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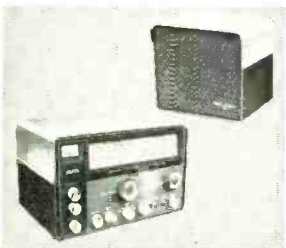

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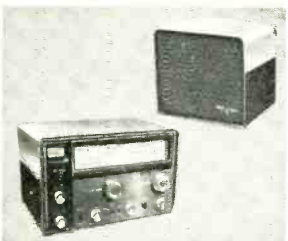

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POPULAR ELECTRONICS

FEBRUARY 1959

VOLUME 10 NUMBER 2

Special Hi-Fi Features

Electronic and Audio Construction Projects

Amateur and SWL

Features and Electronic Developments

Departments

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Average Net Paid Circulation 267,136

This month's cover drawn by Ed Valigursky

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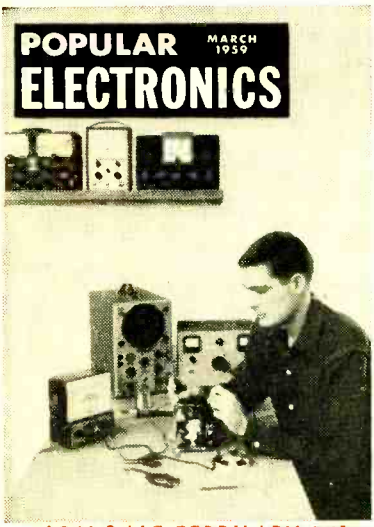


(ON SALE FEBRUARY 24)

The home experimenter on our March cover is deep in the midst of trouble-shooting an a.c./d.c. receiver. Surrounded by all that test equipment, he should be particularly interested in the special POPULAR ELECTRONICS series explaining the theory and operation of test equipment.

Of special interest to the build-it-yourself fans will be construction articles on a one-transistor, four-channel mike mixer and a pocket FM signal injector. An article on the vertical antenna, theory and installation, will appeal to the hams.

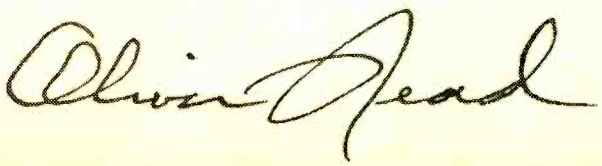
An exclusive POPULAR ELECTRONICS feature will describe some of the hazards presented by the new atomic power plants.

notes from the editor

MAN IN SPACE. Ten years ago, if you talked seriously about sending a man to the moon, chances are you would find people leaving you to talk to saner individuals. In our post-Sputnik era, however, it has not only been declared quite possible that we will get to the moon in our lifetimes, but it is almost certain that we will do so. Experiments with North American Aviation's X-15 rocket plane should provide enough information about conditions in space to allow the design of operational space-ships. Don't miss "Electronics in Space" on page 43.

THE VOICE OF HI-FI. Where do you get good articles on high fidelity? You hire good high-fidelity writers. This is easier said than done--good hi-fi writers are as rare as a quiet moment at an audio fair. But, by golly, we've corraled one now and we plan to keep him busy. Starting in this issue, Joseph Marshall is going to take us all the way through hi-fi, from soup to nuts--or, in the jargon of the trade, from preamp to loudspeaker. . . . Joe Marshall is well known as a writer on the subject of hi-fi and is the author of a book, "Maintaining Hi-Fi Equipment"--which we highly recommend, incidentally. We are very happy to have him aboard and look forward to learning things from his series on "Inside the Preamplifier," "Inside the Power Amplifier," "Inside the Tape Recorder," etc. (See page 47.)

TEST EQUIPMENT. Another POPULAR ELECTRONICS series is on test equipment, written by Larry Klein, our technical editor. It's interesting to note how this series was born. Since Larry is quite an authority on test equipment (he's working on a book on test equipment in his spare time), he has frequently been called upon to recommend books explaining how meters, generators, and scopes work. This was not an altogether happy situation for Larry since he couldn't find a book that explained the workings of test equipment the way he would explain them. Well, one thing led to another, and one day Larry showed up with a huge sheaf of typewritten pages. "Here's our new test equipment series," said he. . . . So we got the ball rolling last month with the first part on the VOM and are following with the second part in this issue (page 53). If you missed the January installment, look it up--we think you'll like it.



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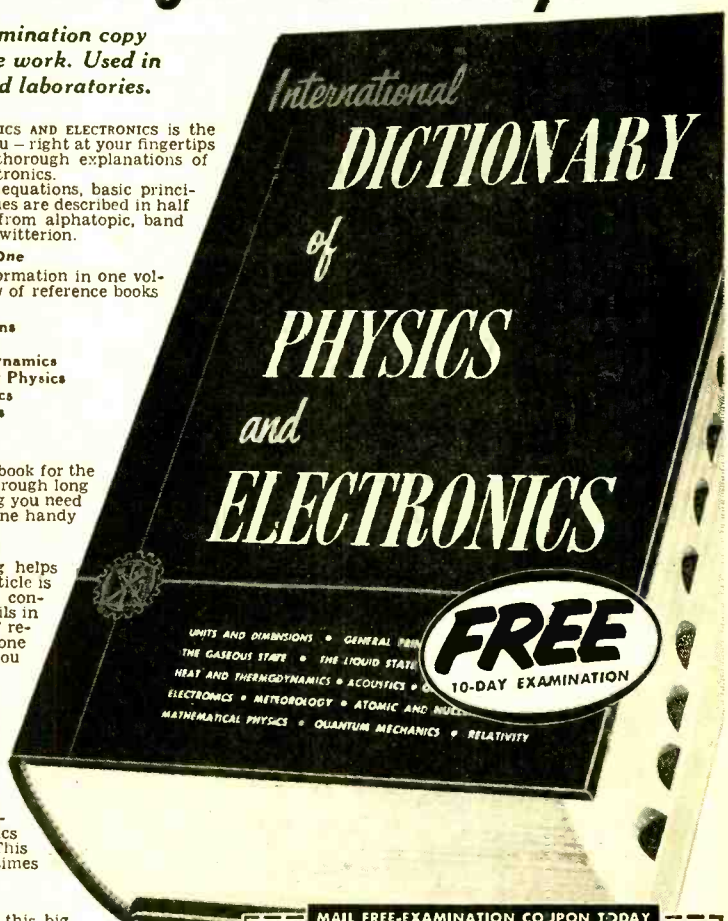

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Dog Teaches Boy

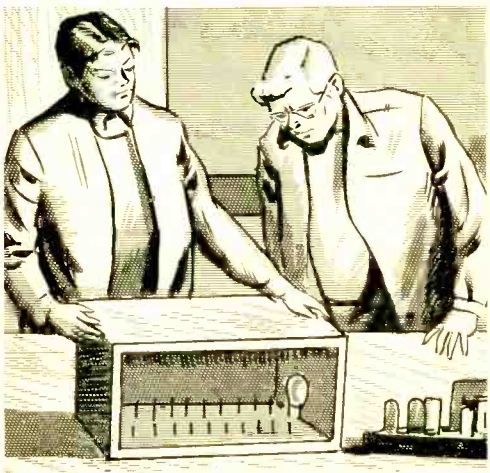
CARL LOOKED PUZZLED as he examined the strange object resting on the workbench in the basement laboratory. His pal, Jerry, watched him with a broad grin. The object was a sort of wooden box with one glass side. It was about ten inches wide, two feet long and a foot high.

Through the glass side of the box, two orderly rows of large spike nails could be seen sticking up from a board in the bottom. The spikes were spaced about two inches apart in each row, and the rows were approximately four inches apart. At each end of the board, fastened to the bottom of the box, was a porcelain lamp socket holding a small round red lamp. The side opposite the glass window was hinged at the bottom so that the box could be opened, and a heavy electrical cord went into the box at the upper right-hand corner of this hinged cover.

"Okay, what is it?" Carl finally asked.

"It's an electrocution chamber for dogs," Jerry announced with a teasing smile.

Carl shot him a withering look. "I suppose that bed of nails is to make the dog



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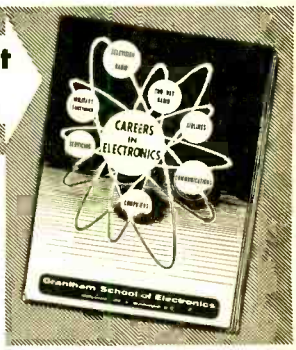

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Carl & Jerry (*Continued from page* 10)

comfortable while he's being electrocuted," he said scornfully. "Quit clowning and tell me what it really is."

"I *did* tell you," Jerry insisted, as he opened a package of wieners. "Here's the scoop! Mom is chairman of the food committee for the meeting of her Sunday School class at the church tonight. They intended to serve hot dogs broiled in the gas ovens of the church kitchen, but the cold weather has broken a gas line running into the church, and it can't be repaired until tomorrow.

"Then I happened to remember seeing a gadget that cooked hot dogs by passing 117-volt house current through them. So I experimented with a single hot dog at a time until I found several things *not* to do; then I built up this affair that will cook ten of them at once. You're just in time to see it checked out."

"What sort of things did you find out not to do?" Carl wanted to know.

"Well, I started out using galvanized nails. They worked all right, but they left a disagreeable taste at the points where they pierced the dogs. I think some sort of electrolytic action took place . . . the taste was very much like brimstone. When Pop heard about this, he cracked that since it was to be a church affair a little taste of brimstone might not be a bad idea, especially for a couple of gossips he knew in that class. You should have seen the look Mom gave him. It would have cooked several pounds of dogs. Anyway, these uncoated nails leave no taste."

As he talked, Jerry was carefully fastening the wieners to the nails by thrusting opposite spikes in the two rows through the ends.

"The nails should go through as close to the ends as possible without splitting out because the dog is cooked by current passing between the nails," he explained.

"What are the little red bulbs for?"

"Mostly atmosphere. Of course, they also serve as pilot lamps to indicate when the current is on, but relying on a voltage-indicating pilot lamp is dangerous. It's too likely to burn out and fail to give warning that the voltage is present. But you will notice that this heavy-duty plug mounted up here in the corner of the box has two

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Carl & Jerry (*Continued from page* 12)

heavy leads that go down through the board and are connected to two copper strips soldered to the heads of each row of spikes. The plug matches up with this socket which is fastened to the door so that only when the door is entirely closed does the plug engage the socket and apply voltage across the two rows of spikes and the two lamps."

"Wouldn't a simple Microswitch in one lead work just as well?" Carl asked.

"You know better than that. In the first place, this gadget will be operated in the church basement which has a cement floor. You know that one of the two wires ordinarily bringing current into the house is grounded while the other is 'hot.' If you stand on the ground and touch that single hot wire, you can electrocute yourself.

"It may take two to tango, but never forget it takes only one wire to electrocute you if you're standing on the ground or touching anything grounded, such as a gas or water pipe, a radiator, or a bathroom fixture. A switch that opens only one wire of a device has a fifty-fifty chance of opening the ground lead instead of the hot lead. That's like playing Russian roulette with a six-gun with three loaded cylinders. Now I'll show you another reason for not using an ordinary switch."

AS HE said this, Jerry plugged the dog-roaster into a panel with an a.c. ammeter. The two bulbs in the box lit up, and the ammeter pointer swung over to indicate six amperes of current.

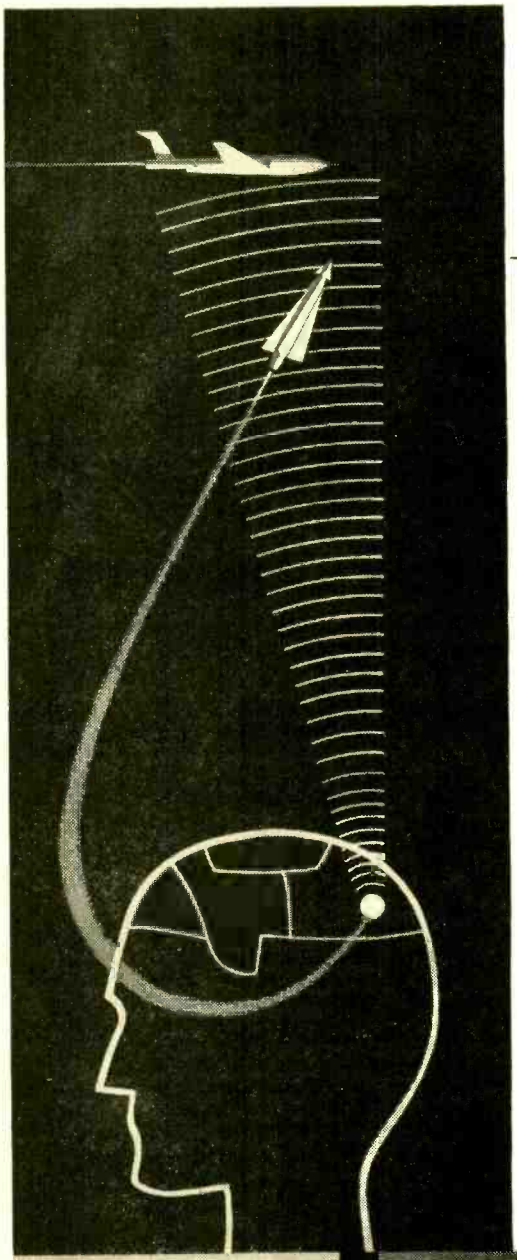
"Hey, nothing's happening," Carl remarked.

"Oh, yes, it is; just keep watching."

The ammeter needle gradually crept over. When it reached about twelve amperes, the hot dogs showed signs of heat. They smoked a bit and began to sizzle. Their skins started to swell and grease dropped from them. The current went up to sixteen amperes. In only about a minute and a half, Jerry pulled the plug.

"That sixteen amperes of current is too much for an ordinary Microswitch," he explained, opening the door and handing Carl a still-smoking wiener. "Each dog takes about an ampere-and-a-half of peak current; so ten dogs are about all that can be cooked at one time from an ordinary wall socket. How does that taste?"

"Not bad, not bad at all!" Carl approved



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Brainpower for the brawny Nike-Hercules

The Army's newest surface-to-air guided missile — the lethal Nike-Hercules — is now operational. Because it is, no unfriendly plane will be able to fly sufficiently high, fast or evasively to escape a fatal rendezvous with it.

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Two sets of radar data are electronically computed and plotted. Hercules is "steered" by radio signals, then detonated at precise point of interception.

Carl & Jerry (*Continued from page* 14)

as he reached for another. "It really seems to be thoroughly cooked all the way through. Why do you think the current goes up that way?"

"I don't know exactly, but I know what it makes me think of. I've been boning up recently on precautions to be observed in working with electricity, and I found out several things I didn't know before. One is that the human skin offers the best protection against electrocution from low voltage sources. While skins vary widely, the average dry skin presents a resistance of about 90,000 ohms per square centimeter. When the skin is wet with water or sweat, it drops to around 900 ohms. That's just the epidermis. The dermis has practically no resistance at all. I've been told that six volts are enough to cause fatal shock if the electrodes are thrust beneath the skin."

"It's really the current that does the dirty work, isn't it?"

"Right! But how much current do you suppose it takes to cause death?" Jerry inquired.

"Just a few amperes, I'd guess."

