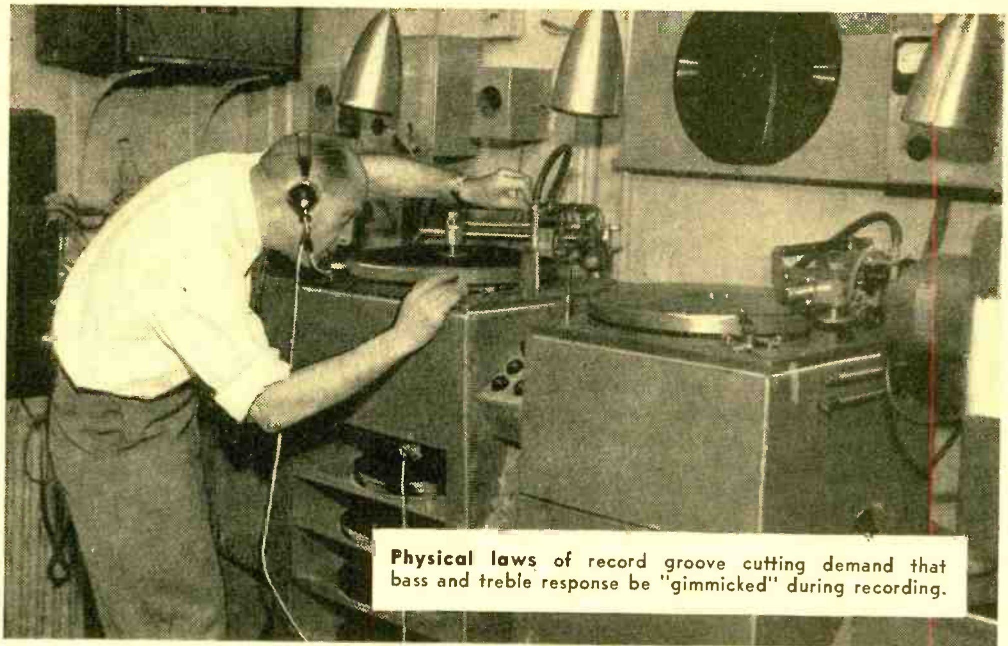
Testing a man's reactions to supersonic flight speeds by seating him at a computer is a lot safer than doing it by putting him into an unproved flying model. Data machines against wall compute factors that simulate flight at "Mach 2" speed.



Engineer adjusts section of giant computer. Built by G.E., this equipment checks out advanced design jet engines before they are built. Millions of dollars, and two years time, are expected to be saved by its use. Twenty-seven miles of wire, 6000 vacuum tubes, 300,000 soldered connections, and an air-conditioning system are among its features.

Control console of jet engine simulator built by G.E. for the ARDC is shown below. Machine occupies floor space equivalent to three average dwellings. Controls, manned by special staff, include 1700 indicating lights and 2750 dials.





Physical laws of record groove cutting demand that bass and treble response be "gimmicked" during recording.

Photo, Courtesy Presto Recording Corp.

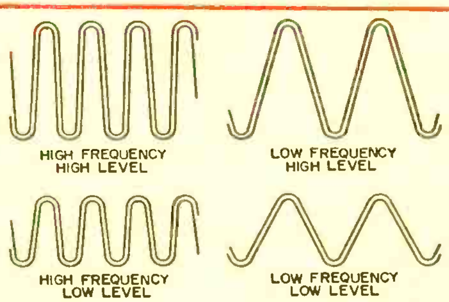
Why We Equalize Our Hi-Fi

By LEON FIELDS
and R. M. JOHNSON

To release completely all the music trapped in your record grooves, use the correct curve on playback

RECORDS may be discs, but they're far from being "flat." The frequency response curve of a modern LP record shows a marked dip in the bass region and a definite rise in the treble area. Most listeners have experienced the "different" tonal quality of different recordings—played on the same hi-fi system with all controls left in the same positions.

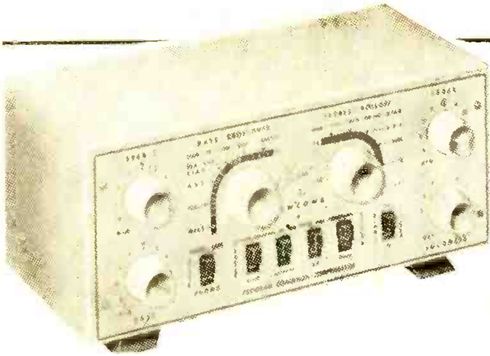
Obviously, the hi-fi system may be "flat" —but not for every record. A new element of "unflatness" is introduced by the record itself. The "unequal" response is due to a deliberate skewing of the frequency curve gimmicked into the recording by the people who made it. During playback, the curve must be counter-gimmicked, or "equalized." Once equalized, the recorded signal assumes the tonal balance it had when it was performed live originally.

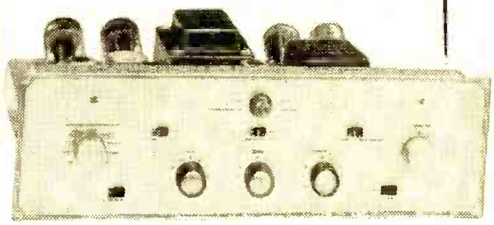


Exaggerated representation of record grooves shows how they change at different frequencies and varying levels of intensity.

If records were to be made without their frequency curves being deliberately "unflattened," there would be no need for equalization. But records are made "unflat" for very good reasons, which have a direct bearing on the quality and fidelity of the recorded music.

Low-Frequency Turnover. The record groove is made by a magnetic cutter. This device has an excellent frequency response but one major drawback—it tends to swing quite wide at low frequencies. If allowed to go unchecked, the magnetic cutter would describe a groove whose amplitude would be too great for practical use. Such a groove would take up too much space on the record; what's more, during playback the pick-





Equalization settings on representative amplifiers. Separate controls for turnover and roll-off are included on Newcomb "Classic" (above). Scott 99-B (upper right) has six equalization positions on input selector switch; simplification is achieved by grouping several similar curves under one heading. Altec "Melodist" (right) simplifies problem even further, with only four equalization settings on selector switch. General idea is to provide low-cost unit with enough versatility to handle most records.

up would have a very hard time indeed tracking such a groove.

To overcome these problems, the recording engineer resorts to a trick: he records all the bass notes but restricts the lateral excursions of the cutter doing the job. Consequently, frequencies below a certain point in the audio range (the "bass turnover" point) are actually recorded with less intensity than frequencies above that point. To hear them correctly, then, some kind of "boost" must be provided on playback. More of this later.

Pre-Emphasis and Roll-Off. As the low end of the audio band is restricted in amplitude on a record, so is the high end artificially boosted. At high frequencies, the magnetic cutter would produce grooves of such tiny amplitudes that the desired signal would be overwhelmed by noise—high-frequency noise from the cutting process itself and from the very structure of the record surface material. To obtain the added signal strength needed by the highs in order to ride over the noise, the recording engineer forces the cutter to describe grooves whose amplitudes are somewhat greater than they would be "normally."

The additional amplitude for these grooves is obtained by treble boost or "pre-emphasis" in the recording process. Frequencies above a certain point in the audio range (the treble "roll-off" point) are actually recorded with more intensity than frequencies below that point. To hear them correctly, some kind of high-frequency reduction, or cut, or "roll-off" must be provided on playback.

As a result of these bass and treble tricks

GLOSSARY OF TERMS

Boost—Increasing the amplitude, or relative intensity, of a signal from a completely flat or uniform level.

Constant amplitude—A method of record cutting in which the side-to-side, or lateral, excursions of the cutter are held to a fixed limit on the record. Also, a type of playback cartridge (specifically, a crystal or ceramic cartridge) in which changes in frequency correspond to changes in the amplitude of the groove being tracked.

Constant velocity—A method of record cutting where lateral speed of the cutting stylus is the same regardless of frequency. Also, a type of playback cartridge (magnetic) in which changes in frequency correspond to the changes in the lateral velocity of the tracking stylus.

Cut—Decreasing the amplitude of a signal from a flat level (opposite of "boost").

Lateral excursion—The side-to-side movement, or undulation, of either the cutting stylus or the playback stylus in following the record groove.

Magnetic cutter—A magnetic head, fitted with a cutting stylus, and driven by a high-powered amplifier. The cutter impresses the groove on a record.

Playback—Converting the recorded signal into sound by means of a pickup, amplifier, and speaker.

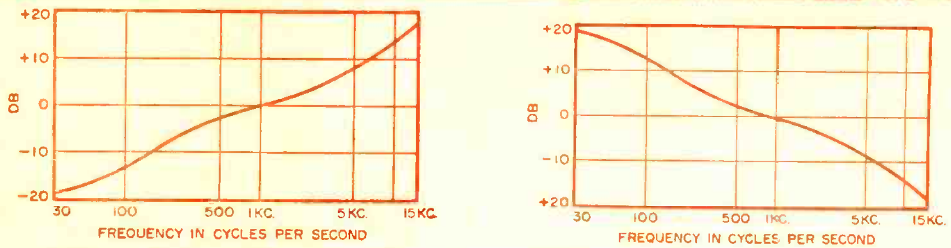
Pre-emphasis—Providing boost for treble frequencies above their normal intensity level. When used in recording, it must be equalized by roll-off during playback.

Recording—Converting live sound into a record by means of a microphone, amplifier, and magnetic cutter. The amplifier required to drive a cutter is of much higher power rating than that needed to drive a loudspeaker for playback.

Roll-off—Reducing the intensity of the recorded treble frequencies during playback. Roll-off is accomplished by a gradual—rather than sharp—decrease in treble intensity.

Tracking—The movement of a stylus as it follows the record groove.

Turnover—A frequency below which all bass notes are attenuated or reduced in amplitude during recording. Also, the same frequency below which all notes must be "boosted" during playback.



Curve at left is typical characteristic used by record manufacturer. Bass response has been decreased in amplitude; high end has been boosted. Playback, without correct equalization, would produce "unflat" tonal response. Curve at right is RIAA playback characteristic; note how its bass and treble portions are treated to counteract recording characteristic.

employed during the cutting of the record, the frequency curve impressed on the disc is anything but "flat." Such a curve, played back with no equalization, would produce very weak bass and screechy treble.

For proper playback, the bass must now be boosted, and the treble cut. The recording characteristic curve must be matched by its exact opposite—or inverse—curve. This curve, called the "playback equalization curve," is obtained from fairly simple circuits which are inserted after the cartridge in a playback system. Such circuits are invariably incorporated in all modern amplifiers.

Why Different Curves? A few years ago, when hi-fi recording came into its own with the development of improved equipment and record surface materials, engineers had to grapple with the problem of extended frequency range. The methods of turnover and roll-off, just described, were given more attention.

The big trouble was the lack of universal agreement on selecting the exact frequency for bass turnover and the precise degree of treble roll-off. Objective considerations of stylus velocity and groove amplitude were often compounded and confounded with subjective opinions of "what sounded right." As a result, there were almost as many recording curves as there were recording companies. The table on this page lists the more prominent of these curves.

In mid-1953, the Recording Industry Association of America (RIAA)—an organization made up of nearly all the record manufacturers in this country—agreed on one curve to do the job. By May, 1954, the RIAA curve was adopted throughout the

SWITCH POSITION	FULL NAME OF CURVE	COMMENTS
AES	Audio Engineering Society	Dates from 1951.
BBC	British Broadcasting Corp.	Not used in USA.
COL	Columbia Records	Used prior to 1954.
DEC, or DEC-FFRR	Decca Records, British Div.	See "FFRR."
DEC-LON	Decca Records, London Div.	Similar to "COL" curve.
EMI-78	EMI Studios, Ltd., London	Used only in Great Britain.
EUR	"European"	Makeshift curve conforming to no specific recording characteristic, but approximating a playback curve for old foreign records.
FOR	"Foreign"	See "EUR."
FFRR	"Full frequency range recording"	Dates from 1949. "FFRR" is trade-mark of American Division, Decca.
HMV	"His Master's Voice"	RCA, British Div.
LON	London Records, Inc.	See "DEC-LON."
LP	"Long-playing"	See "COL."
NAB	National Ass'n. of Broadcasters	Dates from 1949.
NARTB	National Ass'n. of Radio and Television Broadcasters.	Evolved from old NAB curve; now taken to mean same as RIAA curve.
ORTHA	"Orthacoustic"	Similar to old NAB curve with response extending down to 30, and up to 15,000 cps.
ORTHO	"Orthophonic"	Used by RCA; same as RIAA curve.
POP	"Popular"	Another makeshift curve designed to boost bass and provide sharp treble roll-off; makes for "juke-box" effect.
RIAA	Recording Industry Association of America	The standard curve in the USA since 1954; same as NARTB and ORTHO (see text).

Playback curves that have been used in recent years. Each curve equalizes the pickup to provide a flat response for a given recording characteristic. Because of similarities among curves, many amplifiers group several curves under the same switch position. Such settings make for lower cost amplifiers and come close enough for practical use. Since mid-1954, all records made in the USA follow the RIAA curve.

industry. Virtually all new discs cut since then follow this curve.