"You're wrong, a thousand times wrong. Only 15 to 25 *milliamperes* of current are enough to destroy your muscular control and render you incapable of releasing your grasp of the wire or gadget that's killing you. The current soon causes the skin to

. . . Jerry plugged the dog-roaster into a panel with an a.c. ammeter. The two bulbs in the box lit up . . .

the case of the stereo

HUM MINGBIRD

or MAGNETIC *vs* CERAMIC

You may have been reading many controversial advertisements as to the merits of various stereo cartridges . . . namely, the magnetic version vs. the ceramic version. Qualified claims are made by their manufacturers . . . and most are accurate. But how a specific cartridge *sounds* in your stereo system is really the criterion. Let's consider the real facts:

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- SOLD ON MONEY-BACK GUARANTEE
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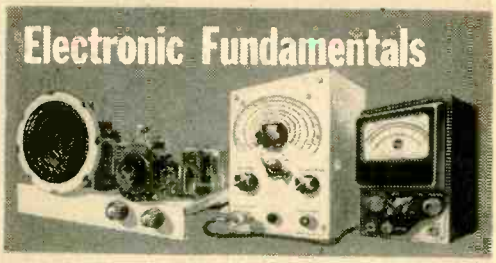

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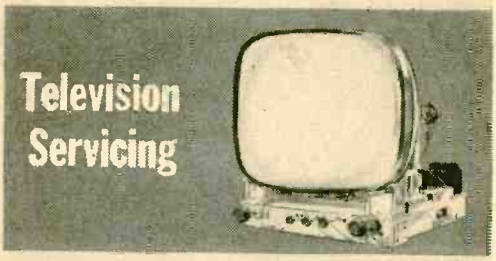

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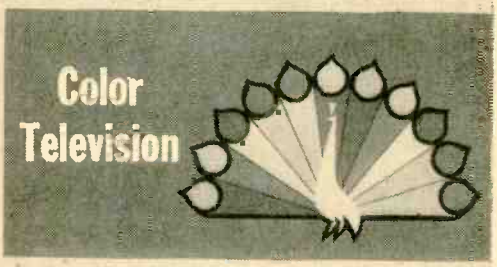

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Carl & Jerry (*Continued from page* 16)

blister, and that deprives you of its insulation. Then, with the inner skin offering no resistance to the current, it rises rapidly, just as it does in those hot dogs. Ventricular fibrillation, or electrically produced heart spasm, can occur at between 75 and 100 ma., and then you've had it."

Carl shivered. "Not a very pretty picture," he commented; "but what started you on this safety kick?"

"I just got to thinking that we're probably going to be working with electricity the rest of our lives, and it's plain stupid not to be well informed on its dangers. That would be like a laboratory technician not understanding how to handle deadly microbes or an auto mechanic being ignorant of carbon monoxide poisoning.

"PEOPLE think 117-volt house current is too low to be dangerous, but many of them have discovered that they were dead wrong; and I use the word *dead* deliberately. More people are electrocuted by house voltage than by any other source. Naturally, one reason for this is the widespread use of this particular voltage; but another reason is that folks don't have the respect for this voltage that they should. People working with higher voltage are usually specially trained to take careful precautions, and they take them; but any dub can stick his finger into an electrical socket to see if it is turned on and to show others how much electricity he can take. He's the guy who will tell you: 'Aw, 110 can't hurt you.'"

"You won't catch me doing anything as stupid as that," Carl promised. "I don't think I'll ever bite another hot dog without thinking about the sight of these having the grease fried out of them with 117 volts."

"Good!" Jerry exclaimed. "Now what do you say to this idea? Suppose we agree to watch each other carefully for any careless or dangerous practices. Let's never be in so great a rush to see how an electrical gadget is going to work that we skimp on safety measures. Let's try to make every electrical device we put together as nearly foolproof as possible, just as I did with this dog-roaster. Let's not depend on our being careful and alert. There will be times when we'll be excited or in a hurry and may forget to check a switch or pull a plug. Let's see to it that we always protect ourselves

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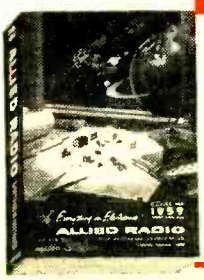

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Carl & Jerry (*Continued from page* 20)

from our own carelessness. Is that okay?"

Carl's sinewy fingers wrapped themselves around Jerry's pudgy hand. "It's a deal," he solemnly agreed. "You watch me, and I'll watch you; and the first one who gets careless receives forty lashes with a wet noodle. Say, who's going to operate this dog-burner at the party tonight?"

"I am. Want to come along?"

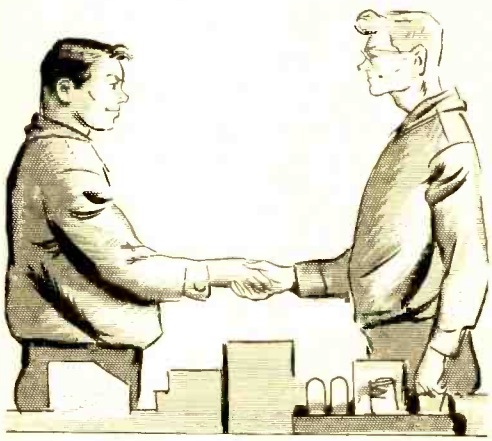
"Yep. Wait a minute. I'll be right back."

This last sentence was cut off by the slamming basement door as Carl took the outside steps two at a time. In a couple of minutes he strode back into the laboratory. On top of his head was a huge mushroom-shaped chef's hat that nearly brushed the low ceiling, and his lean frame was wrapped in a snowy white apron that had "Chef" printed on the front in big letters.

"My uncle sent me this for Christmas, and I've been thinking I'd have to wait for next summer's barbecues to try it out," he explained. "Now I won't. How do I look? Pretty sharp, huh?"

"I'm not sure that's the word, but you look different, anyway. All I can think of are those white-crested cranes we used to see standing along the river bank when we were fishing last summer. But you wear that getup, and we'll give these poor little dogies a real send-off on their last round-up."

"Eet weel be my plaizhure, M'sieu," Carl said in an atrocious French accent as he drew himself to his full height and saluted smartly. —30—



. . . Carl's sinewy fingers wrapped themselves around Jerry's pudgy hand. "It's a deal," he solemnly agreed. "You watch me, and I'll watch you . . ."

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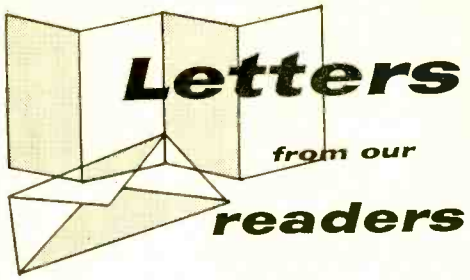


For Foreign Readers

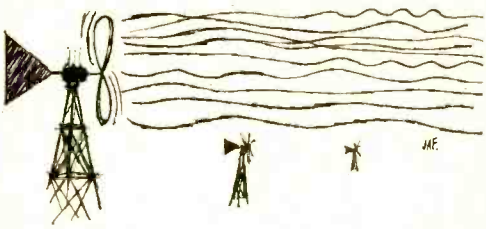
■ To simplify matters for some experimenters and hobbyists in foreign countries, I would suggest that when circuits are designed for 117 volts a.c. it should also be indicated (by means of an inset on the schematic and a small paragraph in the text) how users of 220-240 volts a.c. can make use of the circuitry in their countries.

MARGHUB ALAM, USN
Monterey, Calif.

The easiest way to handle this situation is to use a 220 to 110 stepdown transformer. However, in some cases, a dropping resistor in the line will do the job provided that the circuit's current requirements are constant.

Wind Generators

■ In the December *Letters from Our Readers*, you mentioned that you were looking for some plans for a wind generator. There is a booklet on the subject published by the Oklahoma Agricultural and Mechanical College, Stillwater, Okla. It is called "Plans for the Construction of a Small Wind Electric Plant," by Arnold Benson, publication # 33. The plans are very complete and include templates for the propeller. They are sold for a very nominal sum.



I. E. SWIRE
Brooklyn, N. Y.

Novice Net

■ Although it may not seem possible, it has happened. A Novice has received the coveted BPL Traffic Award. Yes, Novices are really interested in traffic-handling and like to pass radiograms. Unfortunately, there are not very many nets in which they can participate.

In order to keep this interest glowing in New Jersey, we have established the New Jersey Slow Speed Net. This gives beginners a chance to pass traffic at speeds they can enjoy and copy. Our net has been in operation for a year, and we all agree that it sure has been fun handling messages.

Both Novices and Generals are welcome into NJSS and we hope many more will become interested. We feel that there are many Novices who don't know about NJSS. Perhaps if more

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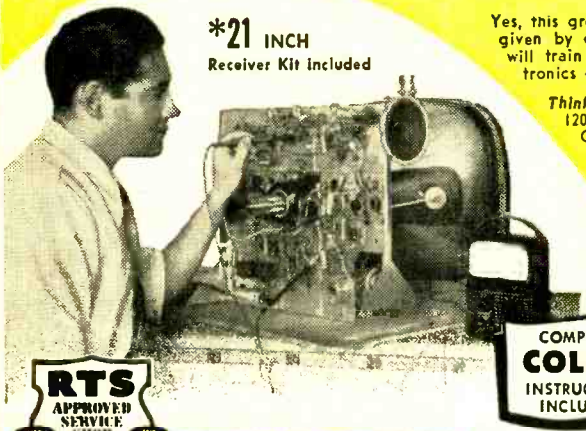

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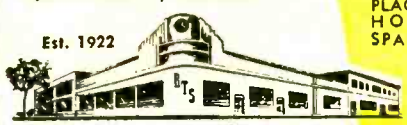
2. Radio and TV test Equipment.
3. Letterheads, calling cards, repair tickets, etc.
4. Basic inventory of tubes, parts, supplies.
5. Advertising and promotional material.
6. Plans for shop arrangement.
7. Instructions on how to go into business.
8. Continuous consultation and help.
9. The right to use RTS Seal of Approval, and the RTS Credo.
10. The right to use the Famous Trade Mark.

you build these and other units

RADIO-TELEVISION TRAINING SCHOOL
5100 S. VERMONT AVENUE
LOS ANGELES 37, CALIFORNIA

Est. 1922



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We must insist that the men we sign up be trained in Radio-TV Repair, Merchandising and Sales by our training methods—because WE KNOW the requirements of the industry. Therefore, we will TRAIN YOU . . . we will show you how to earn EXTRA CASH, during the first month or two of your training period. YOU KEEP YOUR PRESENT JOB. TRAINING TAKES PLACE IN YOUR OWN HOME, IN YOUR SPARE TIME!

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SEND ME FREE — all of these big opportunity books — "Good Jobs in TV-Electronics," "A Repair Shop of Your Own" and "Sample Lesson." I am interested in:

☐ Radio-Television ☐ Industrial Electronics (Automation)

Name _____ Age _____
Please Print
Address _____
City & State _____
300

Letters

(*Continued from page 24*)

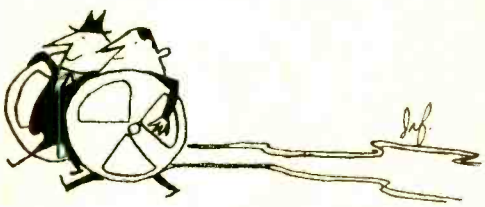
of these fellows hear about it and give it a try, they will find out for themselves what it is like to pass traffic in a real traffic net.

JOHN SORRENTINO, K2ZHK
Crawford, N. J.

One of the best ways for a Novice to go General is to "get-on-the-air." Use that Novice ticket and the General will come as easy as pie.

More on Tape Pals

■ I would like very much for you to place my name in your *Letters from Our Readers* column concerning tape pals. I would like to hear from



anyone interested in vehicle and driver safety, mainly safety supervisors from different countries. All tapes, regardless of interest, will be answered.

TERRY THERIAULT
P. O. Box 258
Lancaster Park, Alberta, Canada

More on Mars

■ The MARS Technical Program was conceived by Mr. Harvey McCoy, AF21YX, 109 Willow Ave., Huntington, L. I., N. Y., in 1956, and generally along the lines you have described for the First Army Technical Program in "A MARSman Tells All" (Dec. '58). Mr. McCoy's ideas for a technical net within the Air Force MARS structure received favorable consideration and he was made Net Director of the Eastern Technical Net with special frequencies being made available for the broadcasts. From the beginning, the Technical Net broadcasts from station AF21YX were enthusiastically received. Mr. McCoy recently received a citation from General Curtis LeMay, Vice Chief of Staff, USAF, for his work on the development of the MARS Technical Net.

ALFRED W. TYLER, MAJOR, USAF
New York, N. Y.

Report and Request

■ One of the best projects I constructed from POP'tronics plans was the flashing light with transistors ("Flash Light with Transistors," Sept. 1958). It was kind of late in the season, but we used it a little on the dock before the cold hit and brought us back down south.

Just one request, if possible. Would it be practical to have a construction project of a Van de Graaf generator or a Tesla coil?

DAVID FRASER
Toronto, Ont.

POP'tronics plans to run constructions details on the "hair-raising" high-voltage inventions of both Messrs. Van de Graaf and Tesla in the near future.

—30—

Now...choose your vocational training!

new "choose-it-yourself" training system guarantees CHOICE, not chance

Now you can pick the vocational training *you* like! Under the Army's new "CHOOSE-IT-YOURSELF" Vocational Training System, *you* choose your vocational training . . . and it's guaranteed *before* you enlist. Here's your opportunity to get valuable training and practical experience in the kind of work you *enjoy!*

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Atomic Weapons	Printing	Construction	Metal Working
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Here's how you "CHOOSE-IT-YOURSELF":

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. . . before enlistment!

Choose the vocational training *you* like from the categories currently available. Your Army recruiter will give you all information and advice you need.

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. . . before enlistment!

Take aptitude and physical examinations . . . to be eligible, you must have a qualifying aptitude score and meet minimum physical requirements for your choice.

3. KNOW
. . . before enlistment!

If you qualify, you *know* you'll *get* the vocational training you like! Your choice is written into your future Army record—guaranteed *before* you enlist.

CHOOSE, QUALIFY and KNOW . . . without the slightest obligation to enlist! You *get* the Army vocational training you like—guaranteed in writing—or you *don't enlist!* This week, ask your local Army recruiter for complete details about the new Army system which lets *you* do the choosing.

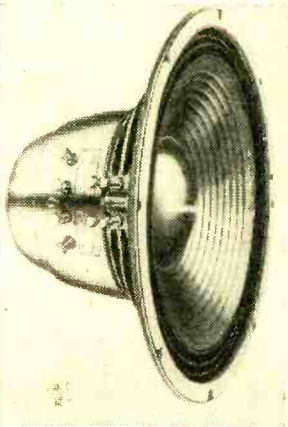
NEW "CHOOSE-IT-YOURSELF" VOCATIONAL TRAINING SYSTEM

U.S. ARMY

NEW products

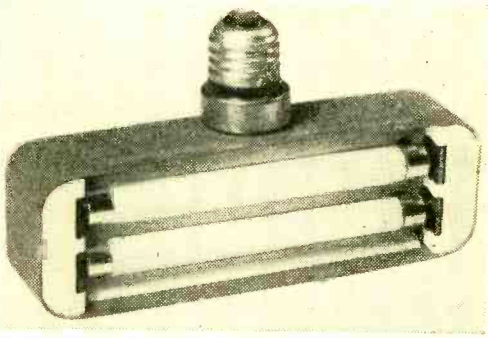
DUAL VOICE COIL WOOFER

The University Model C-12SW 12" woofer eliminates the need for a second woofer in a stereo speaker system. Since the C-12SW features two voice coils, both stereo amplifiers can be connected to it for full bass coverage of both stereo channels. Stereo effect is obtained by the use of auxiliary high-frequency speakers placed for optimum effect. The C-12SW may also be used for extending the bass response of any hi-fi system. Net price, $39.50. (*University Loudspeakers, Inc.*, 80 S. Kensico Ave., White Plains, N. Y.)