The RIAA curve represents a carefully worked out compromise which combines the best features of all older curves. It is an excellent curve for recording, and when properly equalized on playback provides full frequency range, tonal balance, proper dynamics, etc.

Equalization Settings. The record collector may now ask: "What about my records made before the use of the RIAA curve? Don't I need at least two dozen different equalization settings on my playback equipment for them?"

Well, to be completely precise and scientific, you might need more than that. But let's be realistic—the table on this page shows the deviation of two widely used older curves from the new RIAA curve. Note that the average discrepancy in response is hardly more than 2 decibels. This figure constitutes about the lowest perceptible change in level that most human ears can detect under any circumstances.

True, we have picked two curves for comparison which are fairly close to the RIAA curve. But there is a significant pair of controls on your equipment to help solve the problem: the treble and bass tone controls. The range of compensation available on most hi-fi tone controls is wide enough to simulate any playback characteristic. A slight degree of bass or treble adjustment, superimposed on the RIAA response curve, will approximate or equal virtually any recording characteristic dreamed up by recording engineers.

Amplifiers which incorporate a variable equalizer control, with several control settings for different curves, simplify the job for you. All you have to do is select the correct equalization position for a given record. This position is stipulated by the record manufacturer or by the amplifier manufacturer.

Such a control is, of course, a great convenience and provides a simple and accurate means of compensating for the particular recording curve used. The less costly amplifiers may have anywhere from three to six such equalization settings on one rotary switch. The more expensive units, particularly those which use a separate chassis for the preamp-control, may provide separate switches for five positions of turnover and five positions of roll-off, thus affording a total of (5 × 5) = 25 different playback curves.

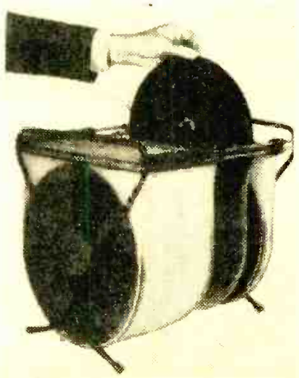
Using an amplifier with a built-in variable record equalizer frees the treble and bass controls for the ultimate in subtle adjustments to suit all listening moods and room acoustics. This is a sometimes complex subject to be handled in a subsequent article. Also to be discussed in a future issue are the newer types of crystal and ceramic pickups which handle the problem of playback equalization in a different and quite intriguing way. —30—

FREQUENCY	AES	LP
30	−3.9	+4.6
50	−1.0	+3.7
100	+1.1	+1.6
300	+1.0	0.0
400	+0.8	−0.2
500	+0.7	−0.3
1000	0.0	0.0
2000	−0.4	+0.4
5000	−1.1	+1.3
10,000	−1.7	+1.8
15,000	−1.7	+0.4

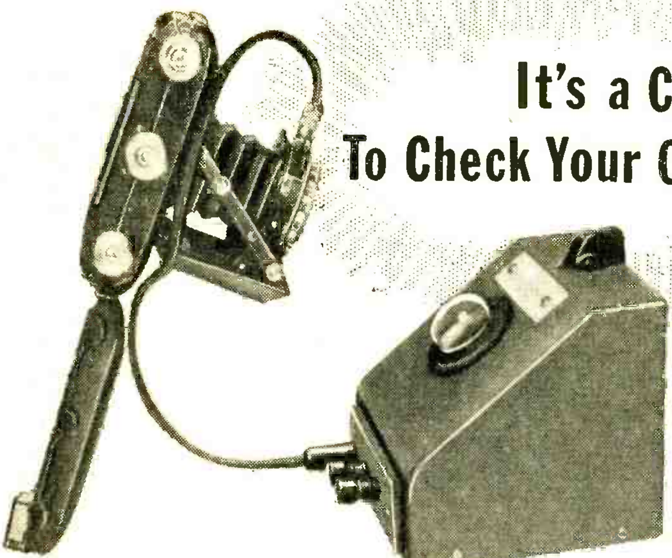
Two widely used older curves were the AES and Columbia's LP. This chart shows the amount of error incurred when playing records made with such curves and using the new RIAA playback curve instead of the AES and LP curves theoretically required. Average discrepancy is about two decibels, scarcely audible. Bass control handles frequencies below 1000 cycles; treble, above 1000 cycles. Increase setting to compensate for minus error; decrease to compensate for plus error.

Accessories Clean, Store Records

NEW ACCESSORIES, designed to make life easier for hi-fi enthusiasts, and safer for their prized records, have been announced by Robins Industries Corp., 214-26 41st Ave., Bayside 61, N.Y. Shown in the photo is "Audio-File" AF-50—a series of suspended plastic containers. Each container is transparent and self-closing. Besides holding up to 50 records safely and keeping them free from warpage, the unit permits you to file discs in any fashion. Retail price is $24.99.



For cleaning records, Robins has produced "Jockey Cloth" SC-1. Chemically treated, the cloth eliminates the static charges on records that attract dust and grime. The cleaned record sounds better and lasts longer. Needle wear is also reduced. The cloth sells for $1.00.



It's a Cinch To Check Your Camera Synch

By
R. L. WINKLEPLECK

The synch tester is used by looking through open back of camera and observing image of the shutter when it is tripped.

ALMOST EVERY amateur photographer must wonder many times whether or not his flash gun is properly synchronized with his camera shutter. For the benefit of the casual photographer, "synchronization" is the happy state when the camera shutter reaches its maximum opening simultaneously with the peak light output of the flash bulb. A few photographic repair shops have synchronization checking devices. Generally, however, an effort is made to match flash and shutter either by eye or by actually making a few test shots.

The average between-the-lens shutter is wide open for only a few thousandths of a second (milliseconds), and most flash bulbs are at rated output for a similarly short period. Consider further that the flash bulb reaches its rated output, not instantaneously, but either 5 or 20 milliseconds after the flash circuit is closed. If flash synchronization is to be even closely approached, an exact test method is needed.

HOW IT WORKS

This circuit places a 150-volt charge across the OA4G tube's cathode and anode, which are shunted by a 1.0-μfd. capacitor. The flash contacts of the camera or synchronizer, when closed, apply a voltage to the starter anode which triggers the tube instantly. This is the setting to use when synchronizing electronic flash guns that have a zero delay. When a resistance of 350,000 ohms is placed in the starter circuit, the tube flashes five milliseconds after the contacts are closed to match the delay of Class "F" flash bulbs such as SF and SM. By increasing this resistance to 1.5 megohms, a delay of 20 milliseconds is achieved which corresponds to that found in Class "M" flash bulbs such as Press 25 and #5. Power for the OA4G is supplied by a simple rectifier circuit consisting of *SR1*, *C1* and *R6*.

Probably not one flash gun in fifty in use today is really and truly synchronized. In most instances, peak flash brilliance and open shutter occur closely enough to produce a picture. However, a lot of valuable flash light is wasted. This means that money must be spent on large bulbs when small, less expensive ones would do the job, or else it's necessary to use a large aperture when a smaller one with greater depth of field would give a better picture. It means standing too close to the subject to get enough light and, even worse, it frequently means underexposed negatives.

Here is a straightforward design for an electronic flash synchronization tester which is entirely accurate and so simple that almost anyone with a soldering iron can put it together in an evening. Best of all, the essential parts cost well under ten dollars—and this figure can be easily chopped in half by digging into the ever-present junkbox.

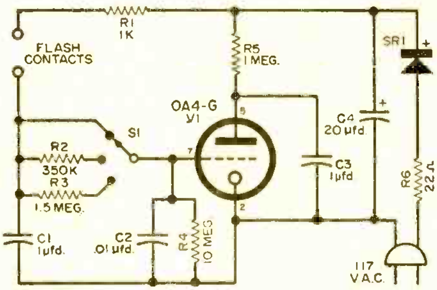
The heart of the tester is an OA4G cold-cathode thyratron tube which emits a weak, blue-white light when it is "triggered." It has especial merit for this job since it flashes very dependably under a given set of conditions and the flash is of very short duration. Light intensity is increased in this application by temporarily overloading the tube.

Wiring the tester is simplicity itself. Lead length or arrangement is unimportant. It's only necessary to observe good construction practice. By taking advantage of the otherwise unused tube-socket connections, most of the parts can be soldered directly to the socket. This may conveniently be done before the socket is fastened in place. The flash contact posts and the triple-throw switch provide additional tie points. Be sure to observe correct polarity of the electrolytic capacitor.

To use the synch tester, attach the camera or synchronizer flash contacts to the tester's contact posts. Open the aperture wide and set the shutter at the speed recommended for flash. Open the back of the camera and aim the lens at the OA4G. When shutter is tripped, tube will fire.

Watch through the open back of the camera and, if the synchronization is perfect, the light of the tube will be seen through the wide-open lens. If the synchronization is nearly right, the light will shine through the partially open lens with the individual leaves of the shutter outlined in sharp detail. The extremely short flash duration stops shutter motion dead.

Binding posts and sockets on front panel permit connections of various types of camera flash cords.

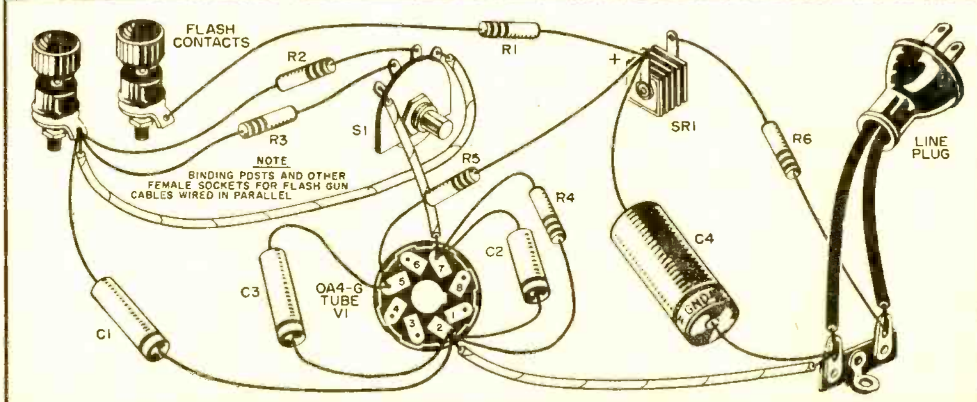


C1, C3—1-µfd. capacitor
C2—.01-µfd. capacitor
C4—20-µfd., 150-volt electrolytic capacitor
R1—1000-ohm, 1-watt resistor
R2—350,000-ohm, ½-watt resistor
R3—1½-megohm, ½-watt resistor
R4—10-megohm, ½-watt resistor
R5—1-megohm, ½-watt resistor
R6—22-ohm, ½-watt resistor
S1—1-pole, 3-pos. switch (Centralab Type 1461)
SR1—65-ma. selenium rectifier
V1—OA4G tube
1—Octal socket
2—Binding posts

Schematic wiring diagram and parts list.

Slight adjustment of the synchronization will show whether the shutter is opening early or late, and a bit more adjustment will put it right on the nose. If no light can be seen through the lens, the synchronization is way off and adjustment will gradually bring shutter and flash into alignment. It's as simple as that.

This tester can be put together as a breadboard layout, but it will be more satisfactory housed in any convenient size and shape of box. An inclined front meter box is very good, and the addition of several receptacles to take the various types of flash cords serves to make the unit quite versatile. —30—

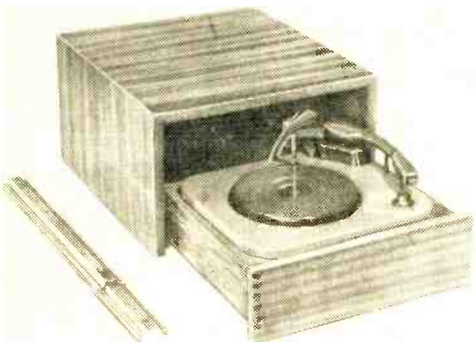


Pictorial diagram of the synchronization tester shows how to hook up various parts.

TOOLS and GADGETS

STEEL SLIDE FOR RECORD CHANGERS

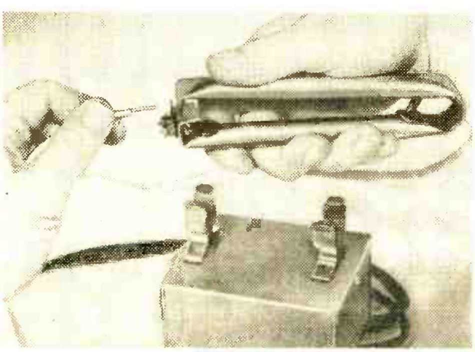
A low-cost sliding device for record changers and tape recorders now makes it possible to pull out these units to their full



depth, thus providing easy access for proper operation. It is supplied with neoprene mountings which cushion the transmission of vibration and shock, and features a quick release and a positive-lock stop. Only one such device is required for each instrument—eliminating the need for careful alignment, and reducing installation costs. (*Steel Slides, Inc.*, Dept. SS310-12, 1 Lawton St., Yonkers, N. Y.)