"SCREW-IN" FLUORESCENT LIGHT

A "screw-in" fluorescent lighting fixture is being marketed by *Herbach and Rademan, Inc.*, 1204 Arch St., Philadelphia 7, Pa. The Harco bulb unit is completely self-contained and can be screwed into any standard light socket. According to the manufacturer, it provides up to five times the illumination of an incandescent lamp



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Tested — and now used in top schools, and repair shops — Course volumes are simple enough for green beginners, amazed "pros" with new easy methods. Starts you doing simple repairs — and earning money — from very first chapter. ABC pictures and directions make tougher jobs a "snap." Before you finish you can earn many times its cost.

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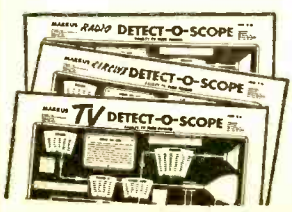

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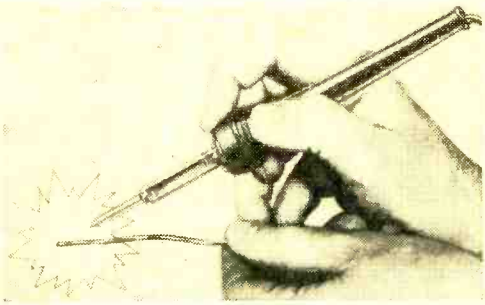
products

(*Continued from page* 28)

which consumes the same amount of power. It is available in three models, all 6¾" x 2⅛" x 1¾", and includes two cool white lamps. Price, $11.00.

MINIATURE SOLDERING IRON

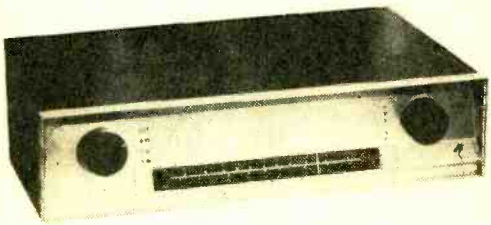
A miniature soldering iron, the "Might-Mite Solder-ette," is being offered by *Tube*



Wholesalers Co., Box 61, Baldwin, N. Y. This 25-watt iron is suitable for making all types of electrical repairs and may be used in the most crowded chassis areas. The copper alloy tip is replaceable. Price, $2.98.

AM-FM TUNER

An AM-FM tuner, the Model EM-085-ER, has been introduced by *Erie Resistor Corp.*, Erie, Pa. It features an etched wiring board and Erie PAC's. Circuitry includes two i.f. stages, a limiter, Foster-Seeley discriminator circuit, and a.f.c. The EM-085-ER's



front panel is gold metalized plastic; its cabinet is finished in black and measures 12½" x 9½" x 3⅛". Net price, $84.50.

TRANSFORMERS FOR TRANSISTORS

A complete line of miniature transformers designed explicitly for transistors is available from *Amplifier Corp. of America*, 398 Broadway, New York 13, N. Y. Thirteen basic types of transformers are being made for use in 90 different impedance-matching circuits. There are four types of frequency response ranges to cover all ap-

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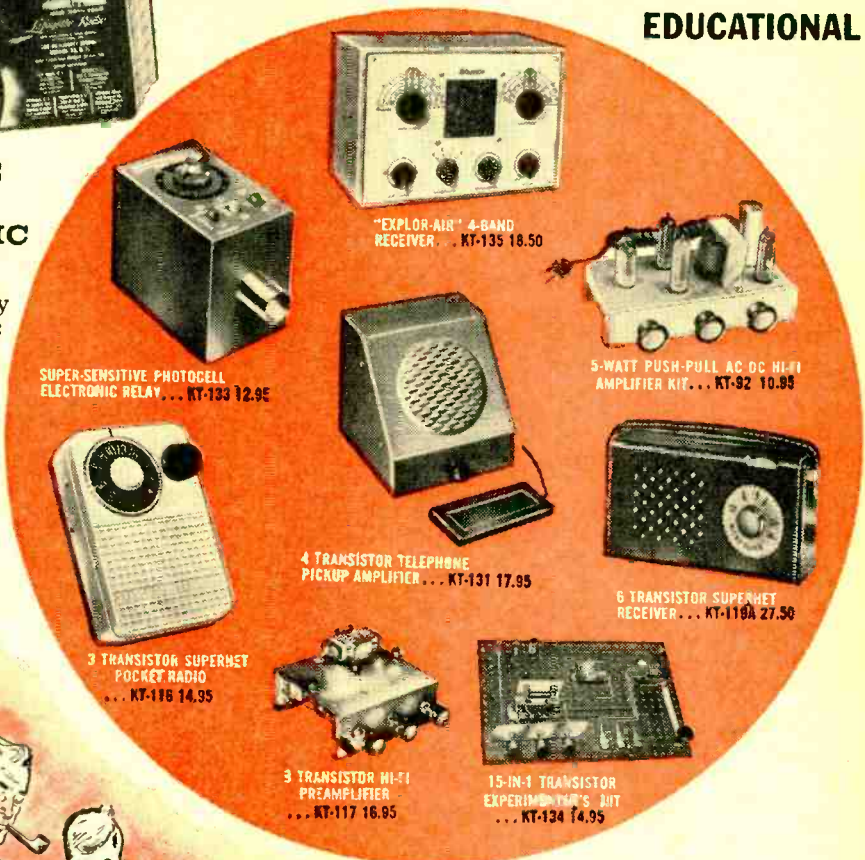

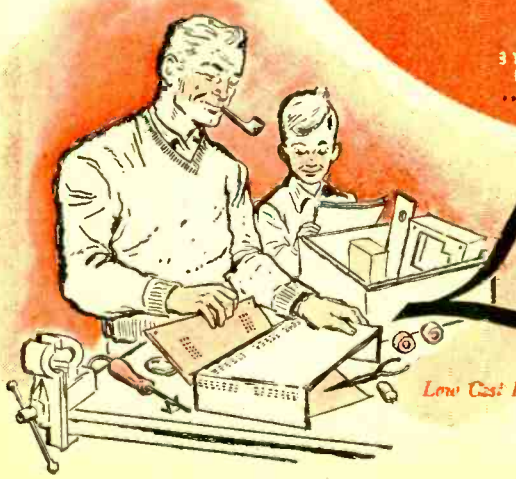

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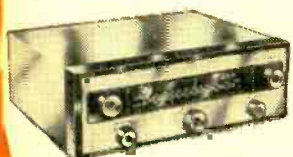

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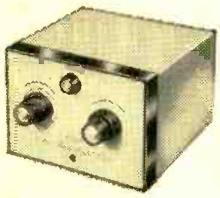

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City....., *Zone*...., *State*.....

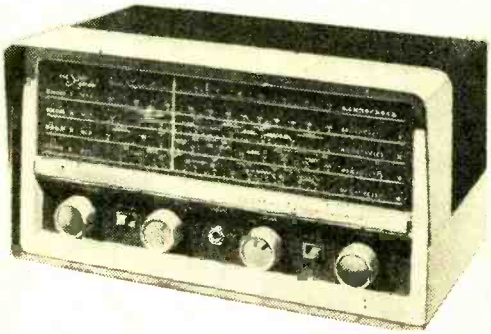
products

(*Continued from page* 30)

plications from high fidelity to voice transmission. The transformers are available in four types of cases, all fully mu-metal-shielded. Complete technical specs and factory prices may be obtained from the manufacturer.

SHORT-WAVE RECEIVER

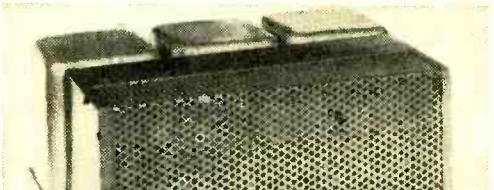
Short-wave listeners will be interested in the new NC-60 receiver being manufac-



tured by the *National Co., Inc.,* Malden, Mass. The NC-60 covers 540 kc. to 31 mc. in four bands with electrical bandspread on all frequencies. Features include separate tuning coils for each band, a front-panel phone-output jack, large dial scale, and an attractive black and grey cabinet. Price, $59.95.

STEREO AMPLIFIER

Stereophiles will find the new Acrosound Stereo 20-20 amplifier well worth their consideration for inclusion in a stereo system. It is a dual-channel basic amplifier with



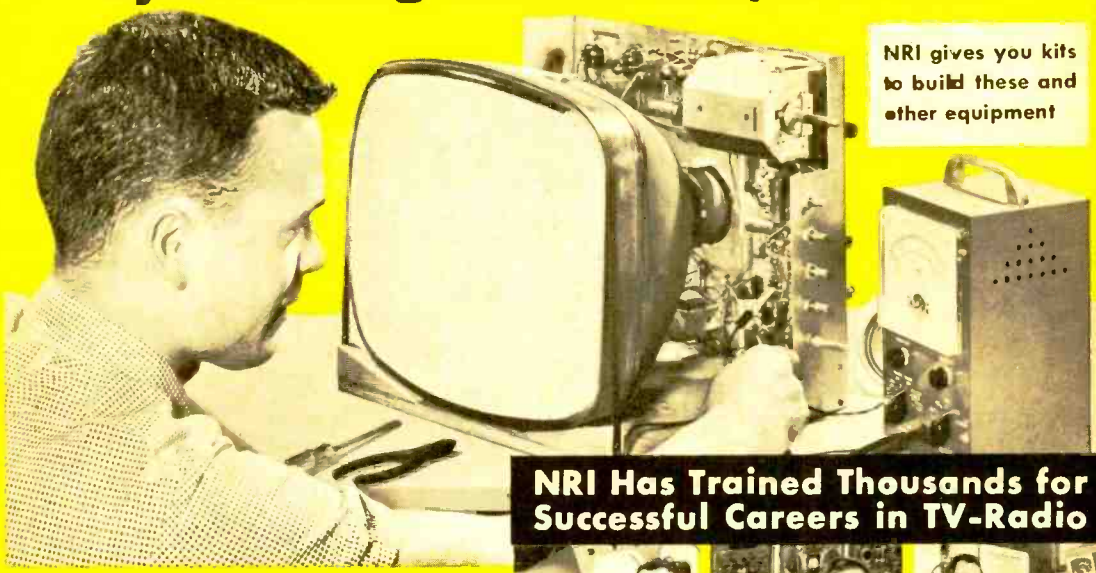
each channel providing 18 watts output at 1.5% IM distortion. The two channels may be paralleled to provide 36 watts output for

(*Continued on page* 108)

Learn TELEVISION-RADIO

Servicing or Communications

by Practicing at Home in Spare Time



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"Now Studio Engineer at KATV. Before enrolling, I was held back by sixth grade education." BILLY SANCHEZ, Pine Bluff, Arkansas.

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NRI students find it easy to start fixing sets for friends a few months after enrolling, pick up $10, $15 and more a week extra spending money. Many who start in spare time soon build full time TV-Radio service businesses. NRI has devoted over 40 years to developing simplified, practical training methods. Learn-by-doing. You get many kits to build equipment for actual practice.

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J. E. Smith, Founder

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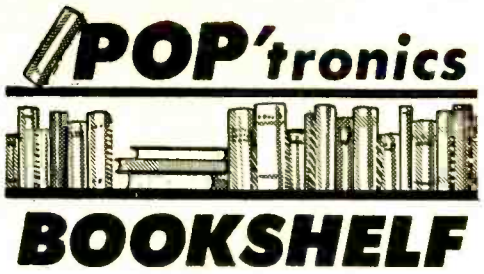


"TRANSISTOR FUNDAMENTALS AND APPLICATIONS" by W. W. Lenz and W. W. Cook. Published by Radio Corporation of America, Camden, N. J. 43 pages. Soft cover. 50 cents.

Starting with the atomic theory necessary for an understanding of transistors, this book then takes the reader through the different types of transistors, transistor amplifiers, methods of coupling, oscillators, power supplies, etc. The text is unusually well presented and the illustrations will help you to understand just what happens when those electrons and holes get together.

Recommended: as a reference book on transistors for everyone interested in the subject.

"TV SIGNAL DISTRIBUTION AND ANTENNA TECHNIQUES" published by Howard W. Sams and Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 186 pages. Soft cover. $2.95.

Every type of TV signal distribution system is fully explored in this book. All problems from the initial installation of an antenna system to final trouble-shooting and maintenance are covered. Additional sections provide information on bidding, cost estimating, and selling such installations. The text is easy to understand and the illustrations are helpful.

Recommended: to the service technician who would like to enter the field of multi-set TV installations.

"HANDBOOK OF ELECTRONIC CIRCUITS" by RCA Service Co. Published by Howard W. Sams and Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 66 pages. Soft cover. $1.00.

A practical and concise reference source of circuit information is invaluable because few of us can carry *all* the details of *all* basic circuits in our heads. This handbook contains circuit diagrams and circuit descriptions of a number of the most commonly used basic electronic circuits employed in both commercial and military equipment. In addition, an analysis of each circuit is included with respect to the most common causes of failure.

Recommended: to anyone whose daily work has anything to do with electronic circuits.

"EXPERIMENTAL BASIC ELECTRONICS" by Rupert N. Evans and Charles B. Porter. Published by McKnight and McKnight Publishing Co., Bloomington, Ill. 104 pages. $3.00.

Working on the principle that theory and experience should go hand in hand, this book presents 18 experiments in elementary electronics along with the theory involved in each. Thus, after step-by-step instructions are given explaining how to build various pieces of simple electronic gear, an explanation follows which covers the theoretical aspects of each circuit.

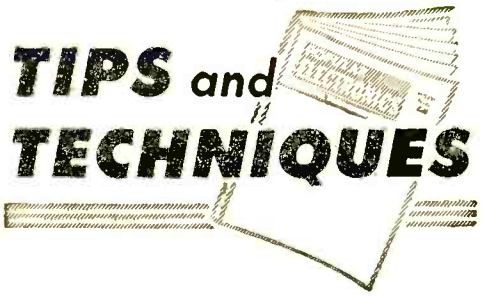
This book is ideally suited for beginners in electronics. However, more experienced readers would wish for more than just 18 experiments.

Recommended: to the beginner in electronics.

"BASIC PULSES" by Irving Gottlieb. Published by John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. Soft cover. 176 pages. $3.50.

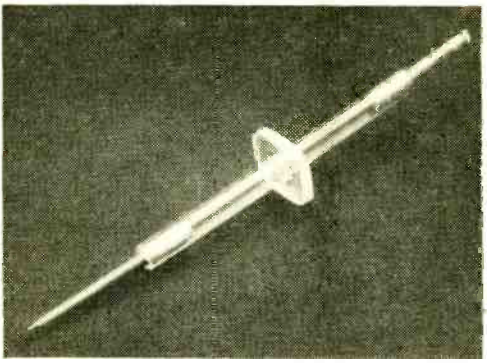
The use of pulses has spread far and wide in the electronic field. Radar, television, telemetry, and computers, as well as industrial operations, all utilize pulses in myriad ways. Now, anyone with a knowledge of electronics can learn the basics of pulses quickly and easily with this new "picture book" course. It explains what pulses are, their composition, shaping techniques, measurement, generation and application. The highly pictorial approach accompanied by only as much text as is deemed essential for maximum clarity not only makes this course understandable but it is always easy reading.