HOT WIRE STRIPPER

Wherever a hand stripper is needed for plastic insulated wire, you can use this hot wire stripper to advantage. With a heated nichrome wire to sever the insulation, a simple twist of the wrist cleanly strips the



wire. It is impossible to cut or nick even the finest wire strands since no sharp blades are used.

Made from durable stainless steel tubing, the stripper unit is lightweight and easily operated. Power is supplied from the regular 117-volt a.c. supply through a step-down transformer housed in a grey metal box. Also provided are an "on-off" switch and a handy metal clamp for holding the stripper when it is not in use. Price, $18.95. (*Western Electronic Products Co.*, 655 Colman St., Altadena, Calif.)

"DO-IT-YOURSELF" TUBE TESTER

You can test your own TV and radio tubes—and even your picture tube—easily and safely with this A.B.C. tester. Just plug the lead cord into any a.c. or d.c. outlet, insert the tube in the socket, and the pilot light on the tester will instantly indicate whether the tube needs to be replaced. If the test light fails to go on, the tube is bad. One service call saved will pay for this precision instrument which is housed in a

rugged metal case. Only $3.95 postpaid, or c.o.d. plus charges. (*Omega Electronics*, 4700 W. Washington Blvd., Chicago, Ill.)

RADIO OR TV VOLUME CONTROL

"Tello" automatically turns down your radio's volume as you pick up the telephone—when you finish talking, the original volume is restored. "Tello" is a device which clips onto the telephone stand; its two leads are connected to the speaker terminals of the radio or TV set. Lifting the receiver activates the device by shunting a suitable load across the speaker voice coil. Replacing the telephone receiver cuts out the "Tello" action. Retail price, $5.79. (*Tello Corp.*, 342 Madison Ave., New York 17, N. Y.)

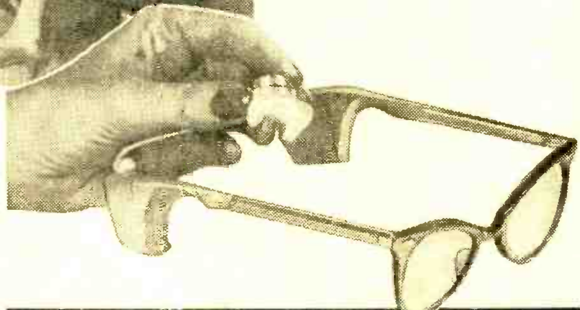
BRASS CLIP FOR TAPE REELS

"Magi-Clip" keeps recording tape from unreeling. A non-magnetic brass clip, it holds the tape securely and reduces tape wear. Snapping over one flange of a tape reel, it lets you handle, mail or store neat

(*Continued on page* 104)

"Table-model" hearing aid, vintage 1924, weighed about 124 lbs. This pioneer design by Radioear Corporation created a sensation in its day by allowing two hard-of-hearing people to conduct normal office work, such as dictation, with one another. The telephone was also wired into the audio amplifier, flashing a light whenever the bell rang.

By contrast, the latest model by the same company (below), is completely contained in ear pieces of glasses—including microphone and battery.



Miniaturization Shrinks Hearing Aids

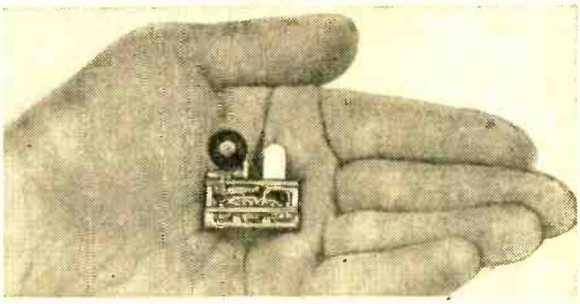
MODERN hearing aids are a direct outgrowth of radio. Both are based on the same principles of sound amplification through vacuum tubes. The development of hearing aids has largely paralleled that of radio in the growing electronic sophistication of circuits as well as in their physical design.

Back in the nineteen-twenties, people with impaired hearing first discovered that they could understand spoken words far better on the radio through earphones, turning up the volume control. The idea then suggested itself to construct electronic amplifiers exclusively for the improvement of hearing. These early models were huge six-foot table-type monsters powered by 6-volt automobile batteries and huge 135-volt B batteries.

As radio components grew progressively smaller over the years, the bulk of hearing aids shrank to the portable dimensions of a small suitcase and later to the still familiar pocket models.

The next step in miniaturization came in 1953 when transistors took the place of the relatively large and fragile tubes. This also eliminated the need for the B battery since transistors need only an A battery to function. It is historically noteworthy that these hearing aids were the first commercial application of the then newly developed transistor.

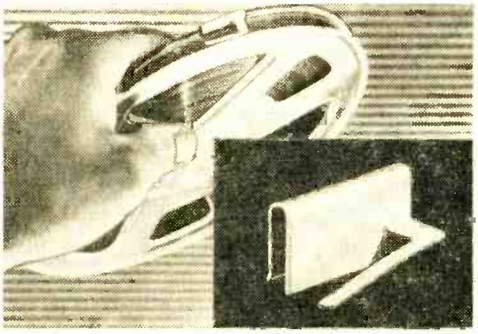
The pictures on this page are dramatic proof of the miniaturization achieved in hearing aids, which set the trend for all fields of electronic design. —30—



Heart of the modern eyeglass hearing aid is this tiny three-transistor amplifier (above) weighing less than half an ounce. Black "knob" on left is volume control which protrudes through slot in case. Next to it is the clip, which holds a battery of aspirin tablet size that lasts about 130 hours. Battery is shown in center of picture below, flanked by a dime and the former battery model for size comparison.

reel without fear of either unwinding or wrinkling.

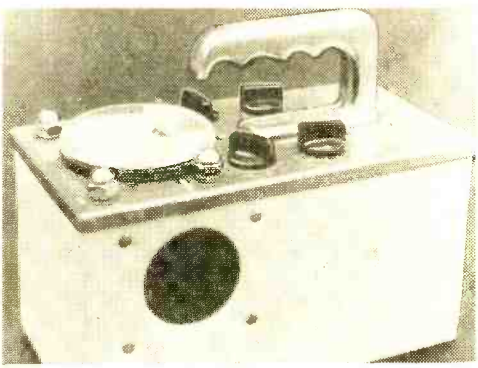
You can apply or remove a "Magi-Clip" with one hand. Fitting any size of reel, it can be used on either full or slightly less



than full reels. Four for $1; 10 for $2; 30 for $5. (*Niblack Thorne Co.,* Dept. P-1, Box 86, Scottsdale, Arizona)

SCINTILLATION COUNTER FOR CARS

If you want to go prospecting in an automobile—this is for you! The built-in loudspeaker of the Model 143 scintillation counter starts giving out a tone when your car is driven in the vicinity of a radioactive deposit (i.e., when a preset gamma radiation level is reached). And the sound increases in pitch proportionately as your car



comes closer to the deposit (when the preset level is exceeded).

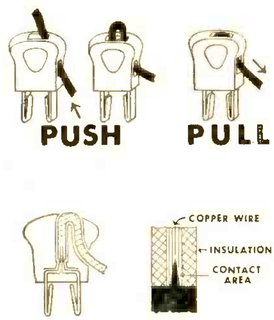
The Model 143 can be used with headphones in an airplane or in a noisy place, and it features a built-in battery tester that individually tests each battery in a few seconds. It has an eight-range sensitivity switch and five time constants. All tubes are of the plug-in type and most of them can be obtained at any radio store. (*Gardiner Electronics Co.,* Phoenix, Arizona)

TRANSISTOR RADIO KIT

Listing at only $8.95, the "Trans-Atomic" transistor radio kit features matched germanium transistor and diode, calibrated slide rule dial for precision tuning, world-famous "Loopstick" for added power, and an unbreakable palm-sized plastic case. The set will operate for months on its self-contained 10-cent flashlight batteries. It can be assembled in one evening with only a screwdriver. (*Superior Electronics Corporation,* 4-6 Radford Place, Yonkers, N. Y.)

"PUSH-PULL" ELECTRIC PLUG

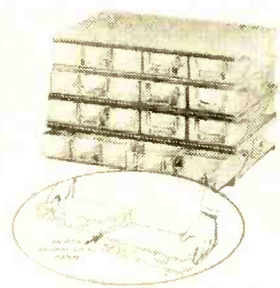
Wiring is easy and fast (five seconds) with the Jiffy "Push-Pull" plug. There are no moving parts to misalign or get out of order, and it is said to give eight times the contact area of a standard automatic plug. Common No. 18 parallel cord is pushed through one slot into the other and then pulled tightly — that's all it takes.



A metal wedge 3/16" long enters directly into the cord end, without piercing any insulation. The cord comes from the side of the plug where it should be; so it lies close to the wall, out of the way. The plug is available in brown or ivory Bakelite. (*Eagle Electric Mfg. Co., Inc.,* 23-10 Bridge Plaza South, Long Island City 1, N. Y.)

"SEE-THRU" DRAWER CABINETS

If you're a *find*-it-yourselfer as well as a do-it-yourselfer, you'll appreciate the STAK-UP "See-Thru" drawer cabinets which keep contents dust-free, easily accessible, and in full view at all times. The drawers are made of heavy-gauge clear plastic. An interlocking feature lets you stack each cabinet quickly and safely to any

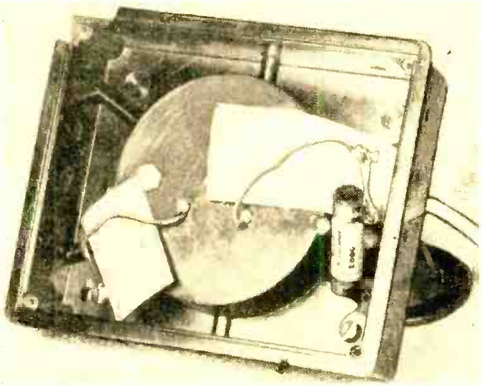


practical height. The sturdy metal cabinet frames come in five different colors to match most office and workshop decors. Removable dividers provide three compartments in each drawer. Two different models are available: No. ST-130 has one double and two single drawers, and No. ST-150 offers the double and four single drawers. (*Jayem Sales Corporation,* 31 Coffey St., Brooklyn, N. Y.) —30—

TIPS and TECHNIQUES

AMMETER CONVERTS TO VOLTMETER

By connecting a suitable resistor in series with the meter element, an ammeter may be converted into a voltmeter. The photo shows a 15-milliampere meter with a 1000-



ohm resistor connected to it. The scale to be used for measuring volts will, of course, be the 0-15 scale.

To convert this scale, use Ohm's law:

$$R = E/I$$
$$R = 15/.015$$
$$R = 1000 \text{ ohms.}$$

Similarly, a 10,000-ohm resistor in series with the meter element converts the meter for measuring up to 150 volts. —*H.L.*

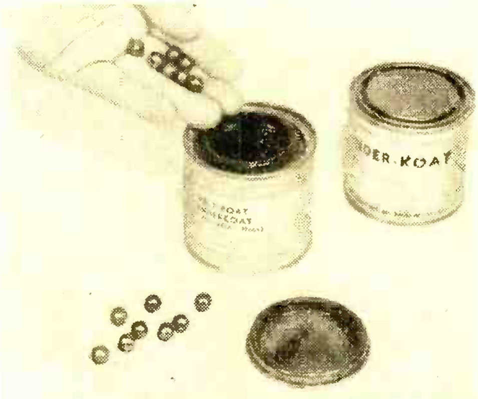
"SELF-STIRRING" ENAMELS

It is not unusual to find several cans of enamels or varnishes in the typical electronics workshop. Glossy enamels and crystalline and wrinkle varnishes are used for finishing metal panels and cabinets. Thick "undercoat" varnishes serve as reflocking for phono turntables. Conventional varnishes and paints may be applied for finishing radio and TV cabinets as well as loudspeaker enclosures.

In most cases, these finishes are used at infrequent intervals, with the result that the pigments tend to settle in the bottoms of the cans.

You can convert your cans of enamels and varnishes into "self-stirring" cans simply by adding a half-dozen or more pieces of heavy buckshot. Steel balls from discarded ball bearings will also do nicely. Use balls with at least a ¼" diameter. If you prefer buckshot, use at least the #00 size, or larger.

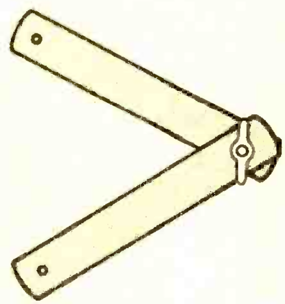
With buckshot or balls added, a vigorous



shaking of the can prior to use will do a topnotch mixing job. —*L.E.G.*

EASILY MADE MOUNTING HOLES

Laying out mounting holes on a chassis for transformers, chokes, and other components can be an easy job. Take any two short, equal lengths of metal strips and bolt them together at one end to form a "V" (see drawing). A bolt and wing nut will hold them in place. Two 4" pieces of aluminum strip with ⅛" holes drilled ½" from both ends work fine—so do the strips from an Erector set. To use the "V," spread the pieces till the holes match those on the part being mounted. Transfer the "V" to the desired mounting place on the chassis, mark the holes and drill. You'll find this to be an accurate method.—*B.E.*



TIN FOIL AIDS TV RECEPTION

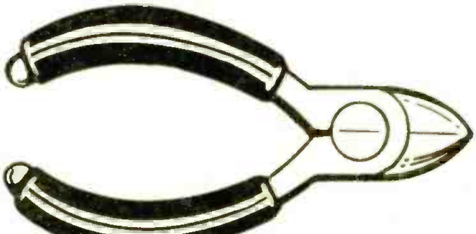
If the picture on your TV set is marred by interference from an FM station or any other nearby transmitter, here is an easy stunt that may effect an improvement.