Recommended: as a source of material for profitable spare-time study. —30—



ALIGNMENT TOOL IMPROVEMENT

The writer has three gripes against round alignment tools: they roll around on the workbench; they are hard to pick up; and they haven't enough leverage for hard-to-turn i.f. slugs and trimmer-capacitor screws. As shown in the photo, these problems can be solved by the simple addition of a ¾" square piece of plastic cemented to the center of the alignment tool handle. Saw a ¾" square from a piece of scrap plastic about ⅛" thick, and drill a hole in the center slightly smaller than the diameter of the alignment tool handle. Ream or file the hole just enough so it can be pushed onto the alignment tool with a snug fit. Apply Duco cement, or regulation plastic cement, to both sides of the plastic square, and let it set overnight. The sharp corners

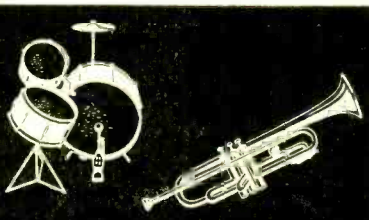


of the plastic square can be rounded off a little with a file.—*Art Trauffer, Council Bluffs, Iowa.*

OPERATION DEEP-FREEZE

Radio batteries from portables are usually removed and left on the shelf, where they generally deteriorate over the winter months. Recalling that a polar expedition found ten-year-old batteries still usable after thawing, we tried the following proce-

2 Kits and a Cartridge play everything



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WEATHERS TECHNICAL MAGIC IS SOUND

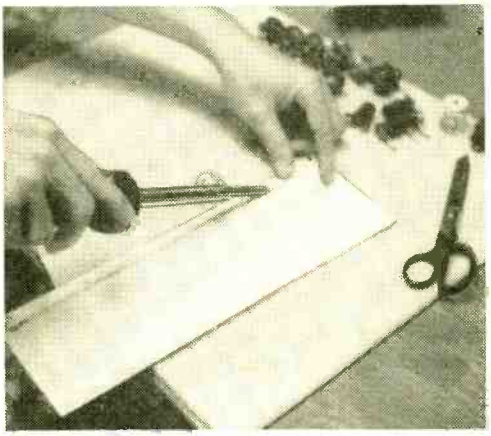
Tips

(*Continued from page 38*)

dure. We wrapped in pliofilm a 67½-volt battery which delivered 62 volts after summer use and put it in deep-freeze in the fall. Early the next summer, the battery was removed, allowed to thaw out, and tested. The voltage was still 62 volts under load. It is at present in a portable radio and still in use.—*George Dugonis, Philadelphia, Pa.*

"SEAL 'EM IN PLASTIC"

Every enthusiastic experimenter, ham or serviceman accumulates a wide and varied assortment of electronic components. While the so-called "junk box" may be a suitable place for some of the more durable items, such delicate parts as coils, relays, etc., demand a more sophisticated treatment. The solution—seal them in plastic. Just take a



sheet of clear plastic (salvaged from shirt wrappers or food wrappers) and fold it over the items you want to package. Then run your hot soldering iron down the edges. A little practice will give you the knack of sealing the plastic without melting it. You can handle a number of items by arranging them in rows inside the package and running the iron between the different rows; the individual packets can then be cut into strips or into separate packages. —*Miles M. Avery, Pharr, Tex.*

PHONO PLUG GRIPPING PROBLEM

Everyone, at one time or another, has had trouble with the RCA-type phono plug jacks. The main difficulty is the lack of gripping area on the plug. You can solve this problem by simply soldering a 3/16" washer to the rear of the plug.—*Charles Bittner, Erlton, N. J.* —30—

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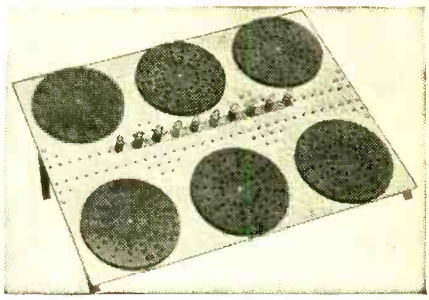
With the 1959 model **GENIAC®**, the original electric brain construction kit including seven books and pamphlets, over 400 parts and component rack, and parts tray, and all materials for experimental computer lab plus **DESIGN-O-Mat®**.



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TEXT PREPARED BY MIT SPECIALIST

Dr. Claude Shannon, known to the readers of **Popular Electronics** for his invention of the electronic mouse, that runs a maze, learning as it goes, formerly a research mathematician for Bell Telephone Laboratories is now a research associate at MIT. His books include publications on Communication theory and the recent volume "Automat Studies" on the theory of robot construction. He has prepared a paper entitled "A Symbolic Analysis of Relay and Switching Circuits" which is available to purchasers of the **GENIAC**. Covering the basic theory necessary for advanced circuit design it vastly extends the range of our kit.

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You are safe in joining this group because you are fully protected by our guarantee, and have a complete question and answer service available at no cost beyond that of the kit itself. You share in the experience of 20,000 kit users which contributes to the success of the 1959 **GENIAC**—with **DESIGN-O-Mat®** the exclusive product of Oliver Garfield Co., Inc., a Geniac is truly the most complete and unique kit of its kind in the world.

COMMENTS BY CUSTOMERS

We know the best recommendation for **GENIAC** is what is has done for the people who bought it. The comments from our customers we like best are the ones that come in daily attached to new circuits that have been created by the owners of **GENIACS**. Recently one man wrote: "**GENIAC** has opened a new world of thinking to me." Another who designed the "Machine that Forecasts the Weather" commented:

"Several months ago I purchased your **GENIAC** *Kit and found it an excellent piece of equipment. I learned a lot about computers from the enclosed books and pamphlets and I am now designing a small relay computer which will include arithmetical and logical units . . . another of my pet projects in cybernetics is a weather forecaster. I find that your* **GENIAC** *Kit may be used in their construction. I enclose the circuits and their explanation."*
Eugene Darling, Malden.

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☐ I have enclosed $19.95 (plus 80c shipping in U. S., $1.50 west of Miss., $2.00 foreign), 3% New York City Sales Tax for N.Y. City Residents.

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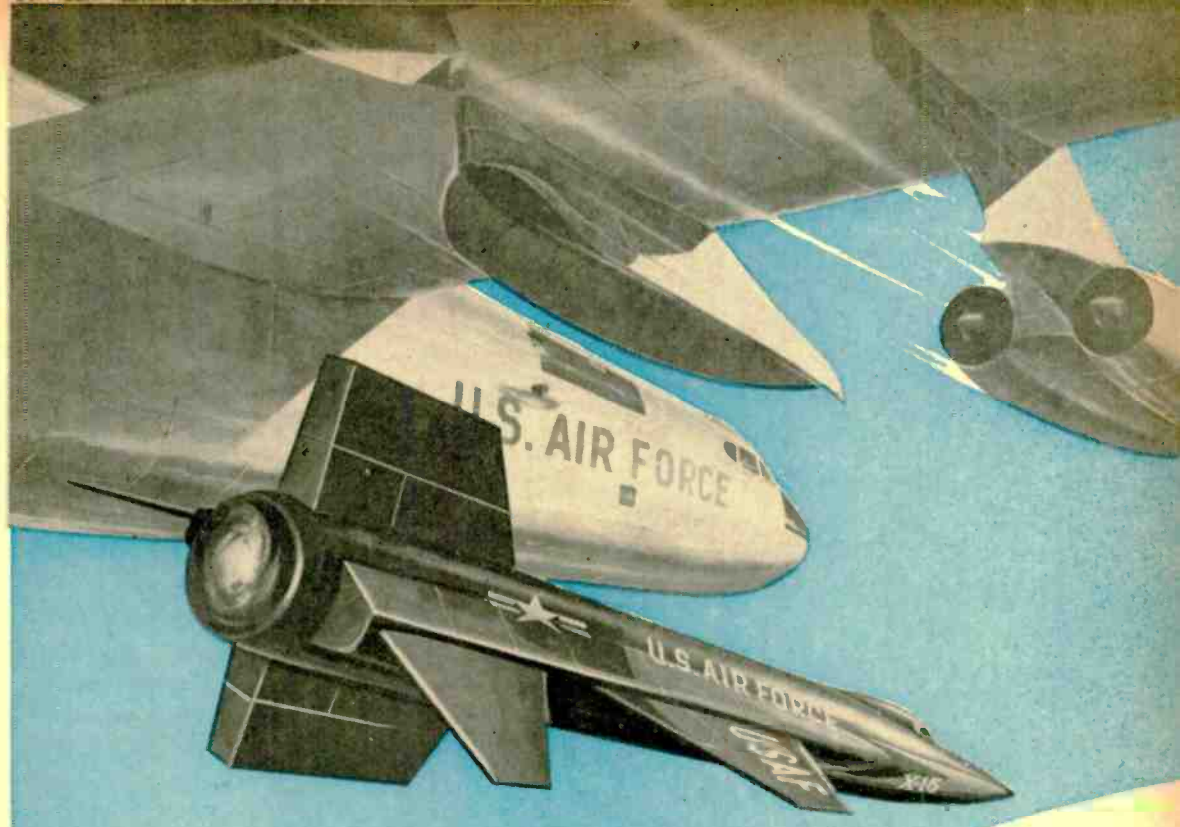


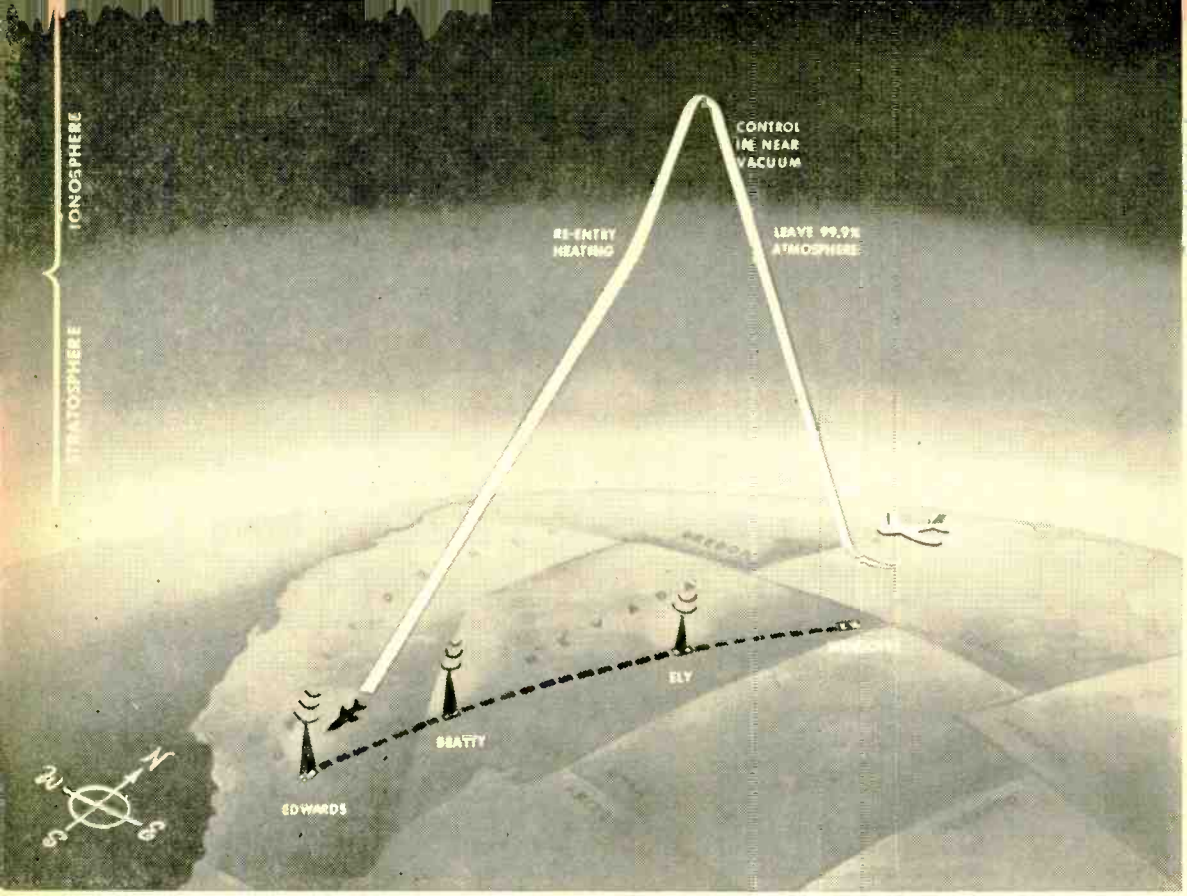
Electronics in Space

By SIMON DRESNER

ELECTRONICS has the starring role in the dramatic exploration of the last remaining frontier: outer space. North American Aviation's X-15 rocket research plane, scheduled to be launched this month, will carry a man for a few minutes to the fringe of outer space and beyond. Tremendously powerful rocket engines will push the X-15 to fantastic speeds in the near vacuum of space, but delicate microscopic electronic instruments will guide it surely and deliberately on its journey.

Accurate navigation is all important in space flights, and with a man aboard a rocket, no chances can be taken. Inertial navigation, which was developed for our big satellite-carrying rockets, will be the guiding hand during the X-15's brief brush with space.

Inertial Navigation. The principle of inertial navigation is as old as Newton's laws of motion. Inertia is a resistance to a change in direction of motion, a resistance which can be measured and used to guide a rocket or ship. It is independent of gravity, the earth's magnetism, or radar. Inertial navigation was used to guide the "Nauti-



lus" under the North Pole, and it is an incredibly accurate system.

Whether traveling through polar depths or stellar space, inertial navigation is invulnerable to detection or jamming because it is completely self-contained. It is independent of weather conditions or time of day or night, it is free from altitude limitations, and it can be used anywhere in the world without referring to the earth's magnetic field.

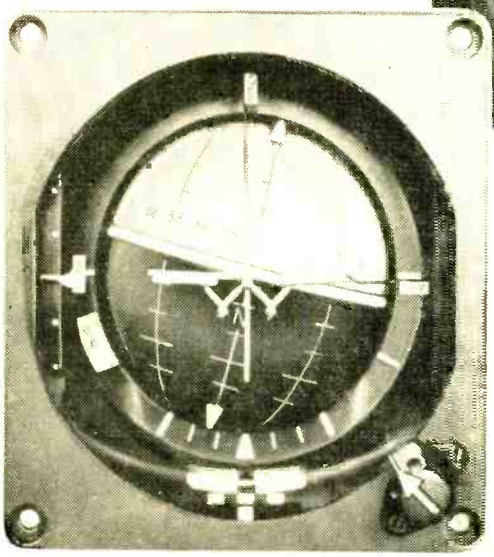
The X-15 will be launched from a B-52 "mother plane." Radar navigation devices will compute its position until the exact moment of launch. From then on, it's on its own and will navigate with a purely inertial system—completely without outside aid. All that has to be known is the geographic location of the starting point and destination — information which is set into the equipment's computer memory before the plane leaves the ground.

Space Speedometers. The key to navigating inertially is the use of accelerometers, or "space speedometers." These work on the principle of the pendulum. When the plane is accelerated, the pendulum arm is displaced with respect to the plane.

The position of the arm can be measured and used to record changes in velocity in any direction, including upwards. This creates an effective altimeter for outer space. Conventional barometric altimeters which

Flight path of the X-15 will carry it for a time into the near vacuum of outer space. Three radar stations will track the space-ship from the moment it leaves the "mother" plane until it lands at Edwards Air Force base.

Wrist controls which pilot will use under severe acceleration are being tested here. The supersonic ejection seat has foot clamps, arm guards, and stabilizing fins to prevent spin.