Wrap a 2" x 2" length of household aluminum foil snugly around the twin-line antenna lead where it is connected to the set. Slide the foil slowly along the twin line in the direction of the antenna while watching the TV picture for an improvement. What you are actually doing is using the inductance and capacitance of the twin line and the foil to tune out the interference.

When the point of best reception is found, squeeze the foil tightly around the twin line and tape it in place. Wrap a second piece of foil around the twin line on the antenna side of this point and move it along the line toward the antenna, as before, until a second point of improvement is found. Squeeze and tape this one in place. If desired, additional pieces of foil may be added in the same manner.

NEW USES FOR OLD COAX INSULATION

Old coaxial insulation can be used to advantage in many applications. Large insulation, such as is used on RG8/U, provides



insulated handles for tools. Simply cut to desired length and slip over handle.

The inner covering can serve to insulate small screwdrivers. Melt the end with a

soldering iron to keep the insulation firmly in place on the shank.

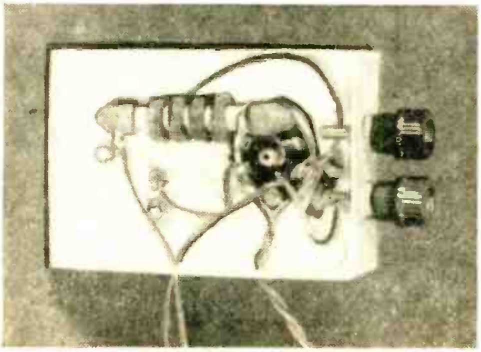
Another use for outer insulation is as a substitute for spaghetti. Also, two pieces of spaghetti can be joined with coax insulation to form a continuous connection.

Holes in the workbench can be filled in with insulation. Melt enough to fill the hole, stuff it in, and wait for it to cool. Then file off the excess until the insert is flush with the bench surface.

And finally, feedthrough insulators and grommets can be fashioned from the coax insulation. —*D.M.D.*

PAPER-BOX CHASSIS

It is customary to use a breadboard when hooking up temporary circuits. But sometimes the flatness of breadboard-type construction is not nearly as desirable as the "boxiness" of chassis-type construction. However, chassis work involves drilling and cutting and expensive spoilage.



A simple solution is to use a cardboard box for the experimental chassis. You can work it with scissors, knife, scratch awl, and razor blade. No hard drilling, sawing, filing, or cutting is required. If you don't need the shielding that a metal chassis provides and if your circuit components won't get hot enough to set paper on fire, the paper box chassis works fine. The accompanying photograph shows a box-mounted Pierce crystal oscillator. —*R.P.T.*

SOURCE OF SUBMINIATURE WIRE

Sizes #20 and #22 hookup wire, popular for conventional wiring and circuit assembly, are much too large for proper wiring of subminiature circuits, such as are used in hearing aids, tiny radios, transistor gadgets, and similar devices. Unfortunately, few parts distributors stock hookup wire in really small gauges, and the limited stock that is available is generally priced quite high.

But if you've a typical shop, you have a ready *and inexpensive* source of subminiature wire already in stock. *Simply strip moderate-size stranded wire!* The resulting

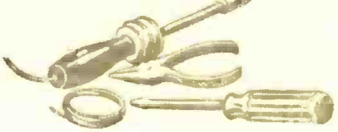
fine wire may be used bare, or may be given several coats of clear plastic (simply by dipping) for insulation. For moderate and higher voltage insulation, use small-size spaghetti tubing. —*L.E.G.*

FULLY ERASED TAPE

When making a new recording on a tape containing a previously recorded program whose signal level is fairly loud, the erase head on some home machines may not completely erase the original recording. This program then remains in the background under the new recording. It is well known that in such cases the old recording can be erased satisfactorily by running the tape through the machine prior to making the new recording, with the controls set for

(*Continued on page* 112)

build your own **HEATHKIT**



... and have fun doing it!

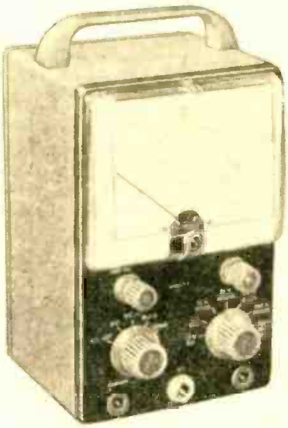
Every Heathkit comes complete with detailed step-by-step instructions and large pictorial diagrams that insure successful construction—even for the beginner. Enjoy both the satisfaction and the economy of "building it yourself."

Circuit boards cut assembly time in half

1% resistors insure instrument accuracy.

High impedance and high sensitivity.

Attractive styling—functional design.



MODEL V-7A

SHIPPING WT. 7 LBS. **\$24.50**

etched circuit vacuum tube

voltmeter kit

In addition to measuring AC (rms), DC, and resistance, the modern-design V-7A incorporates facilities for peak-to-peak measurements. These are essential in FM and television servicing.

AC (rms) and DC voltage ranges are 1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC voltage ranges are 4, 14, 40, 140, 400, 1400, at 4,000. Ohmmeter ranges are X1, X10, X100, X1000, X10K, X100K, and X 1 megohm. A db scale is also provided. Polarity reversing switch provided for DC measurements, and zero center operation is within range of the front panel controls. Employs a 200 microampere meter for indication. Input impedance is 11 megohms.

Etched metal, pre-wired circuit boards insure fast, easy assembly and result in reliable operation. Circuit board is 50% thicker for more rugged physical construction. 1% precision resistors used for utmost accuracy.

Heathkit HANDITESTER KIT

MODEL M-1

\$14.50

Shpg. Wt. 3 lbs.

The Model M-1 measures AC or DC voltage at 0-10, 30, 300, 1000, and 5000 volts. Measures direct current at 0-10 ma and 0-100 ma. Provides ohmmeter ranges of 0-3000 (30 ohm center scale) and 0-300,000 ohms (3000 ohms center scale). Features a 400 microampere meter for sensitivity of 1000 ohms per volt. Handy and portable. Will fit in your coat pocket, tool box, glove compartment, or desk drawer.

Heathkit VOM KIT

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

Features 4½" 50 ua meter and 1% precision resistors.

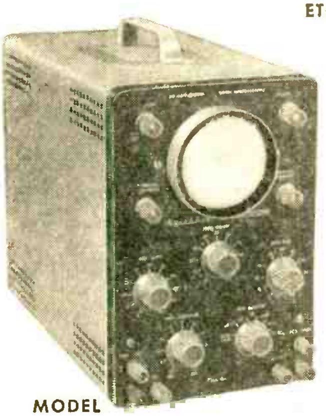
MODEL MM-1

\$29.50 Shpg. Wt. 6 Lbs.

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* BENTON HARBOR 5, MICHIGAN

Heathkit 3" oscilloscope kit

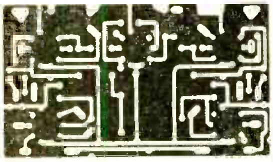
ETCHED CIRCUIT



- Push-pull vertical and horizontal amplifiers.
- Light weight and small size for portability.
- Good sensitivity and broad frequency response.
- Etched metal circuit boards for simplified assembly.
- Attractive panel and case styling.

MODEL OL-1

$29.50 Shpg. Wt. 14 Lbs.



This compact little oscilloscope is just the ticket for use in the ham shack or home workshop. Measures only 9½" H. x 6½" W. x 11¾" D. Weighs only 11 pounds.

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

- Cathode-follower output for isolation.
- No oscillator calibration required.
- Covers 160 kc to 220 mc (including harmonics).

Heathkit signal generator kit

MODEL SG-8

$19.50 Shpg. Wt. 8 Lbs.

This signal generator covers 160 kc to 110 mc on fundamentals in 5 bands. Calibrated harmonics extend its usefulness up to 220 mc. The output signal is modulated at 400 cps, and the RF output is in excess of 100,000 microvolts. Output controlled by both a continuously variable and a fixed step attenuator. Audio output may be obtained for amplifier testing.

This is one of the biggest signal generator bargains available today. The tried and proven Model SG-8 offers all of the outstanding features required for a basic service instrument or for use in experimenting in the home workshop. High quality components and outstanding performance. Easy to build, and no calibration required for ordinary use.

Heathkit grid dip meter kit

This extremely valuable instrument is a convenient signal source for determining the frequency of other signals by the comparison method. Range is from 2 mc to 250 mc. Uses 500 ua meter for indication, and is provided with a sensitivity control and headphone jack. Includes prewound coils and rack. For hams, experimenters, and servicemen.

MODEL GD-1B

$19.50

Shpg. Wt. 4 Lbs.

Heathkit ANTENNA impedance meter kit

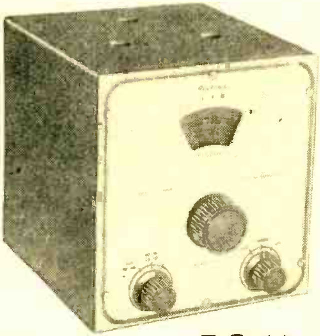
Used in conjunction with a signal source, the Model AM-1 will enable you to measure RF impedance. Valuable in line matching, adjustment of beam and mobile antennas, etc. Will double as a phone monitor or relative field strength indicator. A 100 microampere meter is employed. Covers the impedance range from 0 to 600 ohms. An instrument of many uses for the amateur. Easily pays for itself through the jobs it will perform.

MODEL AM-1

$14.50 Shpg. Wt. 2 Lbs.

HEATH COMPANY *A SUBSIDIARY OF DAYSTROM, INC.*

BENTON HARBOR 5, MICHIGAN



Heathkit vfo KIT

☆ 6AU6 electron-coupled oscillator.

☆ OA2 voltage regulator tube for stability.

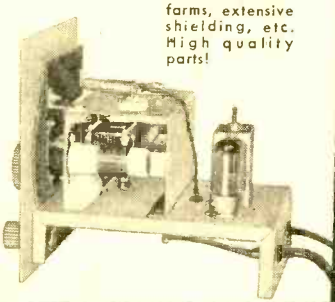
☆ Smooth-acting illuminated dial.

☆ Easy to build and attractively styled.

MODEL VF-1 **$19.50** Shpg. Wt. 7 Lbs.

This variable frequency oscillator covers 160-80-40-15-11 and 10 meters with three basic oscillator frequencies. RF output is better than 10 volts average on fundamentals. Enjoy the convenience and flexibility of VFO operation at no more than the price of crystals. May be powered from a socket on the Heathkit Model AT-1 transmitter, or supplied with power from most transmitters.

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



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

Heathkit CW amateur transmitter kit

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

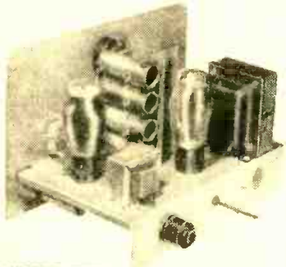
MODEL AT-1 **$29.50** Shpg. Wt. 15 Lbs.

Single-knob bandswitching for 80, 40, 20, 15, 11 and 10 meters.

Plate power input 25-30 watts.

Panel meter monitors final grid or plate current.

Best dollar-per-watt buy on the market.



SPECIFICATIONS:

RF Amplifier Power Input . . . 25-30 watts
Output Connection . . . . 52 ohms
Band Coverage . . . . 80, 40, 20, 15, 11, 10 Meters

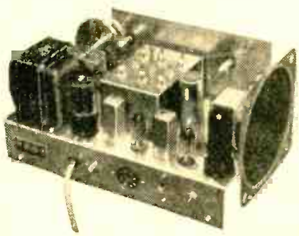
Tube Complement:
5U4G . . . . Rectifier
6AG7 . . . . Oscillator-Multiplier
6L6 . . . . Amplifier-Doubler

Heathkit COMMUNICATIONS TYPE all band receiver kit

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

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

Transformer-operated power supply for safety and high efficiency.



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

Features good sensitivity and selectivity. Separate RF and AF gain controls—noise limiter—AGC—VFO, headphone jack—5½" PM speaker and illuminated tuning dial.

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

CABINET: Fabric-covered cabinet available. Includes aluminum panel, speaker grille, and protective rubber feet. Measures 12-1/4" W. x 6-3/4" H. x 7-3/4" D. No. 91-15. Shpg. Wt. 5 Lbs. $4.50.

SPECIFICATIONS:

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

HEATH COMPANY A SUBSIDIARY OF DAYSTROM, INC.
BENTON HARBOR 5, MICHIGAN

HEATHKIT ECONOMY 7-WATT HIGH FIDELITY

amplifier kit

MODEL A-7D

$16.95 Shpg. Wt.

This is a 7-watt high fidelity amplifier that will produce more than adequate output for normal home installations. Its frequency characteristics are ± 1½ db from 20 to 20,000 cps. Output transformer is tapped to match speakers of 4, 8, or 16 ohms. Separate bass and treble tone controls provided. Features potted transformers, push-pull output, and detailed construction manual for easy assembly.

MODEL A-7E: Provides a preamplifier stage with two switch-selected inputs and RIAA compensation for low-level cartridges. Preamplifier built on same chassis as main amplifier. Model A-7E. Shipping weight 10 lbs. **$18.50.**

Free 52-Page 1956 Catalog

Describes more than 65 interesting "build-it-yourself" projects. Amateur equipment, hi fi amplifiers, and the complete Heathkit line of test instruments. Get yours today!

HEATHKIT BROADCAST BAND

receiver kit

MODEL BR-2

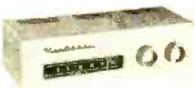
Shpg. Wt. 10 Lbs.

$17.50 Less Cabinet

You can build this table model radio and learn about radio circuit and parts during assembly. Complete instructions simplify construction, even for the beginner. Covers 550 to 1600 kc and features miniature tubes, 5½" PM speaker, and built-in antenna.

CABINET: Fabric-covered plywood cabinet as shown. Parts #91-9, shipping wt. 5 lbs. **$4.50**

HEATHKIT HIGH FIDELITY



fm tuner kit

MODEL FM-3

$24.50

Shpg. Wt. 7 Lbs.

Tunes from 88 to 108 megacycles and features sensitivity and selectivity not expected at this price level. Cabinet supplied with the kit. Built-in power supply and a stage of audio to insure adequate output. Easy to build from step-by-step instructions and large pictorial diagrams.

MAIL TO **HEATH COMPANY** *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 5, MICH.**

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Please ship C.O.D. ( ) postage enclosed for pounds.

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

ON PARCEL POST ORDERS insure postage for weight shown.

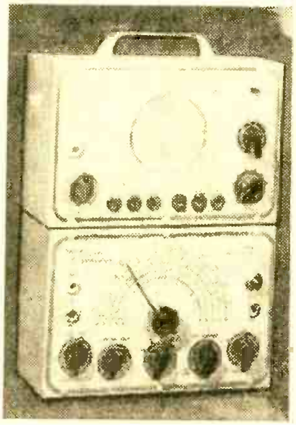
ORDERS FROM CANADA and APO'S must include full remittance.

TIPS (*Continued from page 106*)

recording and the volume control turned down. But it is less generally known that when this treatment fails in stubborn cases success can sometimes be achieved by storing the poorly erased tape at room temperature for a few days. For this reason, tapes with recordings no longer needed should be stored in the erased condition.—*E.F.C.*

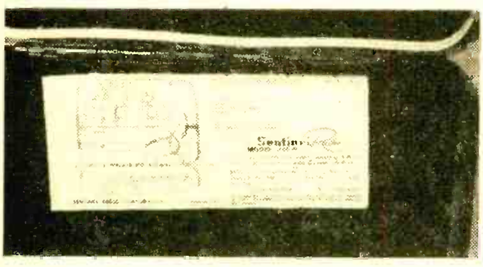
COMBINING TEST INSTRUMENTS

Test instruments that are often used together, and have about the same size cases, can be fastened one to the other to make a single, convenient unit. Machine screws through the bottom and top of the cases will hold the two instruments securely. An alternate method would be simply to strap the two units together around their sides. The photo shows a signal generator, with a signal tracer mounted above it. This combination is both handy and portable. —*H.L.*



SAVE THOSE TUBE LAYOUTS!

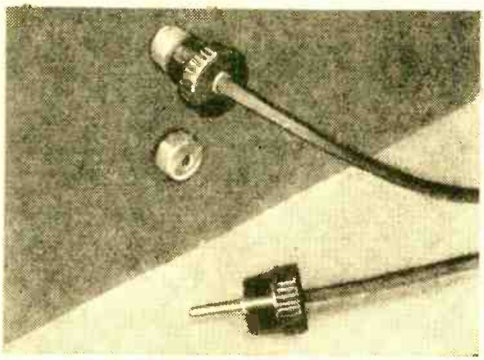
The chassis layout diagram that is usually furnished with a radio set or other electronic equipment is an invaluable guide to future maintenance and service. Generally, such a diagram is pasted to the back of the set. If it isn't, it's a good idea to paste it there. Also, when the diagram shows signs of peeling off, fasten it back in place. The positions of tubes and other data included on such a diagram can save a lot of time at some future date. —*H.L.*



INSULATED HANDLES FOR TIP PLUGS

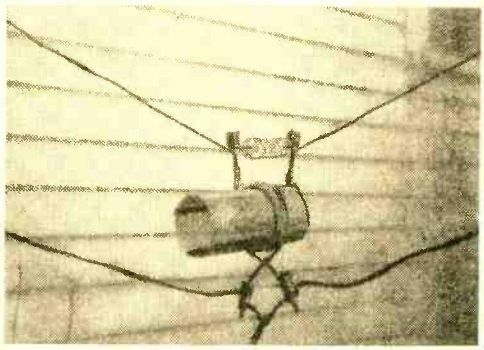
The front ends of tip jacks are insulated; why not the cord tips too? Then, you will be safe if you use the jacks and tips in high-voltage applications. Also, the insulated knobs serve as convenient handles to insert and remove the tips.

As shown in the photo, a couple of binding posts from a discarded "hot-shot" battery can be used. Simply drill a hole through the knob and slip knob onto large end of tip using a little Duco cement. Let set until the cement dries. The knobs should be cemented onto the tips *after* the cords have been soldered into the tips. —*A.T.*



A SHORT DIPOLE FOR "75"

Center-loading a short dipole is one answer to the problem of lack of space for a 120′ dipole. The photo shows the hookup used for an antenna half that length. A center-fed dipole, cut to resonance at 7.2 mc., was lowered to within reaching distance of the ground. The 72-ohm twin lead being used was disconnected.

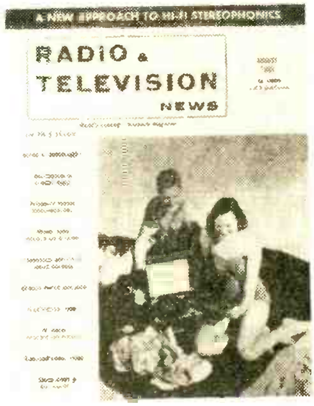


Twenty-five turns of commercial inductance (2½″ in diameter, 8 turns per inch) were clipped across the insulator in the center of the dipole. Then, three turns of No. 12 insulated weatherproof wire were wrapped around the center of the loading coil. The feedline was then reconnected to the three-turn link.

At 3.9 mc., the antenna loads easily, with a standing wave ratio of 1.25 to 1. Using slotted binding posts, the loading coil can be removed readily, and the feedline reconnected to its original position for operating on "40." —*W.H.B.C.*

A NEW APPROACH TO HI-FI STEREOPHONICS!

Learn how you can provide spatial effects by filtering! Read August RADIO & TELEVISION NEWS for details on a new system for recording and reproducing tape with excellent stereophonic quality.



Look for August
RADIO & TELEVISION NEWS
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The Transmitting Tower

(*Continued from page* 81)

comma identified as a question mark—I would recommend it as a good buy to anyone with a tape recorder who is interested in learning the code.

The course is available from Tapedcode, Box 31, Langhorne, Pa. The six-reel course sells for $20, and a three-reel Novice course (8 wpm) is $11. Individual tapes may also be purchased.

Notice to 160-Meter Operators

As a result of changes in the Loran radio navigation system operating on 1850 kc. and 1950 kc., the Federal Communications Commission has reduced the operating privileges of some U. S. amateurs who operate in the 160-meter band.

In the states of Washington, Kansas, Missouri, Arkansas, Illinois, Indiana, Kentucky, Tennessee, Ohio, West Virginia, Virginia, North Carolina, South Carolina, and Texas (west of 99° W or north of 32° N), permissible power has been reduced from 500 watts day, and 200 watts night, to 200 watts day, and 50 watts night.

No 160-meter operation is permitted in the states of Texas (east of 99° W and south of 32° N), Louisiana, Mississippi, Alabama, Georgia, Florida, Puerto Rico, Virgin Islands, Alaska, Guam, and other territories and possessions of the U. S., with the exception of Hawaii.

In the remaining states and Hawaii, the old power limits continue to apply. The new regulations went into effect July 9, 1956, and are expected to continue for approximately one year. No changes in frequency assignments have been made.

News and Views

Larry Puccio, KN2QDY, 132-22 84th St., Ozone Park 17, N. Y., reports: "I had my license and transmitter last November, but no receiver until January, when Ed, W2LJF, lent me one. So far, I have worked 23 states, with California as my best DX. My antenna is 66′ long fed in the center with coaxial cable. It doesn't work half as well as the last beauty I had up, but it stays there."

Pete Duncan, KN6ONH, San Francisco, Calif., tells us what he has been doing. "In six months of operating, I have cards from 25 states, Alaska and Hawaii (three each). Just the other night, I was fortunate enough to work OQ5AM in Kolwezi, Belgian Congo, on 7185 kc. This is my best DX, so far. I have a witness, too—W6KTP was here at the time. I run 60 watts to a 6146, my receiver is an NC-120, and my antenna is a 40-meter 'zepp.'"

Ronnie Stay, 53 Lynch St., Plattsburgh, N.Y., offers encouragement to prospective Novices. "After a month with the RETMA Novice Course, I took my examination. I passed the code without difficulty, and I am sure that I passed the theory as well. K2OGQ and K2-HLY helped me along. I don't see how anyone could fail the exam with this course and the help of a couple of ham friends. I have a Globe Scout 65-A and a 30-watt, home-built transmitter and an NC-98 receiver waiting for the license to come."

Gerhard S. Plessinger, KN5DNQ, (14½), Box 665, Lindale, Texas, says: "I run 33½ watts to an AT-1 transmitter, feeding ½-wave antennas on 80 and 40 meters. My receiver is a BC-342. My best DX is JA1 (Japan) on 40 meters, and I have worked 26 states. I would be glad to schedule anyone wanting a Texas QSO between 3:30 a.m. and 6:45 a.m. on 40 or 80 meters. I would appreciate a little help with General Class theory."

Gary Towner, KN9BNJ, 1017 W. 42nd Ave., Hobart, Ind., supplements his last report: "I was very much surprised to see the diagram of the r.f. amplifier in the May, 1956, *Transmitting Tower*. Here I thought I had something original! Mine is complete with a pi-network output circuit, too. I use a 1625 tube, and I drive it with a home-built 10-watt transmitter. The amplifier really works. Although it runs only 30 watts, I had a hard time making local contacts without it. With it, I have worked four states. My antenna is a 40-meter wire, but I work 80 meters only."

From 1920 Ave. C, Gothenburg, Nebr., **Brian, KNØEHY,** reports: "I've had my license a month and five days, and I have worked 18 states. Both my transmitter and receiver are home-built, but I am getting an AR-3 receiver in a few months. My antennas are a 126′ doublet 35′ high for the 3.7-mc. band and a 65′ one for the 7.15-mc. band. I QSL 100%."

From **Howard Mac Walp,** 526 Washington Ave., Girard, Ohio, comes another offer of help. ". . . In addition to holding a General Class license, I also hold a commercial license, and I would like to be of assistance to prospective amateurs around Youngstown, Ohio."

Eddie Barnes, KN9CXS, 24 Parkway Dr., Sullivan, Ill., says: "My rig is a Johnson Ad-

Response to Letters

If you have ever wondered what happens after one of these "letters" appears in the *Transmitting Tower*, read the following comment received recently. ". . . Since my short note appeared in the column, I've been busy answering letters from 20 states and Canada. Questions have ranged all the way from 'Will a TV antenna work on 80 meters?' to 'Will 180 watts be enough power to use as a Novice?' Most wanted to know how to get started and what books to get. Some of the questions were hard to answer, but I did my best." (Normally, a TV antenna works well only on the TV bands. The Novice power limit is, of course, 75 watts input at all times—*Herb*.)

venturer transmitter and an S-38D receiver. In about six weeks of operation, I have worked 16 states, with 11 confirmed. I'll sked anyone needing Illinois for any reason. (Who needs Illinois?) I need skeds with 32 states."

George Kinal (13), 293 Saw Mill River Rd., Yonkers, N. Y., makes the first year report on his ham activity. "I have just received my General Class license after a year as a Novice. I used a 10-watt transmitter and a 2-tube regenerative receiver. Then, I got an AR-2 receiver, which I still use. I built a preselector for it from POPULAR ELECTRONICS, and I have an extra 15- and 20-meter preamplifier for it. A Q-multiplier and a DX-35 are on the way now. I'll be glad to help anyone around here obtain his license."