Sphere indicator tells pilot the angle of his plane with respect to earth. A horizontal needle shows correct angle of attack to keep the plane from burning up when re-entering the atmosphere.

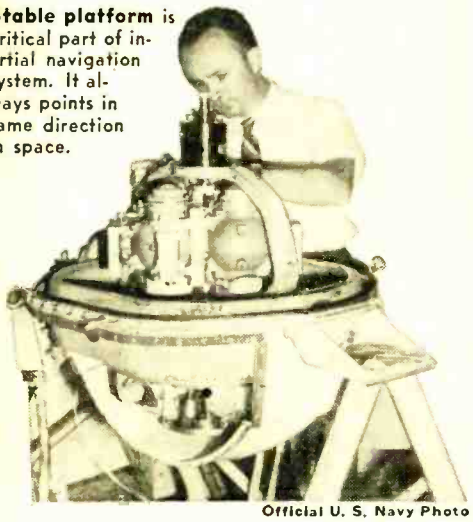
work by air pressure would be useless in the upper limits of the earth's atmosphere and beyond.

Stable Platform. As the accelerometers must be independent of the turning movements of the plane, they have to be mounted on a "stable platform." The platform's stability is achieved by a set of three gyroscopes and a gimbal suspension mounting. These serve to keep the platform in the same spatial or angular relationship to earth no matter what the heading or angle of the aircraft.

The accelerometers mounted on the X-15's "stable platform" will sense the acceleration of the plane in any direction, and from this the altitude or angle of the plane, its velocity, distance, and altitude can be computed. The platform is a marvel of

electronics miniaturization, and carries its own power supplies and amplifiers.

"Where Am I?" That's the question the pilot will be able to answer when his inertial navigator gives him the facts. All the data on velocity and altitude and direction coming from the stable platform and its computers will be digested by another lightweight computer which will interpret



Stable platform is critical part of inertial navigation system. It always points in same direction in space.

Official U. S. Navy Photo

it and display it to the pilot, helping him to stay on a prearranged flight path.

A newly designed three-axis indicator will show the angle of the X-15 in relation to the earth and will guide the pilot when his faster-than-a-bullet craft exits and re-enters the atmosphere.

Red Hot Plane. The X-15, which will fly at a speed better than one mile a second, will glow red like a blacksmith's forge as it plunges back into the earth's atmosphere, hitting a veritable "wall of air." The plane's longitudinal axis must be perfectly aligned with its direction of flight when it re-enters the earth's dense blanket of air. If the plane enters the atmosphere too steeply, it will burn up, or if it approaches the air layer at too shallow an angle, it will "bounce back" into space. To prevent this, the pilot will have an "attitude sphere" in front of him which will give him his angle of approach with regard to the earth in terms of pitch, roll, and yaw. This instrument will receive information from the inertial navigation system.

The "attitude sphere" will give the pilot his precise position visually—so that he can use his human judgment and selection, and command optional maneuvers. In effect, the pilot is part of the guidance system—he is designed into the navigational system as an extremely accurate and super-intelligent servo system.

Wrist Controls. Special controls will permit the pilot to keep the X-15 on course with wrist motion only, because his arms will be pressed tightly into his seat by the tremendous G forces to be encountered.

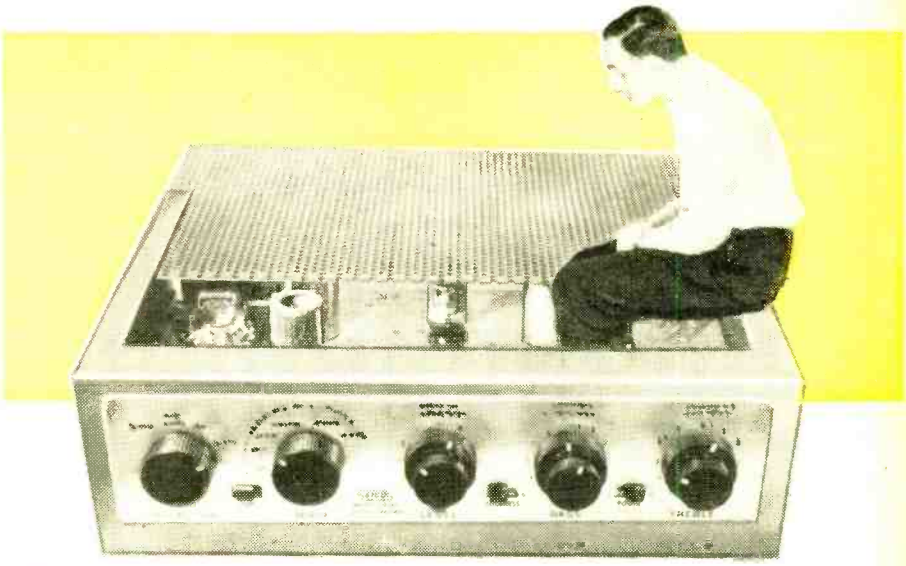
To keep the airplane pointing in the right direction while it is soaring above the atmosphere, the pilot for the first time will bring into use the small hydrogen peroxide jets located in the nose and the wingtips. Acting like jets of steam, they will turn the plane in a direction opposite to their force, so that the plane re-enters the atmosphere nose first.

Tracking by Radar. Ground tracking stations must follow the flight of the plane, keep in constant communication with it, and receive telemetered information. Since the plane's transmitter is constantly moving, the highly directive antennas have to be kept pointing toward the moving plane. To make sure that the antennas stay on target, an automatic tracking facility is built right into the antenna system.

An ingenious system keeps the plane's signal centered right at the focus of the parabolic antenna. If the signal goes off center, electric impulses are sent to servo motors which rotate the antenna back into position. In addition, a computer follows the movement of the antenna and computes the whole orbit of the flight, adding its own correction to the antenna motion. The computer also keeps the antenna tracking for about twenty minutes after the signal fades.

Usually several radar antennas are scattered over the length of the tracking range. When one antenna finds the plane, it signals the other antennas so that they can also find the correct position, even though their signal may be too weak, or the plane over the horizon. The radio signals from all the antennas are combined so that if one antenna loses the signal, another is still receiving it and relays it to the control and communications center. In this way the plane's position is always known, and telemetering signals, communications signals come through without interruption.

As the X-15 soars into space, a thousand and one electronic instruments—radios, computers, gyros, radar—will be watching, along with many anxious eyes. —30—



INSIDE the PREAMPLIFIER

Part I: Preamplification

Joseph Marshall is one of the handful of writers who qualify for the title of hi-fi expert. He has contributed hundreds of articles on high fidelity to almost every periodical in the field and is the author of the book "Maintaining High Fidelity Equipment." It is with great pleasure that POPULAR ELECTRONICS welcomes Mr. Marshall to these pages.

The first of Mr. Marshall's series, "Inside the Preamplifier," will be divided into four parts: Preamplification, Equalization, Tone and Loudness Controls, and Stereo Preamplifiers. This will be followed by a two-part article on power amplifiers, and, eventually, the entire range of audio equipment will be covered.

THE PURPOSE of high fidelity is to deliver to the listener the most faithful possible reproduction of the original sound. But it is not possible to maintain throughout the process of reproduction the exact balance of the original sound. The sound is modified to some degree at almost every point in the long chain between the pickup by the microphone in the auditorium or studio and its delivery to the ear of the listener by the loudspeakers in his living room.

Some of these modifications are due to imperfections in even the best hi-fi equipment, others are deliberately introduced for various technical reasons, and still others are accounted for by variations in the listening conditions.

Sound Modifying Factors. For example, it is not possible to record sound onto tape or disc in its original frequency

balance. It is necessary to cut down the level of the low notes and to boost up the level of the high notes. To restore the original balance, the playback equipment has to reverse this process—boost the lows and attenuate the highs. To do the job perfectly, the playback response must be exactly the reverse of the recording response.

A second factor to be considered is room acoustics. The acoustics of the room in which the sound is reproduced are by no means the same as those of the auditorium or studio in which the sound was originally produced. Every room has different acoustic properties which tend to modify the balance and quality of the reproduced sound. Even the largest living room cannot reproduce the acoustics of an auditorium; but certain compensations can be made to produce a sound that is satisfyingly close to the original.

Another sound-modifying factor is the problem of loudness levels. Very few people can play back a recording of a symphony orchestra at its original level. The volume level is usually reduced to one-tenth or even one one-hundredth of the original volume to be tolerable in the typical living room. But the frequency response of the human ear changes as the volume of the incoming sound is changed. At very loud levels the response of the average ear is reasonably flat. But at low levels the ear is less sensitive to the high notes, and far less sensitive to the very low notes. Therefore, if we want to hear in our living rooms, at living room volumes, an approximation of the balance that existed in the auditorium, we must somehow or other make a correction for this effect.

Finally, human ears are not all the same, either in shape—or in sensitivity. Every individual's ear responds differently, particularly as the loudness level is changed. But recordings or radio programs are balanced for the ear of the engineer in charge, or for what he believes to be an average ear. Not every listener will find this balance suitable and there should be some means of modifying the reproduced sound to suit individual tastes.

Clearly then, to deliver a reasonable facsimile of the original sound, a high-fidelity system must provide means of correcting for these various factors. This is the most important function of the control unit, or preamplifier. It may be an entirely separate and independent unit or it may be "integrated" with the amplifier. In either event, the preamplifier is one of the most critically important sections of a hi-fi system.

Dynakit

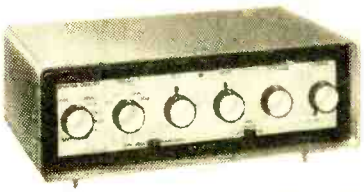
Preamp Functions. No other portion of a hi-fi system does as many jobs as the preamplifier/control unit. First, it must provide *preamplification* of the very weak signals provided by certain program sources. Secondly, it must *equalize* the signal delivered by the signal sources, i.e., it must restore the natural balance that was deliberately modified in the process of recording or transmission. Third, it provides a means of choosing between the several available sources of program material such as disc recordings, tape recordings, radio, etc.

Fourth, it provides a means of correcting, through tone compensation or *tone control,* for the imperfections of the equipment, the acoustics of the listening room, the variations in human hearing, and differences in individual taste. Fifth, it controls the volume or loudness of the reproduction. Sixth, since, as we mentioned before, the response of the human ear varies as the loudness is varied, the control unit usually provides *loudness compensation* to correct for this curious effect.

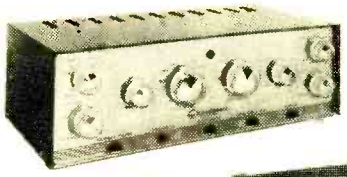
In addition to those primary functions, the preamplifier may also provide means of minimizing record rumble or scratch, for feeding or monitoring a tape recorder, and/or other special features.

Let us look inside the preamplifier and see how it performs these functions.

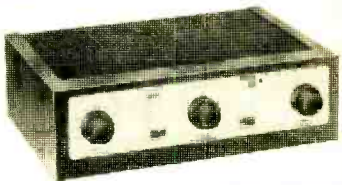
Preamplification. Ceramic or crystal phono pickups can deliver as much as several volts and thus require little or no preamplification. The output of magnetic pickups, on the other hand, runs from as little as one millivolt to as much as 50 millivolts. Thus, they require preamplification of as much as 1000 times. Even more gain than this is needed because the process of *equalization* involves additional loss of 20 db or more, and this must be compensated for



Knight-Kit



Grommes 212B



Eico HF-65

Heathkit SP-1

by higher amplification. Therefore the overall amplification needed ranges from 200 times in the case of the highest-output magnetic pickups to 10,000 times in the case of the low-output models. Inasmuch as the manufacturer of the preamplifier does not know which pickup the purchaser will use, he must provide enough gain to take care of all possibilities.

At least two stages of amplification are needed to provide an amplification of 10,000. In most preamps the two sections of a 12AX7 triode are used in cascade (Fig. 1). Depending on the circuitry, the 12AX7 can provide a total gain of between 1500 and 3500 *before* feedback and equalization. This is not quite enough for the less sensitive pickups. However, additional gain can be provided by the following portions of the preamp and this arrangement serves the average application nicely.

In some preamps, a pentode and a triode, or two pentodes, are utilized to achieve gains between 4000 and 10,000. The Dynakit preamp is a special case in that it uses only the two triodes of a 12AX7 but achieves gain approaching that of two pentodes through the use of a positive feedback loop (Fig. 1). The negative loop provides the equalization and the positive loop increases gain to make up for most of the equalization loss.

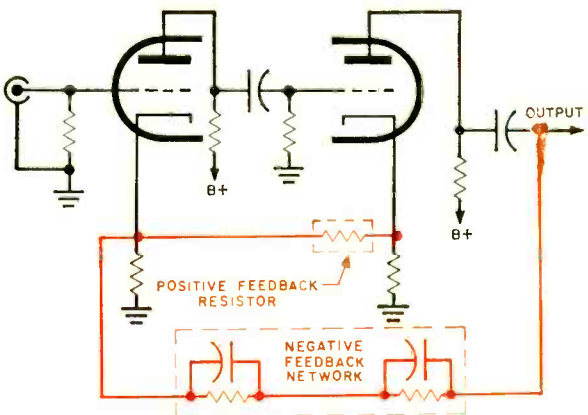


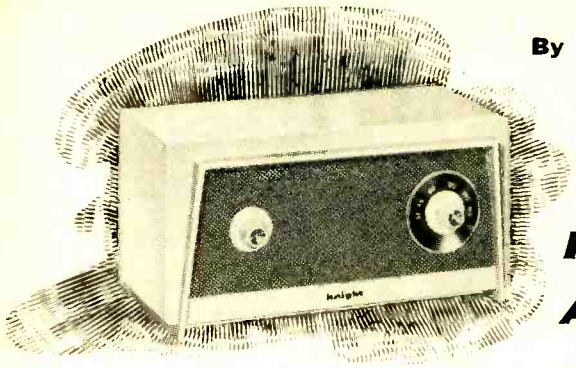
Fig. 1. Circuit diagram of preamplifier with cascaded triode amplifier. The paths of the feedback loops are indicated here in color.

Hum and Noise. The problem of achieving high amplification is complicated by hum and noise. To be completely inaudible, the total noise should be at least 60 db below (or 1/1000th of) the program or signal level. This means that for an average magnetic cartridge with an output of 10 millivolts, the total noise at the preamp's input should be less than 10 microvolts.

For the least sensitive magnetic pickups, whose output may be as low as 1 millivolt, the noise would have to be no more than 1 microvolt. It is almost impossible to keep the noise level down to this latter level—although a few preamps do manage it by using special tubes and circuitry. To reduce hum to the minimum, the best preamps use d.c. to heat the filaments of the preamplifier tubes.

Preamps that do not provide d.c. filament

(*Continued on page* 112)



By WILLIAM I. ORR, W6SAI

HUNT FOR DX AT NIGHT...

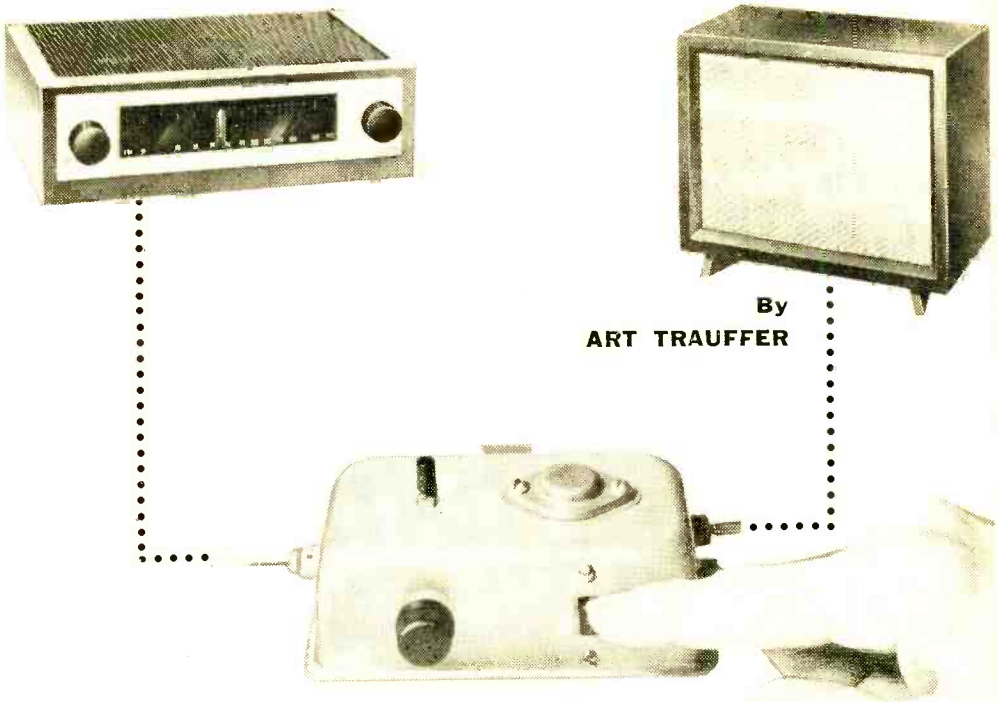
With Your Broadcast Receiver

RECEPTION of broadcast signals from far distant points is possible during the dark hours if you have a sensitive receiver and a good antenna. A "communications" type receiver or a broadcast set having a radio amplifier stage (easily identified by the three-section tuning capacitor) attached to a 100′ wire will "pull in" broadcast stations from across the oceans after your local broadcast stations have "gone to bed."

The European broadcast band (520-1602 kc.) occupies approximately the same range as the American broadcast band. Because of the large number of stations in various countries occupying this portion of the radio spectrum, the broadcast channels are spaced 9 kc. apart, instead of 10 kc., as is customary in the Americas. Thus, the European channels run 539, 548, 557, 566, 575, 584 kc. . . . up to the highest channel of 1602 kc. In addition, a number of stations occupy "split channel" frequencies, such as *Radio Moscow* on 691 kc. (the nearest channel is 692 kc.), and *Radio Cyprus* on 635 kc. (the nearest channel is 638 kc.)

Not limited to the United States maximum power level of 50 kw., many European stations run powers as high as 100 to 250 kw. These giants can be heard along the eastern seaboard of the United States and Canada, and on nights of good reception may be heard in western states. Best reception time is from midnight EST to sunrise during the cool winter and spring months. Your "best bets" are listed at right. Stations marked with an asterisk carry the Armed Forces programs in English. —30—

STATION	LOCATION	FREQUENCY (kc.)	POWER (kw.)
Munich*	Munich, Germany	548	100
Radio Riga	Riga, Latvian S.S.R.	575	300
Lyon #1	Lyon, France	602	100
British Broadcasting Corp.	Daventry, England	647	100
Radio Lisbon #1	Lisbon, Portugal	665	135
Radio Poznan	Poznan, Poland	737	300
Deutschlandssender	Germany	782	300
Radio Roma #2	Rome, Italy	845	150
Frankfurt*	Frankfurt, Germany	872	150
Radio Brussels	Brussels, Belgium	926	150
Radio Berlin	Berlin, Germany	989	300
Hilversum #2	Hilversum, Holland	1007	120
Dresden Radio	Dresden, Germany	1043	240
British Broadcasting Corp.	Droithwich, England	1088	150
Voice of America	Munich, Germany	1196	150
Radio Tangier	Tangier, Morocco	1232	150
Stavanger Radio	Stavanger, Norway	1313	100
Radio Moscow	Kaunas, Lithuanian S.S.R.	1385	250
Radio Luxembourg	Luxembourg	1439	400
Radio Vatican	Vatican City, Italy	1529	100



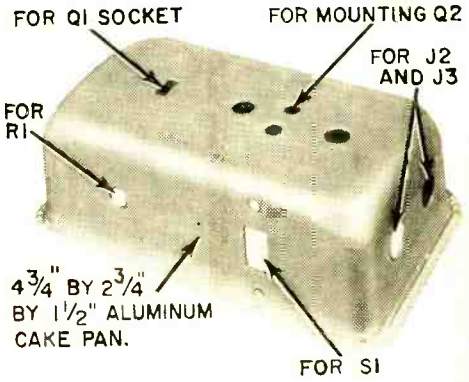
By
ART TRAUFFER

Transformerless Transistor Amplifier

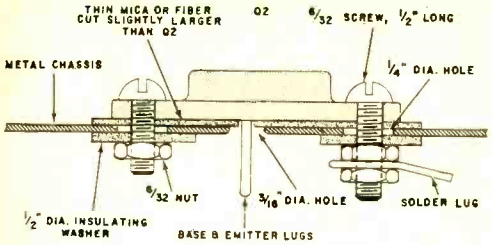
HERE is a low-power amplifier with good fidelity. Used with your AM-FM tuner, it will drive a 12" extended-range speaker to a good volume. At a cost of about $8.50 for materials, you get an undistorted power output of about 200 mw. with excellent frequency response (±2 db from 12 to 12,000 cps).

The unit is compact and easily built. Follow the schematic on page 52. The two transistor stages are direct-coupled and the power transistor drives the speaker without the need of an output transformer.

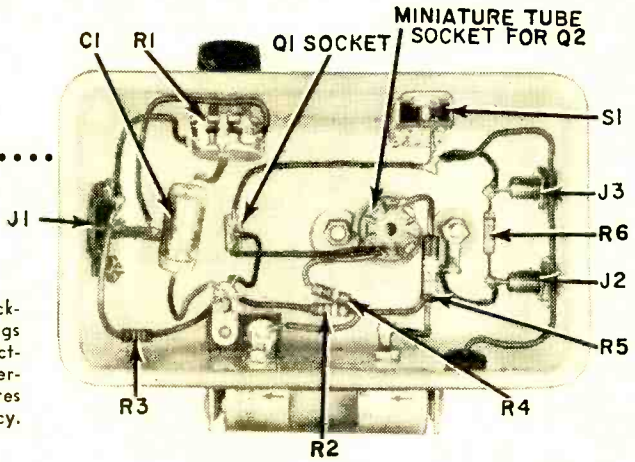
An efficient 16-ohm or 8-ohm speaker is recommended, but a 4-ohm speaker will give satisfactory results. The 560-ohm resistor, *R6*, across the speaker protects the transistors if the speaker is disconnected when the amplifier is on.



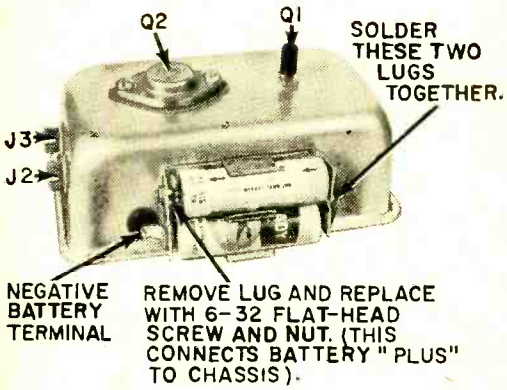
1 A small toy aluminum pan is used as the chassis. The holes can be cut to size with a pen knife and a few small files.



2 Prior to mounting power transistor Q2, cement two 1/2" fiber washers to the chassis as shown. If done correctly, the mounting screws and lugs of Q2 will be insulated from chassis ground.



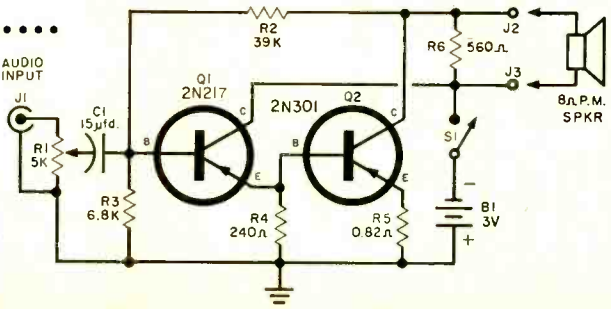
3 Use a 7-pin or 9-pin socket to connect to prongs on Q2. Do not solder directly to prongs. After soldering all components and wires in place, check for accuracy.



4 Rear view of completed chassis. Insulated phone tip jacks are used for J2 and J3. The battery holder terminals are connected so the two cells are in series with the positive end grounded.

PARTS LIST

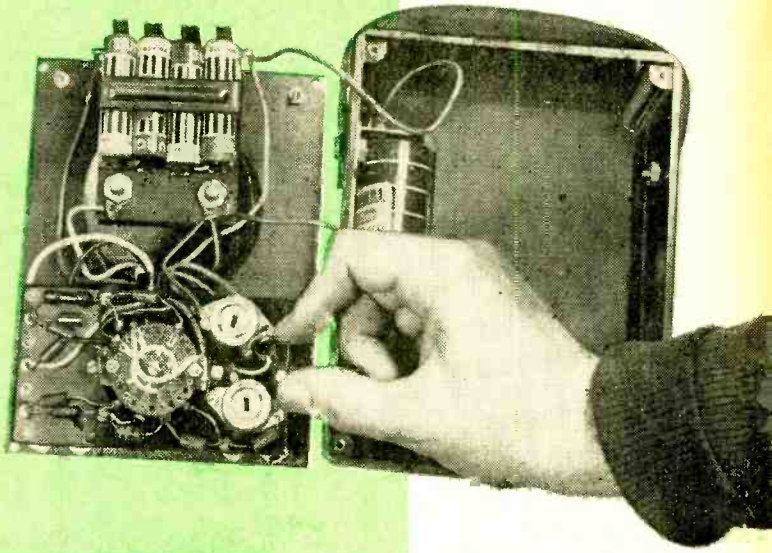
B1—Two size "AA" penlight cells
C1—15-μfd., 25-volt miniature electrolytic capacitor
J1—Phono jack
J2, J3—Insulated phone tip jack
Q1—Transistor (RCA 2N217)
Q2—Power transistor (RCA 2N301)
R1—5,000-ohm miniature volume control
R2—39,000 ohms
R3—6800 ohms
R4—240 ohms
R5—0.82 ohm
R6—560 ohms
All resistors ½-watt composition, 10%, unless otherwise indicated
S1—S.p.s.t. slide or toggle switch
1—Transistor socket
1—7-pin or 9-pin tube socket
1—Acme battery holder, No. 6
2—½"-o.d. fiber insulating washers
1—One-lug terminal strip
1—4¾x2¾x1½" aluminum cake pan



5 Check your wiring with the schematic of the amplifier. If the tuner has a volume control, set R1 fully clockwise for maximum gain. Connect a good quality 8-ohm speaker to J2 and J3.

Test Instruments

Part 2



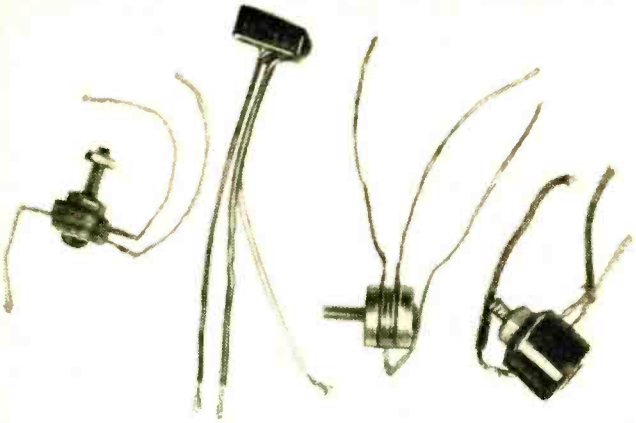
THE VOLT-OHM-MILLIAMMETER

—A.C., Current and Ohmmeter Ranges

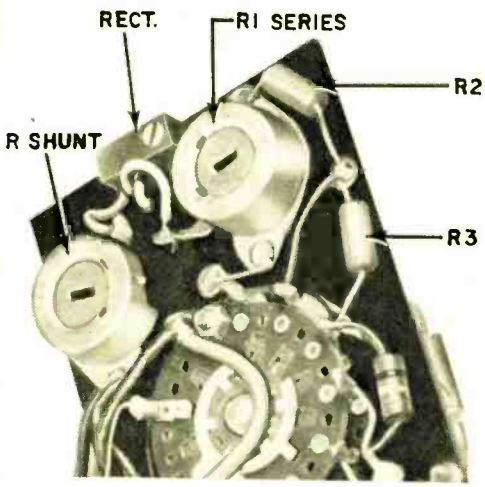
By LARRY KLEIN
Technical Editor

LAST MONTH we covered the d.c. voltage ranges of the standard VOM and worked out some of the basic answers to questions of multiple ranges and the meaning of "sensitivity." This month we'll continue digging into the multimeter's innards, check out the theory of the other functions, and see what they do and how they do it.

A.C. Voltage Ranges. Since the mode of operation of the a.c. section of the VOM is similar to that of the d.c. section (except for the necessary addition of a rectifier), we won't spend too much time on it. The rectifiers found in most VOM's are about the size of a transistor and have the same general appearance. The rectifier's function is to provide a direct current proportional



Several different types of instrument rectifiers. Note size in comparison with dime.



Rectifier is placed immediately adjacent to the two calibration pots in typical VOM.

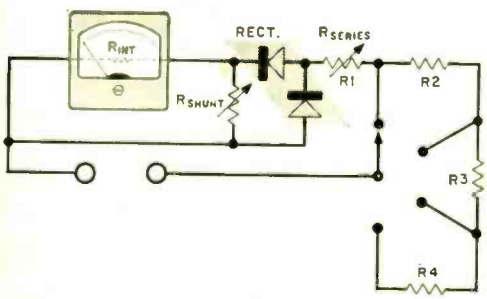


Fig. 4. Typical a.c. voltage measurement circuit of a standard VOM.

to the alternating current fed to it. You'll find the rectifier, usually a copper oxide type, connected *between* the voltage multiplier resistors and the meter movement. See Fig. 4. (Figures 1, 2, and 3 appeared in the January issue.)

Until recently, the a.c. sensitivity of most VOM's was rated at 1000 ohms/volt even if the d.c. scale of the same VOM was at 20,000 ohms/volt. Rectifier inadequacies were mainly responsible for this relatively low sensitivity. The problem is that with a low current flow (50 μa. or less) the rectifiers tend to be nonlinear.

The linearity problem shows up mostly at the bottom end of the meter scale—where the division markings tend to become crowded. An "easy" solution to low-end crowding is to shunt the meter movement with a resistor (R_{shunt}) of about 200-400 ohms and thus pull more current through the rectifier. In practice this works out well, except that the shunting resistor effectively lowers the resistance and sensitivity of the meter movement down to about the 1000-ohms/volt level.

Improvements in materials and design of the rectifier have enabled instrument manufacturers to get by with a higher value of R_{shunt} with a resulting increase in a.c. sensitivity. As with the d.c. range, the higher the sensitivity, the better.

R_{shunt} is usually made variable and is used for exact calibration of the higher a.c. ranges. $R_{series}/R1$ (actually the resistor sets the first voltage range) compensates for small differences in the forward resistance characteristic of the rectifier and in practice calibrates the lowest a.c. range.

The Ohmmeter. Probably the most often used circuit of your VOM, the ohmmeter circuit is also perhaps the least un-

derstood. Although powered by one or more self-contained batteries, you will see that the "ohms" circuit makes use of the same principles discussed above.