George Harlem, WN3CMN, (13), 22 South School Lane, Lancaster, Pa., says: "Since I went on the air last October, nearly all my spare time is spent in the ham shack. My transmitter is a Johnson Adventurer, running 50 watts to a long-wire antenna. My receiver is a National NC-88. I work 80, 40, and 15 meters, but 15 is my favorite. I have worked 27 states, with 15 of them confirmed. My best DX is England, Washington, and California on 15 meters. As long as I have QSL's, I'll QSL 100%, and I'll answer any and all correspondence. I'd like especially to talk to some WN7's and to someone younger than myself."

Steve Frankel, KN2OTT, (13), 247 Parkview Ave., Bronxville, N. Y., gets the final say this month. "My rig is a slightly modified AT-1, and the receiver is a Howard 435-A. But my antenna is the real problem. I live on the first floor of an apartment house in which not even TV antennas are allowed. So my antenna is really makeshift. Still, I have managed to work 18 states and Canada on 80 and 40 meters; so I actually have nothing to complain about."

As always, I remind you that this is *your* column; so let us hear of your experiences, and send along a clear snapshot of yourself and your station. 73,

Herb

Tuning the Short-Wave Bands

(*Continued from page* 69)

The following is a resume of the many reports that have been received in the past month. All times shown are Eastern Standard, 24-hour system. Add five hours if your log is kept in GMT; subtract three for PST.

Afghanistan—*Kabul,* 9975 kc., has an English session daily at 1150-1210 with news; on Wednesday and Saturday at 1215 with a request program. There are two 100-kw. stations under construction. (*DQ*)

Australia—*R. Australia* is now on winter schedule. Australian DX'ers' program will be heard as follows: Saturday—at 1700 on 15,160 kc. for Japan; Sunday—at 0030 on 17,800 kc. (Africa); at 0215 on 11,740 and 15,160 kc. (Europe, New Zealand and South Pacific); at 0830 on 11,740 kc. to Eastern North America; at 1100 on 11,740 kc. to Western North America; at 1100 on 7220 and 11,900 kc. to Asia and Europe. The Eastern North America xmsn is now heard at 0714-0845, the Western North America session at 1014-1115—both xmsns replacing 9615 kc. (*BV, WRH*)

VLX9, 9610 kc., Perth, was noted s/off at 0500, giving call letters and frequencies. This is rarely heard from the ABC regional stations. (*SW*)

R. Puckapunyal, 7850 kc., is scheduled on Tuesday at 0400-0600 but may change. A letter from the station gives the following information: "This station is operated by Army personnel and is primarily intended for entertainment of troops within a ten-mile radius. The equipment used is a control panel of our own manufacture, a transmitter of 75-watt output, using parallel 813's fed into a 15' vertical rod antenna." (*WF*)

ABBREVIATIONS

A—About this frequency
ABC—American Broadcasting Company
BBC—British Broadcasting Corp., London, England
BC—Broadcasting service or station
kc.—Kilocycle
kw.—Kilowatt of power
mc.—Megacycle
m.w.—Medium wave
QTH—Exact location
R.—Radio
s/off—Sign-off of station
s/on—Sign-on of station
V—Verified frequency
xmsn—Transmission from a radio station
xmtr—Transmitter used by station

Belgium—ORU4, Brussels, 15,335 kc., is very strong in Canada and Eastern USA with an all-French and Dutch program from 1615 to 1800. Identification is *Ici Bruxelles.* (*DK, MP*)

A letter from the station reads in part: ". . . despite the protests concerning the closing of our English programs and the discontinuance of our international good will programs that have been made to the responsible authorities, we cannot give you the slightest assurance that they will be resumed." (All foreign language programs were cancelled over a year ago, for material reasons.) (*GH*)

S.W. REPORTERS WELCOME!

"How can I be a reporter for your s.w. column?" This question pops up frequently in our mail and we'd like to answer it by saying that anyone owning a s.w. receiver is welcome to write in and report what he is hearing. If you have but one report, write it on a postcard and send it in. It may be just enough to help another listener log a new country. If you have questions or need help, let me know. Our mail is heavy and at times we get behind schedule, but you will definitely receive an answer. Write to: Hank Bennett, Short-Wave Editor, % Popular Electronics, 366 Madison Ave., New York 17, N. Y. —HB

Brazil—*R. Nacional de Sao Paulo*, Sao Paulo, 6126 kc., has been noted at 0400 with a strong signal and Portuguese announcements. They use a 14-bell interval signal four times. The first bell is low, the second high, and the remaining 12 descending slowly. (*SW*)

A new station in Sao Paulo is operating on 11,855 kc. at 1900-2200. The slogan has not yet been determined for this station. (*RL*)

British North Borneo—*Radio Sabah*, Jesselton, 7185 kc., can be heard around 0622 with a relay of BBC news. (*JB*)

British Somaliland—*Radio Somali*, Hargeisa, operating on 7126 kc., has extended transmission time 15 minutes and is now closing at 1000. (*WRH*)

Canada—*R. Canada*, CKLX-3, 15,395 kc., replaces CKLX-1, 15,415 kc., with English programs for Canadians in Europe between 0655 and 0905. They usually broadcast at 0655-0730 (Monday-Friday) and at 0830-0905, which at times is in French. CKNC, 17,820 kc., is in parallel. (*SW*)

Ceylon—According to a news item heard from *Radio Japan*, the Voice of America relay facilities of *Radio Ceylon* are likely to be abandoned (upon request from the Government of Ceylon). This policy may be somewhat in effect already, as *R. Ceylon* is again using its 15,120-kc. outlet for relay of the Commercial Service. (*WF*)

Chile—CE960, Santiago, 9598 kc., is heard at 2200-2230 with Spanish musical programs. Identification is *Radio la Americana* and is usually easy to catch. (*GN*)

Cyprus—*Sharq Al Adna*, ZJM7, 11,720 kc., is noted daily in Arabic at 0930-1100 with news, plays, music, and Arabic commercials. The signal is usually strong on the West Coast. (*PF*)

ZJM8, 9650 kc., can be tuned on the East Coast after 0000 until 0100 with Arabic talks and music. (*PR*)

Denmark—The current schedule of the *Danish State Radio* is as follows. On 9520 kc.: at 1915-2015 (daily) to Greenland, at 2030-2130 and 2200-2300 (daily) to North America, at 0830-0930 (Sunday only) to Faroe Islands, at 1730-1830 (Monday, Wednesday and Friday) to South America; for Danish ships—at 1830-1900 (Monday, Wednesday and Friday), at 2130-2200 (Tuesday, Thursday, Saturday), at 1200-1230 (Tuesday, Thursday and Saturday). On 15,180 kc.: at 0000-0100 (Tuesday, Friday) to Africa and Middle East. On 15,165 kc.: at 0400-0500 (Tuesday, Thursday, Saturday) to Far East, Australia, and New Zealand, and at 0900-1000 (Tuesday, Thursday, Saturday) to South Asia; program for Danish ships—at 0500-0530 and 1000-1030 (Tuesday, Thursday, Saturday). On 6060 kc.: at 1240-1615 relaying Home Service (daily). (*WRH*)

Dominican Republic—HI7T, Ciudad Trujillo, is being tuned on 3285 kc. around 2245 in Spanish. This one usually has good signals when in the clear. (*TL*)

Dutch New Guinea—*Radio Sorong*, Sorong, is a private station using 500 watts on 3395 kc. The schedule is: Monday and Thursday at 0430-0700, Tuesday and Friday at 0400-0700, Saturday at 2000-2230 and Sunday at 0430-0700. No transmitter is planned for Hollandia. Biak and Sorong are the only stations operating in the country. (*WRH*)

Egypt—Cairo can be heard daily on 9475 kc. at 1300-1600 in English and French. This transmission is beamed to Europe. (*DR*)

England—The BBC has been radiating a special program for the men of the Antarctic Expedition. These xmsns, entitled "Calling The Antarctic," primarily intended for reception in the vicinity of Vahsel Bay, are on the air Tuesdays at 1715-1800 on 9825 and 12,095 kc. and are repeated Wednesdays at 1100-1145 on 21,640 kc. The International Time Signals of the Royal Greenwich Observatory are being transmitted: at 0500 over GBR, 16 kc., and GIC33, 13,555 kc., and GIC37, 17,685 kc.; and at 1300 over GPB30, 10,332.5 kc., in addition to the outlets on 16 and 17,685 kc. GIC33 is located at Leafield, the others at Rugby. This schedule will be on until August 31. (*WRH*)

France—"The English Service of R. N. F." from Paris, 15,400 kc., is heard at very good level at 1500-1600, all in English. News is at 1500, discussion program at 1515. At 1600 s/off, they gave the schedule as 1500-1600 on 49- and 31-meter bands (no mention of this channel), 0245-0300 on 41 meters, and 1445-1500 on 25 meters. The 31-meter outlet can be found on 9625 kc. (*SW, CM*)

French Cameroons—According to a QSL card, *La Radiodiffusion de Cameroun* is now operating: on 6115 kc., Douala, 1 kw.; on 3333 kc., 4 kw., and on 9270 kc., 1 kw., from Yaounde. (*WRH*)

French Equatorial Africa—*R. Brazzaville* is operating to Indochina and the Far East at 0900-1000 on 15,420 kc. instead of on 15,595 kc. (*SW*)

Germany—*Deutsche Welle*, Cologne, has moved from 15,275 kc. to 15,370 kc. for its Latin-American xmsn. It is being heard at 1830-2000 s/off with music, a German discussion at 1900, news in German at 1945. (*SW*)

The outlet on 11,795 kc. is noted around 2130-2140 with English news, dual with 9640 kc. S/off time is 2330 with announcements in German, English, and French. (*RB, SD, KB, and many others*)

Greece—*Radio Athens* now broadcasts in French at 1200-1230, followed by English at 1230-1300 on 15,345 and 17,775 kc. (*WRH*)

Haiti—4VWI, Cap Haitien, 15,418V kc., is being heard Saturday from 0840 to 1034 s/off. "Listeners Post," noted at 0930, said this mail-bag program is repeated at 1630 on Saturday, 2130 on Monday, and 0400 on the following Saturday (the latter xmsn being for South Pacific listeners). 4VEH, Cap Haitien, operates on 9637 kc. in the mornings, on 9657 kc. at 1500-1700 and 2000-2230, and on 9663 kc. at 1700-2000. (*SW*)

Iceland—TFJ, Reykjavik, 12,175 kc., is noted Sundays from 1115 to 1130-close in Icelandic. Usually severe QRM from teletype stations makes this a hard one to log. (*PF*)

India—VUD, Delhi, *All-India Radio*, is on a new channel on 17,820 kc. at 1915-2015 in Tamil, dual to 15,160 kc. VUD, 17,780 kc., is heard at 1930-1940 with 15,380 kc. with English program for Burma, followed by program in Burmese language. (*RL, SW*)

Iran—*Radio Teheran*, 15,100 kc., has English news at 1522, s/off at 1525; it is back on at 1530 with gongs and anthem, and then off again. (*DX*)

Iraq—*Radio Baghdad* is heard with fair to good signals on 11,702 kc. in Arabic at 1030-1130. This station has music often, and the interval signal is a bird chirping. Do not confuse it with Cairo on 11,674 kc. (*GN*)

Jamaica—*R. Jamaica*, ZQI, 4950 kc., is heard well from 1930-2300 s/off with news, music, and commercials—all English. (*SF*)

Japan—Tokyo is operating on 17,845 kc. to Eastern North America at 1800-1830 and 1930-2000, and on 17,825 kc. to Western North America at 2230-2330, both in parallel with 15.235 kc. JOB3, 9675 kc., is heard well at 0415-0515 in South American beam with Spanish and Portuguese during first half hour, Japanese for remainder of program. JOA4, 11,705 kc., operates in dual. AFRS, Camp Drake, 6160 kc., is noted at 0850-0915 with news at 0900. (*RL, CM, SW, GF, RH*)

Luxembourg—*R. Luxembourg* is now relayed on 6090 kc. with English program. The exact schedule is 1300-1900 (Saturday to 1930) during the winter. During summer months, the s/off is at 1800 (1830 on Saturday). (*WRH, CM*)

Mauritius—Forest Side, 15,092V kc., is readable but with poor signals from 2225 to 2315 s/off. English news is presented at 2300. Signal usually becomes progressively worse. (*DX, PF*)

Netherlands—*R. Netherlands,* 17,775 kc., can be tuned at 1045-1125 in English in the South Asia and Africa beam. After the interval signal at 1125-1130, the station goes into Arabic. (*GQ*)

Program #3 signs on at 1630 for Spain, Portugal, and Latin America. This channel was announced as being "experimental" and was dual with 15,425 kc. (*SW*)

Peru—OBX4C, *Radio El Sol,* Lima, 15,193A kc., was noted with test xmsn at 1950-0005 and later with American and Latin-American music, news in Spanish, and a baseball relay in conjunction with *Radio Carve,* Montevideo, and *Radio Splendid,* Buenos Aires. Identification signal is three chords on an organ and Spanish is used throughout. (*WF*)