There are two basic ohmmeter circuits, the *series* and the *shunt* type. In the *series* type (Fig. 5), potentiometer R_{adj} is "zeroed" so that, with the input terminals shorted together, the meter needle swings to full scale and indicates "0" ohms. The total circuit resistance (R_{adj}, R_{int} and the internal resistance of the battery) then is equal to the battery voltage divided by the full-scale current of the meter movement. Now, if a resistor to be measured (R_x) is placed

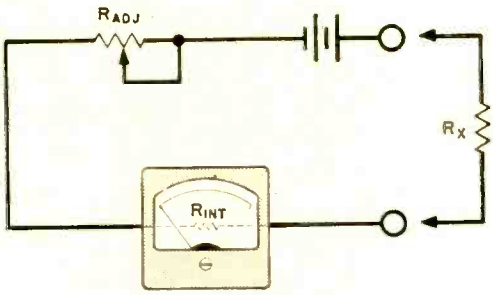


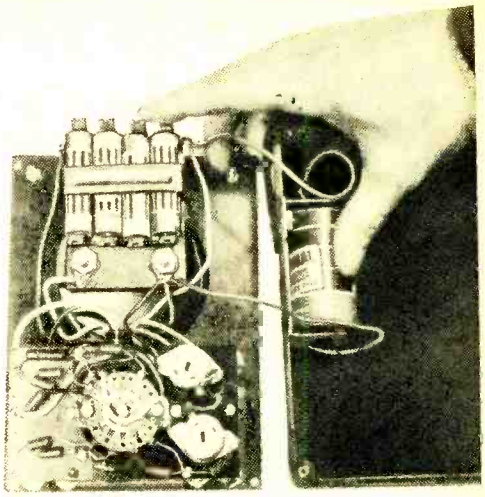
Fig. 5. Series-type ohmmeter circuit.

across the test terminals, the current through the meter will decrease.

Suppose R_x is equal to the original total circuit resistance. The new total resistance is doubled and therefore the current, according to Ohm's law, is reduced by one-half. If the additional resistance is twice the original total, the current is one-fourth of full scale, etc. Thus, it can be seen how the scale of the current meter can be calibrated to indicate directly in ohms while it is actually reading the difference in current flow caused by a change in series resistance.

A 50-μa. meter movement (compared to a 1-ma. movement) will pay off in the "ohms" circuit by enabling a given battery voltage to achieve a higher ohmmeter range. A standard 20,000-ohms/volt meter obtains a reading of higher than 10 megohms with a battery supply of 7.5 volts.

Shunt Circuits. The *shunt* type ohmmeter uses the circuit shown in Fig. 6. R_{adj} is zeroed at full-scale meter deflection with the meter leads *not* shorted. When an external resistance (R_x) is connected in parallel with the meter, the current through the meter decreases. The smaller R_x happens to be, the more current will flow



Four penlight cells and a flashlight cell make up the battery complement for powering the ohmmeter scale.

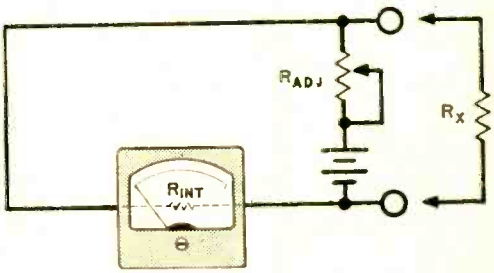


Fig. 6. Shunt-type ohmmeter circuit.

through it and the less through the meter.

Most service instruments use a series-type circuit for all ohmmeter ranges since the series circuit has the advantage that current flows *only* when a measurement is being made. The shunt circuit enables low resistance measurements to be made more accurately, but it will run down the ohmmeter battery if left in the "on" position. See Fig. 7 for a comparison of the two scale calibrations as found on a VOM which uses both types of circuits.

Both Figs. 5 and 6 show basic ohmmeter circuits but you should not expect to meet the exact equivalent in your particular instrument. In actual practice, ohmmeter circuits are much more complicated because provisions are made for switching in additional batteries and series/shunt resistors to enable several ranges of measurement. The average VOM is likely to have two or more

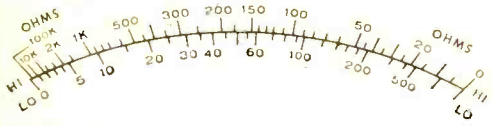


Fig. 7. Comparison of series- and shunt-type ohmmeter scales. LO is the shunt scale, HI the series scale.

ohmmeter ranges and five or six 1.5-volt dry cells connected in series to supply the required voltages.

Current Ranges. The last major VOM function we'll discuss is current measurement. Although the current ranges are probably the least-used VOM feature, they are useful in the hands of the experienced trouble-shooter and are vital to transistor circuit experimentation and design.

As we found before, the basic meter movement of the VOM is usually either of 50-μa.

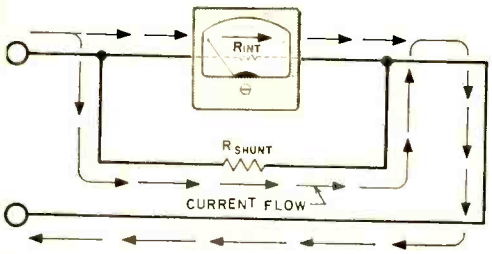
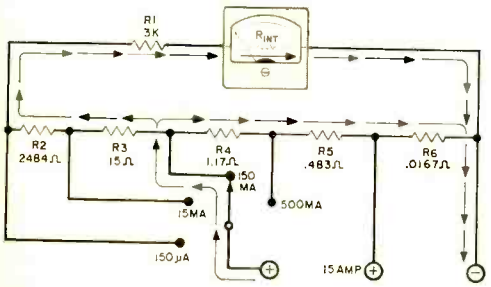


Fig. 8. The arrows indicate current flow in a shunted meter movement.

Fig. 9. Type of Ring circuit used in current ranges of most modern VOM's. Specific values shown are found in the Heathkit VOM Model MM-1.



or 1-ma. sensitivity. Simply shunting the meter movement with the appropriate resistance will reduce the amount of current flowing in the meter movement circuit. (See Fig. 8.) The exact ratio of the current division that takes place is determined by the ratio of R_{int} to R_{shunt}. If R_{shunt} equals R_{int}, the current required to produce full-scale needle deflection will be exactly doubled.

Remember that in our investigation of the shunt-type ohmmeter very much the same sort of action was discovered—except that the current was supplied by dry cells and the shunting resistance was furnished by the resistor (R_x) being measured. In practice, the comparison can't be carried too far, however, because of the use of a "ring-type" circuit (Fig. 9) in most VOM's.

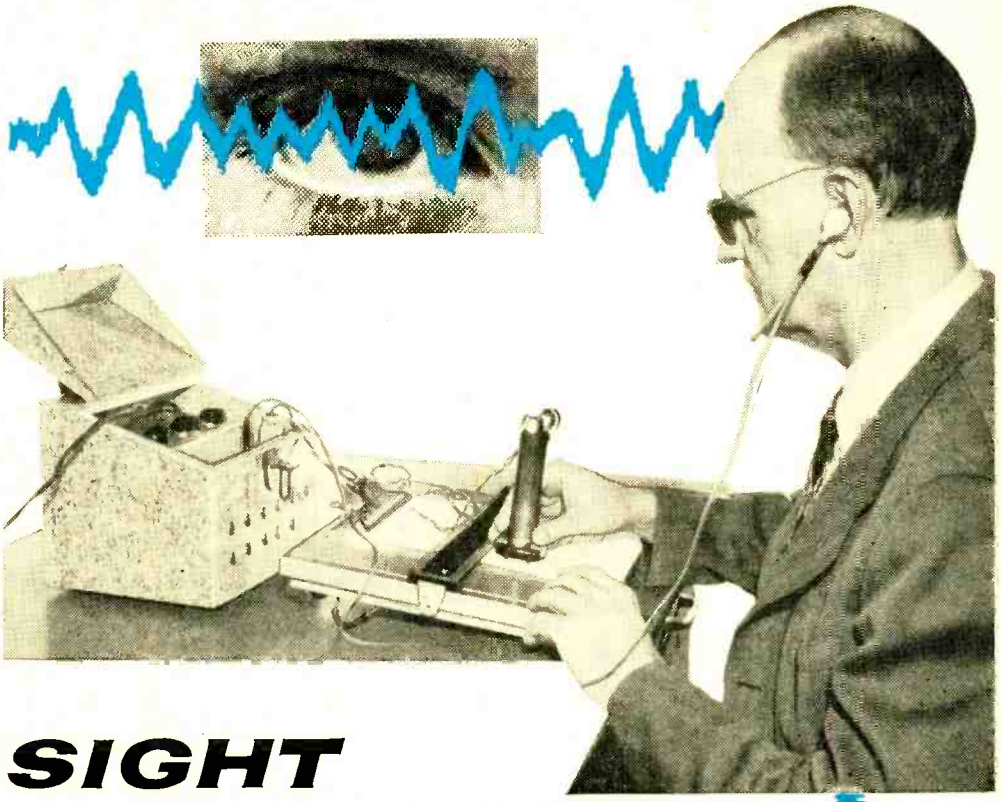
In the ring-type system, the shunt resistors are *all* connected in series *across* the meter movement. The range switch position determines which of the resistors are in series and which are in shunt, as far as the input current is concerned. The resistances needed for each current range are calculated in the same way as in the simple shunt circuit except that the resistance in *series* with the meter has to be taken into account. For example, in Fig. 9, *R4*, *R5*, and *R6* are shunting the resistance presented by *R1*, *R2*, *R3* and the internal resistance of the meter movement (R_{int}).

At this point, one may ask—why go to the complication of the ring circuit when switching two or three shunting resistors would do just as well? It is true that *theoretically* a simple shunt circuit would do as well, but, practically, certain problems would arise. For when dealing with shunt resistors of less than 1 ohm, switch contact resistance becomes important. You can see how .0001 ohms contact resistance could cause a large error if the shunt resistor itself was only .001 ohms. The ring circuit avoids this problem by enabling a higher value shunt resistor to be used for a given meter movement sensitivity.

You'll notice there is a special 15-amp jack leading to the junction of *R5* and *R6* (Fig. 9). This jack serves a dual function in that it eliminates two problems: (1) high currents in switch contacts (they could actually melt with 15 amps through them); and (2) switch contact resistance, which would be quite significant because of the low value of *R6* (.0167 ohms).

That about covers the basic functions of the VOM. Some meters you'll come across might have extra switch positions or scales, and when in doubt as to what a meter will do, your best bet is to write to the manufacturer for details.

Next month we'll get down to practical matters and use the VOM to trouble-shoot a standard a.c./d.c. radio. —30—



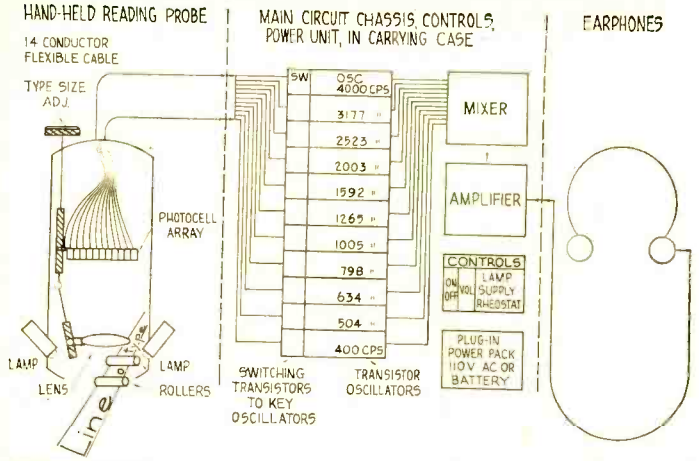
SIGHT THROUGH SOUND

Electronics opens a new window for the blind

AS YOU READ these words, imagine that an electronic scanner is reading them too. Further imagine that you are wearing earphones, and that at the same time you *see* the words, you *hear* the words through the earphones. Impossible? At the moment —yes—electronics can't quite manage this trick *yet*. But recent tests of a new "aural reading machine" indicate that perhaps someday we *will* have a machine that can "read" any printed page aloud.

Think of what this would mean to the thousands of blind people who can read only those books that are written in Braille. They could have a choice of the countless works of fiction that do not appear in Braille editions. They could have at their service the many books on technical subjects that have never been translated into Braille. They could sit down at night and read the evening newspaper. The opportunity to read anything and everything would truly open a new window on the world for the blind.

The "aural reading machines" under development at present cannot read words yet, but they can read letters by the use of photocells that "look" at letters, then



HOW IT WORKS

The Battelle reading machine's reading probe is positioned over a line of print by means of rollers, which also serve to move the probe along the lines of print. The probe contains lamps to illuminate the print and a lens to focus the images of the letters on an array of photocells, each of which "sees" a portion of the space which a letter might cover. Probe can be adjusted for use with different sizes of type.

Each photocell is connected to its own oscillator (each with a specific frequency) which is turned on whenever the photocell "sees" black. The lowest frequency is produced by the oscillator whose photocell "sees" the bottom of the letter "g." The highest tone represents the top of the letter "h."

Frequencies produced by the different oscillators are combined in the mixer. The output of the mixer is then fed to an amplifier which drives a set of earphones. A trained listener can identify each letter by its characteristic tone.

trigger oscillator circuits that produce musical tones which represent the different letters of the alphabet. One such device, designed for the Veterans Administration by the Battelle Memorial Institute of Columbus, Ohio, is now being tested and evaluated. The Battelle electronic reader should enable trained readers to attain reading speeds from 15 to 30 words per minute.

The Battelle-designed electronic reader physically is roughly the size and shape of a portable radio. Weighing about nine pounds and housed in a wooden case measuring about 7" x 9" x 8", it has knobs for volume, light intensity, and the electric power switch. There are three essential parts—a small instrument called a probe which is held in the hand and moved over the printed material to be read, a chassis containing transistorized oscillators and amplifier, and earphones through which the user listens.

Training Group. Blind subjects, chiefly students and faculty from the Ohio State School for the Blind at Columbus, which is participating in testing the Battelle reader, have been trained to interpret the sounds of the Battelle machine during the past year. Each student in the participating group received about 18 hours of instruction on the device, following 48 hours of preliminary training in interpreting the tape-recorded sounds of the machine.

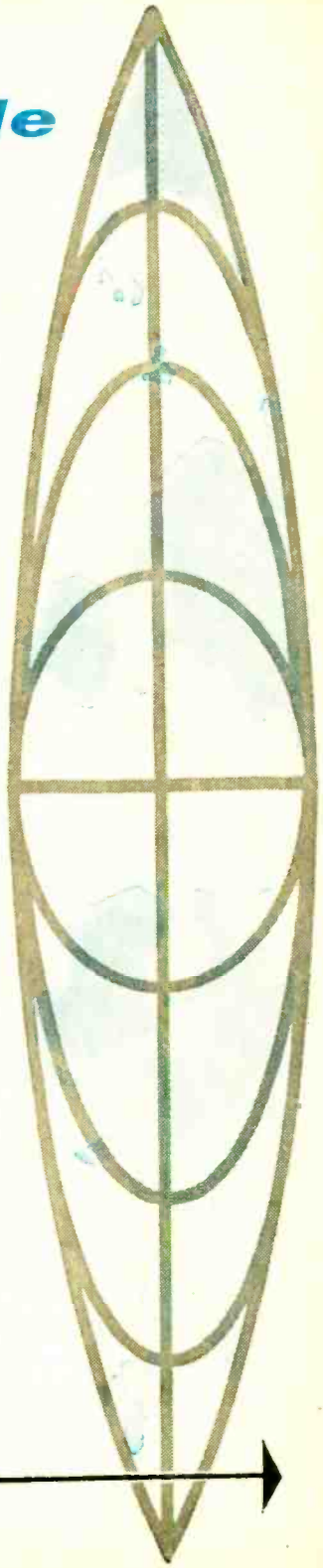
The material read for practice consisted primarily of letters, words, and sentences typed on flat sheets of white paper, using an IBM electric elite typewriter. Toward the end of the period, the more proficient subjects were given a book to read which contained simple stories. Little difficulty was encountered in making the transfer from typewriter print to book print, and in tracking from a flat surface to the curved surface of a book.