Philippine Islands—The National Civil Defense Administration (NCDA), Independence Grandstand, Luneta, Manila, operates two stations: NCDA-1, Manila, on 3305 kc., and NCDA-2, Iloilo City, on 3365 kc. NCDA-1 operates at 0400-0700 (daily except Sunday) on 3305 kc. and at 2000-2100 on 5970 kc. NCDA-2, on 3365 kc., operates at 0400-0700, and after this takes broadcasts from DYRI in Iloilo City. NCDA-1 has English at 0600-0700, consisting of news, sports, editorials, and talks. (*WRH*)

Saudi Arabia—Jidda, 11,950 kc., is noted weakly in Arabic around 1000. This very rarely noted station is not to be confused with Cairo on 12,030 kc. (*GN*)

Spain—*R. Nacional de España,* Madrid, 15,420 kc., is now often heard at 0600 s/on in Spanish. S/on at 0830 is in Oriental language, and signature tune is again heard at 0900 as if starting another xmsn, but this is too weak to read. The regular interval signal and march is used at each sign/on. (SW)

Surinam—*AVROS,* Paramaribo, 15,406 kc., is heard Mondays at 2030-2040 with weekly English news program. They announce as *AVROS,* without mentioning any call letters, and give frequencies in use as being 15,405 kc. and 4742.5 kc. (*SW*)

Sweden—*R. Sweden* has a broadcast beamed to North America at 0815 on 15,155 kc., and again at 2045 on 11,880 kc. The English session to Canada begins at 2000 on 11.880 kc. (*JM, JH*)

Switzerland—HEI9, Berne, is operating on a new frequency of 21,605 kc. at 0945-1130, beamed to India. (*RL*)

HER3, 6165 kc., is noted on the West Coast at 2319 with English to North America, with a signal strong enough to penetrate local CBUX on 6160 kc. (*JB*)

Syria—*Syrian Broadcasting Service,* Damascus, has English to Europe on 9555 kc. at 1630-1730. There is no service to North America although one is planned for the near future. (*DQ*)

Thailand—HSK9, Bangkok, 11,670 kc., is heard well in English with news at 0530, weather at 0540, talk at 0615, and native music at 0545-0615 and 0622-0630, in parallel with 6060 kc. After closing announcements at 0630, they switch over to a foreign language. (*AB, SW*)

Trinidad—*R. Trinidad,* Port-of-Spain, operates on 790 and 3275 kc. between 1900 and 2200, and on 6085 kc. for the 0500-1700 period. (*WRH*)

Union of South Africa—Since May 1, SABC has been testing from 0730 to 0845 (Monday-Friday, except on public holidays) on 25,800 kc., announcing as *The Africa Service of SABC*. Reports are much appreciated. (*WRH*)

SHORT-WAVE CONTRIBUTORS

Anson Boice (*AB*), New Britain, Conn.
J. Ross Brownell (*JB*), Vancouver, B. C.
Ken Bale, W7VCB, (*KB*), Bellingham, Wash.
Rocky Brockwell (*RB*), McKenzie, Tenn.
Silas Dunn (*SD*), Little Rock, Ark.
Grady Ferguson (*GF*), Charlotte 8, N. C.
Phil Finkle (*PF*), Burbank, Calif.
Stuart Fidler (*SF*), Jordan, N. Y.
William Flynn (*WF*), Berkeley, Calif.
Grace Humbert (*GH*), Greenville, N. C.
John Huetter (*JH*), Cleveland, Ohio
Raymond Huss (*RH*), Lakewood, Calif.
David Kimpton (*DK*), Cobourg, Ontario
Roger Legge (*RL*), McLean, Va.
Ted Levecque (*TL*), Bracebridge, Ontario
Chuck Maxant (*CM*), Baldwin, N. Y.
John Mann (*JM*), Montreal, Quebec
Gordon Nelson (*GN*), Inglewood, Calif.
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David Robinson (*DR*), Providence, R. I.
Peter Risse (*PR*), Atlanta, Ga.
Bruce Tuten (*BT*), Atlanta, Ga.
John Beaver (*BV*), Pueblo, Colo.
Stewart C. West (*SW*), Union, N. J.
Gerry Dexter (*DX*), Waterloo, Iowa
World Radio Handbook (*WRH*)
(Full addresses available on request)

Vatican City—HVJ, 9550 kc., has English at 1000 on this channel and on 11,685, 11,740, and 15,120 kc., and at 1315 on the same outlets. In winter they may use 5968, 7280, 9550, and 11,685 kc. for the latter period. (*BT*)

Venezuela—*Le Voz de la Patria,* YVKX, Caracas, has moved from 3390 kc. to 3305 kc. and is heard from 2000 to 2230 s/off. (*RL*)

Unknown—Listeners in South Africa have been hearing a station that identifies as *Freedom Radio*. No frequencies or times have been given as yet. This station is allegedly broadcasting anti-government propaganda. The interval signal is V-for-Victory in Morse code and the opening bars of Beethoven's *Fifth Symphony*. Further details on this station are requested. (*WF, Editor*) —30—

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0A4	3Q4	6AS7G	6J5GT	7A7	12SN7GT
0B2	3Q5GT	6AT6	6J6	7B5	12SQ7
0C3	3S4	6AU4GT	6K6GT	7B7	12V6GT
0Z4	3V4	6AU5GT	6L6	7C5	12X4
1A7GT	4B27	6AU6	6N7GT	7C6	14A7
1B3GT	4B97	6BV5GT	6S4	7C7	14B6
1C7G	5AM8	6AV6	6S7G	7F7	14Q7
1F4	5AN8	6AX4GT	6SA7	7F8	19BG6G
1H4	5AQ5	6AX5GT	6SB7Y	7N7	19T8
1H5GT	5AT8	6BA6	6SC7	7Q7	24A
1J6GT	5AW4	6BC5	6SF5	7Y4	25AV5GT
1L4	5AZ4	6BC7	6SF7	7Z4	25BQ6GT
1L6	5J6	6BE6	6SG7	12A6	25CD6G
1LA6	5T4	6BF5	6SH7	12AH7GT	25CU6
1LC5	5T8	6BG6G	6SJ7GT	12AT6	25L6GT
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1S4	5V6GT	6BK7	6SQ7	12AV6	35W4
1S5	5Y3	6BL7GT	6SS7	12AV7	35Y4
1T4	5Y4G	6BN6	6SV7	12AX4GT	35Z3
1U4	6AB4	6BQ6GT	6T8	12AX7	35Z5GT
1U5	6AC7	6BQ7	6U4GT	12AZ7	50A5
1V2	6AG5	6BY5G	6U7G	12B4	50B5
1X2	6AF4	6BZ7	6U8	12BA6	50C5
2A7	6AH4GT	6C4	6V3	12BE6	50L6GT
2D21	6AK5	6CB6	6V6GT	12BH7	80
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The Electronic Mind

(Continued from page 34)

cording data on a broad, endless loop of tape with many channels.

An important advantage of magnetic drums is their capacity; such drums are made to hold as many as 2,552,000 bits, or about 350,000 characters. Other favorable features are their low cost and the fact that they retain stored data indefinitely.

Magnetic Core Memory. In recent years, pure physical research has opened up new horizons through the discovery of a new basic material: the ferrites. Their impact on electronics is a whole story in itself. Here we are concerned only with their possibilities as memory devices.

Magnetic polarity can be established in ferrites by a current of sufficient strength. Once established, the magnetic field resists change until an equally strong current is passed in the other direction. Thus, for example, the magnetic field of a ferrite with positive polarity can be reversed by applying a sufficiently strong negative current.

In computers, this physical fact forms the basis of a memory system. The ferrites are shaped into doughnut-like rings, called toroidal cores, which are wired together in checkerboard "matrices." A pair of wires, one horizontal and one vertical, intersect at each core. To store an electronic "bit," it is only necessary to apply a polarizing voltage to the pair of wires meeting at a certain core. The magnetic field of that particular core will then shift and hold its new polarity, i.e., it will hold one "bit" of pulse-type information. None of the other cores will be affected, since the current in any one wire is not strong enough to reverse the cores' polarity. Only at the intersection point of the two pulsed wires, i.e., at the desired core location, do the two currents summate and thus achieve sufficient strength to evoke magnetic response.

Magnetic core memory is the current favorite among computer engineers. The reasons are easy to see. To "read out" the information stored in the core memory requires no more time than it takes to send a "sensing" pulse along the diagonal lines to pick up the pattern of magnetic shifts. Six characters can be transferred into or out of the memory in about 20-millionths of a second. At this rate of figuring, the answers come up fast.

Here, with the most advanced of memory devices, we are actually closest to my erstwhile piece of string with the knots tied in it. We may quite literally think of the pulsing wires as strings and of the magnetized cores as the knots. The magnetizing pulses "tie" the knots, and the sensing pulses "feel along" the string to locate the knots.

Of course, my string didn't know the meaning of the knots. Only I did. Neither does the machine mind know the meaning of its memories. Only the creative mind of a human being is able to translate pulses, "bits," characters, or even words and numbers into the kind of living sense from which men build their world. —30—

"Ears" for CD Observer Post

(*Continued from page* 50)

make the final connections to the pickup leads on the support arm and mount the amplifier in place. *A word of caution*—make sure that the pickup leads (*PT1, PT2,* etc.) are connected in series-aiding, as shown in Fig. 1. If any of the leads are reversed, the signal picked up by that unit will tend to oppose and to cancel the signals picked up by the remaining trumpets, greatly reducing over-all sensitivity.

Modifications. Good results can be obtained if only one or two trumpets are used. Construction and wiring are essentially the same, but the horizontal support arm's design may be modified. In fact, if a single trumpet is used, the support arm is not needed at all—a simple bracket will suffice!

The trumpet may be eliminated altogether if you have a military surplus store nearby. Simply pick up a surplus radar antenna (a parabolic reflector or "dish" measuring about 3′ to 5′ in diameter), and mount a small microphone cartridge at its focal point to pick up the reflected and concentrated sound waves. This makes an excellent pickup and has even better directional characteristics than the trumpets. Use a low-impedance microphone (such as the Shure MC-11) or a crystal "MIC." cartridge (such as the Argonne AR-52) together with a step-down matching transformer (such as the Argonne AR-129).

Some experimenters may find that the high gain provided by the three-stage amplifier is more than is needed for their applications. Where this is the case, the second stage may be dropped out entirely, saving a transistor, socket, transformer, and associated components. Simply connect the "green" and "black" leads of transformer *T1* to feed the *TR3* stage di-

TRANSFORMER QUIZ

(Answers to questions on page 87)

1. b	2. d	3. c	4. a	5. b
6. d	7. c	8. b	9. a	10. b

rectly, and rewire the circuit accordingly.

Adjustment and Use. This listening device is designed to have maximum gain at speech and higher frequencies, and is relatively insensitive to low frequencies such as the rumble of thunder. Since low frequency sounds—the wail of a siren, roar of a gasoline engine, or "boom" of explosions—generally carry for quite long distances, special pickup and amplification are not needed to hear and identify such signals. The instrument is thus most valuable for listening to voices or to higher pitched signals which are normally heard at relatively short distances.

The instrument is moderately—but not highly—directional. It is designed to pick up sounds over a comparatively large area and to *approximate* the location of the sound rather than to pin-point it. Where a more directional pickup is needed, you should use the parabolic reflector pickup described above.

For best results, mount the completed instrument on a heavy-duty camera tripod with a standard *PAN* head. This will permit you to control the elevation and direction of pickup at will. —30—

Experimenters' R and C Stocks

THE AUTHOR was recently faced with the problem of deciding which capacitors and ½-watt resistors were most often used. Making a survey of the component values used in circuits published in the leading magazines seemed to be the only satisfactory solution. The project encompassed a wide variety of different circuits and covered about two years.

Results on the ½-watt resistor appear in Table 1, data on the capacitors in Table 2. These tables show that the 0.01-μfd. capacitor and the 100,000-ohm resistor are used much more frequently than any other values. Thus, both should be No. 1 in your stock.

A	B	C	D	E
100K	470K	2.2 meg.	100 ohms	220 ohms
	1 meg.	10 meg.	3300 ohms	680 ohms
	220K	4700 ohms	1500 ohms	1800 ohms
	47K	10K	6800 ohms	8200 ohms
		22K	330K	18K
		4.7 meg.	3.3 meg.	39K
		1000 ohms	1200 ohms	150K
		2200 ohms	270 ohms	180K
		33K	2700 ohms	1.8 meg.
		270K	27K	150 ohms
		15K	56K	820 ohms
		470 ohms	68K	390K
			120K	390 ohms
				3900 ohms

Table 1.

A	B	C	D
0.01 μfd.	100 μμfd.	47 μμfd.	0.5 μfd.
0.1 μfd.	0.001 μfd.	220 μμfd.	1.0 μfd.
	0.005 μfd.	470 μμfd.	
	0.05 μfd.	0.002 μfd.	
		0.02 μfd.	
Table 2.		0.25 μfd.	

Table 1 should be read from left to right and from top to bottom. The resistor value in Column A is assumed to be needed 100% of the time. With this as a base, the values in Column B will be used about 50% of the time, those in Column C—11 to 25%, Column D—6 to 10%, and Column E—5% or less of the time. The values near the top of each column are used more frequently than those near the bottom. A typical stock might consist of 10 resistors of the value shown in Column A, 5 each of those in Column B, 3 each in Column C, and 1 or 2 each of those in Column D. Those in Column E may be neglected unless you want to go in for a 100% stock.

Table 2 should be read in a similar manner, except that the vertical arrangement of the capacitor values has no significance. Values in Column A are used most frequently and should be stocked in the greatest quantity; those in Column D are used only 5 to 10% of the time.

Use of these tables won't guarantee that you'll have all the ½-watt resistors and capacitors you will need for any particular project but—statistically at least—you'll be closer to it than you would be with any hit-or-miss system. —*B. W. Blachford*

WHERE ARE YOU?

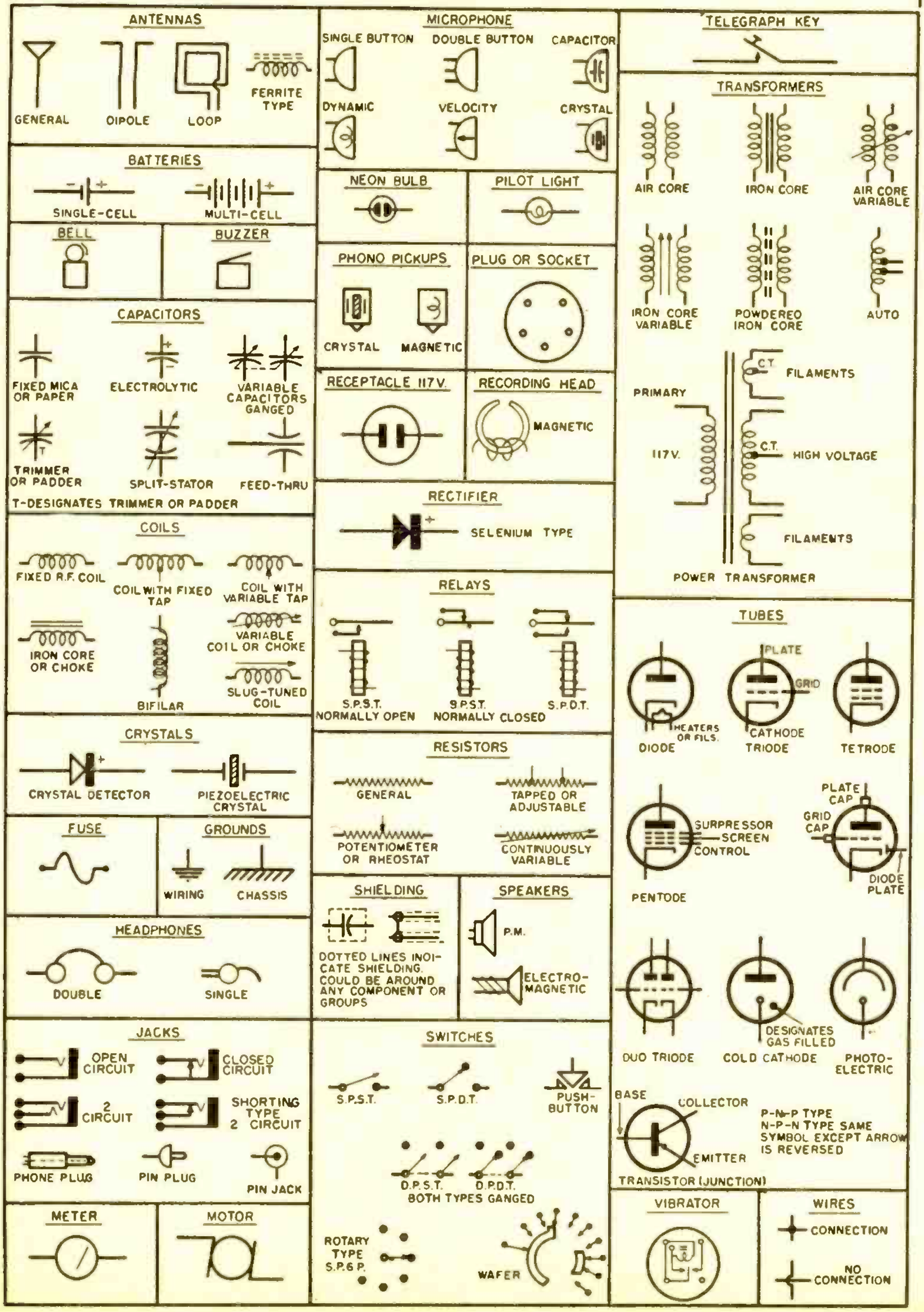
The circuit shown on page 82 is part of the "Van Amp" as manufactured by General Apparatus Company.

A hi-fi audio signal fed into these two cathode-follower stages is essentially divided as a function of frequency by the double RC output networks. These signals are then used to drive two different power amplifiers and separate speakers for optimum hi-fi acoustical balance. The four potentiometers in the double RC networks vary the dividing frequency over a range of from 90 to 1100 cycles. The input potentiometers adjust the voltage gain of the two channels.

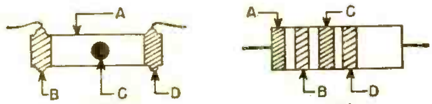
Further information on the "Van-Amp" may be obtained from the manufacturer at 346 East 32nd St., New York 16, N. Y.

Don't forget—we are interested in seeing suggested circuits that might puzzle our readers. Send them to Puzzle Editor, POPULAR ELECTRONICS, 366 Madison Ave., New York 17, N. Y.

STANDARDIZED WIRING DIAGRAM SYMBOLS



RESISTOR COLOR CODE



(A) (B)

The ohmic value of a resistor can be determined by means of the color code. There are two standard methods of indicating this value.

In Fig. A, the body (A) and end (B) indicate the first and second digits of the value while the dot (C) indicates the multiplier to be used. The tolerance of the unit is indicated by the end color (D). For example, if the body (A) is green the number is 5; if the end (B) is grey the second number is 8. If the dot (C) is red the multiplier is 100 or two zeros should be added. The resistor is then a 5800 ohm unit. If the end (D) has no color, the tolerance is ±20%.

In Fig. B, the first two stripes indicate the first two digits; the third stripe the multiplier; the fourth stripe the tolerance. Thus, if stripe (A) is green, (B) is grey, (C) is red, and (D) is silver, the resistor is a 5800 ohm, ±10% unit.

RETMA COLOR CODE CHART

COLOR	VALUE	MULTIPLIER
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10,000
Green	5	100,000
Blue	6	1,000,000
Violet	7	10,000,000
Grey	8	100,000,000
White	9	1,000,000,000

TOLERANCE CODE

Gold—±5% Silver—±10%

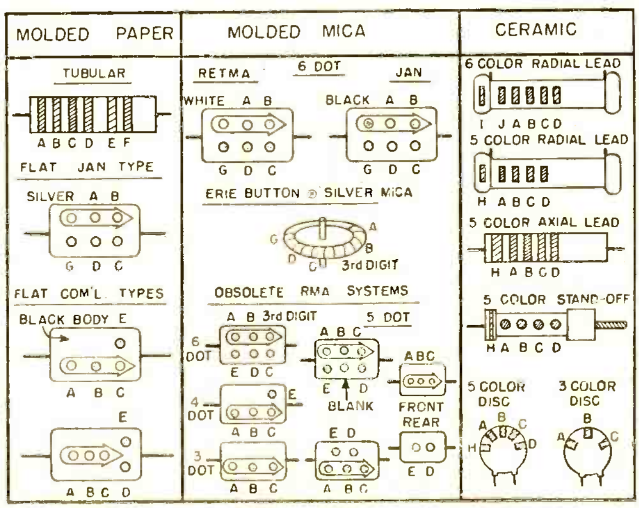
No Color—±20%

CAPACITOR COLOR CODE

	MOLDED PAPER		MOLDED MICA		CERAMIC	
Color	Multiplier	Tolerance	Multiplier	Tolerance	Multiplier	Tolerance
Black	1	20%	1	20%	1	20% or 2.0μμfd.*
Brown	10		10		10	1%
Red	100		100	2%	100	2%
Orange	1000		1000	3% (RETMA)	1000	2.5% (RETMA)
Yellow	10,000	5%	10,000		10,000	
Green				5% (RETMA)		5% or 0.5μμfd.*
Blue						
Violet						
Gray					0.01	0.25μμfd.*
White		10%			0.1	10% or 1.0μμfd.*
Gold	0.1	5%	0.1	5% (JAN)		
Silver		10%	0.01	10%		
None		20%				

*Capacitance less than 10μμfd.

Capacitance is given in μμfd. Colors have same values as on resistors, except as indicated in tables. Colors (A) and (B) are for first two digits; (C) is for multiplier. (D) is for tolerance. (E) and (F) give voltage rating in hundreds of volts; (E) is used only for ratings less than 1000 volts, (E) and (F) for first two digits of ratings 1000 volts or more. Values of colors for (E) and (F) are same as in resistance values. (G) is class or characteristic of capacitor, (H), (I), and (J) give temperature coefficient. (G), (H), (I), and (J) are not listed in the tables, since this information is seldom needed by the average home builder.



HOME-BUILT ENCLOSURE

Looks Good with Burlap Finish

AN EASY and inexpensive way to finish your home-built loudspeaker enclosure—so that it will "belong" in the living room—is to cover it with decorator's burlap. Costing only about six cents a square foot, this fabric comes in a variety of solid colors. It is sold in 3' and 4' widths—dimensions that tie in nicely with the sizes of panels on the average enclosure. What's more, the fabric's loose weave permits all the sound from the speaker to come through unimpeded.

Prepare Wood Surface First. Fill in all screw-holes and other surface defects on the wooden panels with Plastic Wood or spackle. Then, sandpaper until smooth. If a light shade of burlap is to be used, your preparation is done.

If a dark color of burlap is desirable, the raw wood may show through the fabric's loose weave. To prevent this, paint the wood a dark color—it need not match the burlap. Using paint provides you with another advantage: if you let the paint set until it is not quite dry, its tacky surface will make for a good bond between the burlap and the wood.

If you don't paint the wood, you can bond the burlap to the enclosure with rubber cement or any neutral-colored glue.

In most cases, one long strip of burlap can be wrapped around the sides and front of the enclosure, with a separate piece covering the top. This leaves a few edges of the fabric that must be secured to the wood. Fasten these edges of fabric where they won't show, along the bottom and back of the cabinet.

Secure the Edges. One way to secure an edge of burlap is to fold it under itself to create a narrow hem, and then tack it to the wood with upholstery nails. Another method is to glue and staple the burlap without first making a hem.

With darker colors of burlap, a metallic glint may show if staples are used. To prevent this, simply daub the top of the strip of staples with a dark-colored paint before loading them into the stapling machine. Let the paint dry thoroughly so that it will remain on each staple and not interfere with the stapling process.

Incidentally, a few staples driven at random into the larger surfaces covered by the burlap will give you extra insurance against sags or bulges.

Neatly applied, burlap will prove a cheap but effective way of getting your home-built enclosure to look good as well as to sound good. —*Wm. B. Rasmussen*

Classified

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AUGUST 1956 ADVERTISERS' INDEX

Superior's New Model TC-55

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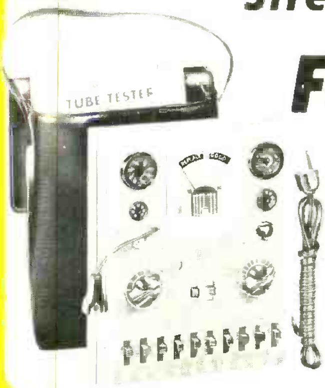

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Superior's New Model TV-11

Standard Professional TUBE TESTER

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★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because <u>all elements are numbered according to pin-number in the RMA base numbering system,</u> the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. <u>Thus it is impossible to damage a tube by inserting it in the wrong socket.</u>

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

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

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

$47.50

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

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

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

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

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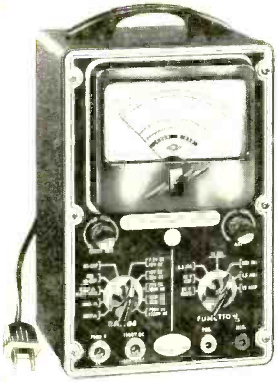
All prices net, F.O.B., N.Y.C.



Superior's New Model 670-A

SUPER-METER

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

SPECIFICATIONS:

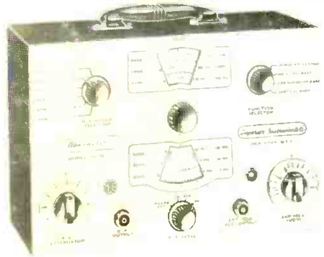
D.C. VOLTS: 0 to 7.5/15/75/150/750//1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad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

ADDED FEATURE:

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

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

$28.40



Superior's New Model TV-50

GENOMETER

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

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

7 Signal Generators in One!

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

R. F. SIGNAL GENERATOR: The Model TV-50 Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: The Mode TV-50 projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50 includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

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

Only **$47.50**

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