Reactions of the subjects to the electronic reader were mostly favorable, although there were also some unfavorable reactions. On the favorable side were the convenience of the small size and portability of the instrument, the ease with which the parts could be packed into the carrying case, the light weight of the headset, and the basic simplicity of the principle of operation. Unfavorable reactions arose from the tangling of the headset cords, the presence of continuous tones in the output caused by occasional malfunctioning of the prototypes, the difficulty encountered with letters that sound alike, and the difficulty of tracking. Most of the subjects felt that the last two objections could be eliminated with additional practice and training.

Only five prototype models of the electronic reader have been made, and further development of both the device and training methods will be required before quantity production is advisable. If further development justifies it, the VA hopes to furnish these readers to blinded veterans within the next few years. —30—

Short-Wave Listeners' Guide

English language short-wave stations from distant lands can take you on an armchair trip around the world. Just tune your short-wave receiver to the stations listed here—you'll find that they come in loud and clear almost anywhere in North America.



THIS is not intended to be a complete listing of every English language short-wave broadcast, as such a list would necessarily encompass hundreds of stations, frequencies and schedules which have never been heard in North America. The purpose of this list, which begins on the next page, is to indicate which of the many broadcasts emanating from the various countries of the world are most readily monitored and reported by listeners in the United States and Canada.

Because of the technical nature of short-wave broadcasting, many of the frequencies and schedules contained herein are subject to change by the originating stations at any time. These schedules are the latest ones available and were in effect, to the best of our knowledge, at the time we went to press.

The letter "v" after a frequency indicates that the frequency may vary slightly from the one listed. When a station is listed as operating within an "mc. band" rather than on a specific frequency, this means that the station has available several frequencies in that band and may use any or all during a broadcast, depending upon the conditions at the time of the transmission. All stations operate daily, except where indicated.

If you hear these stations and care to write to them for complete program schedules or verifications, you should address your letter as follows: name of station, city and country in which it is located. In requesting a verification, be sure to include complete programming information such as: time the station was heard, type of receiver used, the antenna used, and any other data which you feel may be of interest.

This list was compiled in Eastern Standard Time (EST) because it makes log-keeping easier for listeners in the United States. Our thanks go to the Engineering Services, International Service of the Canadian Broadcasting Corporation for their cooperation.

Compiled by **TOM KNEITEL**

ENGLISH LANGUAGE SHORT-WAVE BROADCAST STATIONS BEST HEARD IN NORTH AMERICA

COUNTRY	FREQ. (kc.)	CALL LETTERS	STATION NAME (City)	TIME SCHEDULE (EST)
			EUROPE	
Albania	6900	ZAA	R. Tirana (Tirana)	1700-1730 2330-0030
	7850	ZAA	R. Tirana (Tirana)	1530
Austria	7245	—	Osterreichische Rundfunk (Vienna)	0430-0530
Belgium	15335	ORU3	Belgian Magazine (Brussels)	1730-1800 Tu Th F Su
Bulgaria	9700	—	R. Sofia (Sofia)	2000-2030 2300-2330
Czecho-slovakia	9550	OLR3A	R. Prague (Prague)	2030-2100 2200-2300 0000-0300
	11745	OLR4F	R. Prague (Prague)	
Denmark	9520	OZF	V. of Denmark (Copenhagen)	2000-2130 2200-2300
Finland	9554	OIX2	Soumen Yleisradio (Pori)	0700-0830
	15190	OIX4	Soumen Yleisradio (Pori)	
	17798	OIX5	Soumen Yleisradio (Pori)	
France	7240	—	Rdfsn. Francaise (Paris)	0245-0300 W 0900-1000 Sa Su
Germany (East)	9730	—	Democratic Germany (Leipzig)	1830-2030
Germany (West)	11795	—	V. of Germany (Cologne)	2030-2330
Great Britain	15310	GSP	British B/C Corp. (London)	1545-1815
	17715	GRA	British B/C Corp. (London)	1545-1745
Greece	15345	—	R. Athens (Athens)	1215-1245
Hungary	6195	—	R. Budapest (Budapest)	1900-2030 2200-2400
	9833	—	R. Budapest (Budapest)	
Italy	11905	—	R. Italiana (Rome)	1730-2225
	15400	—	R. Italiana (Rome)	1730-2010
Luxembourg	6090	—	R. Luxembourg (Junglinster)	1300-1800
Monaco	6035	3AM3	R. Monte Carlo (Monte Carlo)	1705-1735 Tu Th Sa
	7140	3AM4	R. Monte Carlo (Monte Carlo)	

COUNTRY	FREQ. (kc.)	CALL LETTERS	STATION NAME (City)	TIME SCHEDULE (EST)
			AFRICA	
Angola	5033	CR6AA	Rdfsa. do Lobito (Lobito)	1100-1700
Bechuanaland	5900	ZNB	"Z.N.B." (Mafeking)	0600-0700 1200-1400
Belgian Congo	9655	OTC	Belgian Magazine (Leopoldville)	1930-2000
Canary Islands	7000	—	R. Atlantico (Las Palmas)	0800-1030 1400-1900
	9490	—	R. Atlantico (Las Palmas)	0800-1300 1700-1900
Ethiopia	9608	—	R. Addis Ababa (Addis Ababa)	0500-0600
French Equatorial Africa	9730	—	R. Brazzaville (Brazzaville)	0000-0200
Ghana	9640	—	R. Ghana (Accra)	0100-0300
Ivory Coast	4940	—	R. Abidjan (Abidjan)	1245-1300 M W F
Kenya	7240	VQ7LO	Cable & Wireless (Nairobi)	0500-0600
Liberia	15120	ELWA	R. Voice of W. Africa (Monrovia)	1800-1945 Tu
	21535	ELWA	R. Voice of W. Africa (Monrovia)	1955-2145 W 1800-1945 Tu
Mauritius	14983v	V3USE	Mauritius B/C Svce (Forest Side)	0245-0500 0930-1230 2300-2315 (all M-F)
Mozambique	9636	CR7BJ	Lourenco Marques R. (Lourenco Marques)	0000-1100
	11741	CR7BF	Lourenco Marques R. (Lourenco Marques)	2230-1400
Nigeria	9655	—	Nigerian B/C Svce. (Lagos)	0430-1030
Northern Rhodesia	7185	ZQP	Cent. Afr. B/C Sta. (Lusaka)	0500-1000
	9710	ZQP	Cent. Afr. B/C Sta. (Lusaka)	0500-1045
Seychelles	4990	ZCQ3	Seychelles B/C Svce. (Mahe I.)	1015-1115

Netherlands	9590	—	R. Nederland (Hilversum)	1615-1655
	15220	PCJ2	R. Nederland (Hilversum)	
	17730	—	R. Nederland (Hilversum)	
Norway	9610	LLG	R. Norway (Oslo)	2000-2115 2300-0015
	11735	LKQ	R. Norway (Oslo)	
	15175	LLM	R. Norway (Oslo)	
	21670	LLP	R. Norway (Oslo)	2300-0015
Poland	11815	—	Warsaw Calling (Warsaw)	1930-2230
	15275	—	Warsaw Calling (Warsaw)	1900-2230
	17800	—	Warsaw Calling (Warsaw)	
Portugal	17 & 21 mc. bands		This Is Portugal (Lisbon)	0815-0900
	15 & 17 mc. bands		This Is Portugal (Lisbon)	1215-1300
Rumania	9570	—	This Is Bucharest (Bucharest)	2030-2200 2330-2400
	11937	—	This Is Bucharest (Bucharest)	1800-2200 2230-2300
Spain	6130	—	V. of Spain (Madrid)	0015-0100 2215-2300
	9585	—	V. of Spain (Madrid)	?215-2400
Sweden	9620	SBU	R. Sweden (Stockholm)	2130-2245
	11810	—	R. Sweden (Stockholm)	2000-2115
	17840	—	R. Sweden (Stockholm)	0900-0930
Switzerland	6165	HER3	Switzerland Calling (Berne)	2030-2215
	9535	HER4	Switzerland Calling (Berne)	
	11865	HER5	Switzerland Calling (Berne)	2315-2400
U. S. S. R.	9620	—	R. Moscow (Moscow)	1800-2000
Vatican City	15135	—	Vatican R. (Vatican)	1000, 1315
Yugoslavia	6100	—	R. Belgrade (Belgrade)	0730-0800
	6150	—	R. Belgrade (Belgrade)	1330-1400
	7200	—	R. Belgrade (Belgrade)	
	9505	—	R. Belgrade (Belgrade)	0700-0800
Senegal (F. W. A.)	4985	—	R. Dakar (Dakar)	1715-1115 Tu Th Sa
Sierra Leone	3316	—	Sierra Leone B/C Svce. (Freetown)	0145-0300 1145-1700
Somaliland (British)	6200	VQ6MI	R. Somali (Hargeisa)	0930-1118
Southern Rhodesia	9505	ZEA	This Is Rhodesia (Salisbury)	0000-0130 0400-0700 (M-F only)
Tanganyika	5050	—	Tanganyika B/C Svce. (Dar-es-Salaam)	2215-2340 M W F
Tangier Int'l Zone (Morocco)	9418	WTAN	V. of Tangier (Tangiers)	0345-0500 Su
	11515	—	Ibra Radio (Tangiers)	1615-1645
	21455	—	V. of America—Relay (Tangiers)	0945-1000
Uganda	5026	—	Uganda B/C Svce. (Kampala)	1230-1430
Union of S. Africa	9720	—	Springbrook Radio (Paradys)	0000, 1005-1025
	15230	—	S. Afr. B/C Co. (Johannesburg)	0600-1100 Tu Th Sa
NEAR EAST				
Afghanistan	18637	—	R. Kabul (Kabul)	1040-1100
Iran	15135	EPB	R. Teheran (Teheran)	1530-1545
Iraq	6188	—	B/C Svce. of Iraq Rep. (Baghdad)	1200-1300
Israel	9009	4XB31	V. of Israel (Tel Aviv)	1500-1515 0645-0700
	9009	4XB31	V. of Zion (Tel Aviv)	1515-1730 1800-1845
	11845	—	V. of Zion (Tel Aviv)	1515-1730
Jordan	6521	—	R. of Hashemite Kingd. of Jordan (Ramallah)	1100-1730
Lebanon	8003v	—	R. Liban (Beirut)	0045, 0325, 0725, 1000
Turkey	9515	TAT	Ankara R. (Ankara)	1815-1900
	15160	TAU	Ankara R. (Ankara)	1600-1645
United Arab Rep. (Syria)	15165	—	United Arab B/C Svce. (Damascus)	0030-0130 0330-0730
FAR EAST				
Borneo (North)	7180	VS4S	R. Sabah (Jesselton)	2345-0015 0600-0700

(Continued on page 62)

ENGLISH LANGUAGE SHORT-WAVE BROADCAST STATIONS BEST HEARD IN NORTH AMERICA *(Continued from page 61)*

COUNTRY	FREQ. (kc.)	CALL LETTERS	STATION NAME (City)	TIME SCHEDULE (EST)
Burma	11765	XYZ	Burma B/C Svce. (Rangoon)	0915-1015
	15365	XYZ	Burma B/C Svce. (Rangoon)	
Cambodia	6090	—	Rdfsn. Nat'l. Khmere (Phnom-Penh)	0715-0730 M Tu Th F Su
Ceylon	6004	—	R. Ceylon (Colombo)	0230-0430
	15230	—	V. of America—Relay (Colombo)	1400-1615
	17800	—	V. of America—Relay (Colombo)	
China (Communist)	11820	—	R. Peking (Peking)	2000-2130
	15095	—	R. Peking (Peking)	
Goa	9610	CR6AD	Emissora da Goa (Goa)	0130, 0230, 0430, 0630, 0730, 0800, 1000, 1030
India	15240	VUD	All India Radio (Delhi)	1445-1545
	17780	VUD	All India Radio (Delhi)	0830-0915
Indonesia	9710	YDF6	V. of Indonesia (Jakarta)	0930-1030
	11770	YDF2	V. of Indonesia (Jakarta)	
Japan	11705	JOA4	R. Japan (Tokyo)	0000-0100
	17855	JOA24	R. Japan (Tokyo)	1800-1900
	21620	—	R. Japan (Tokyo)	
Korea (South)	15405	HLKA	V. of Free Korea (Seoul)	0030-0130
Laos	7145	—	Nat'l B/C Sta. of Laos (Vientaine)	2030-2045
Malaya	6135	ZHP	R. Malaya (Singapore)	0230-0430
	7200	ZHP3	R. Malaya (Singapore)	0035-0130 0327-1030 (both M-Th)
Nepal	7100	—	R. Nepal (Kathmandu)	2335
Pakistan	15145	—	R. Pakistan (Karachi)	1030-1045
	17750	—	R. Pakistan (Karachi)	0330-0415 0545-0600
	21590	—	R. Pakistan (Karachi)	
Sarawak	9565	—	R. Sarawak (Kuching)	0800-0930
Dominican Republic	5970	HI4T	La Voz Dominicana (C. Trujillo)	2100-2115 Sa
	9735	HI2T	La Voz Dominicana (C. Trujillo)	
El Salvador	6180	YSMA	V. Suprema de Occidente (Santa Ana)	1945-2000
Fed. of British Terr. in Caribbean	3255	—	R. Antigua (St. John, Antigua)	0530-0800 M W F
	3255	—	R. Monteserrat (Plymouth, Montess.)	2000-2030 Su
	17908	—	Windward Is. B/C Svce. (St. Georges, Grenada)	1800-2000
Guatemala	5952	TGNA	R. Cultural (Guatemala City)	2200-2345
	9668	TGNB	R. Cultural (Guatemala City)	
Haiti	9770	4VEH	La Voix Evangelique (Cap Haitien)	0430-0600 Ex Su
	11850	4VWI	La Voix Evangelique (Cap Haitien)	
Honduras	6060	HRYN2	V. De Merendon (San Pedro Sula)	2210 W
Jamaica	4950	—	R. Jamaica (Kingston)	0550-2310
Mexico	6045	XETW	V. De Tampico (Tampico)	0530-0830 1930-0100
	9625	XEBT	El Buen Tono (Mexico, D.F.)	1915
Trinidad	6085	VP4RD	R. Trinidad (Port of Spain)	0500-1800
SOUTH AMERICA				
Argentina	9690	LRA	R. Del Estado (Buenos Aires)	2100-0100
Bolivia	9444	CP39	Southern Cross R. (La Paz)	1730-1800

Taiwan	9575	—	V. of Free China (Taipei)	2030-2100
	11815	—	V. of Free China (Taipei)	
	15345	—	V. of Free China (Taipei)	
Thailand	11670	HSK9	R. Thailand (Bangkok)	2315-0015
Vietnam	7265	3WT	V. of Free Vietnam (Saigon)	0115-0200 0845-1000

PACIFIC AREA

Australia	11810	VLC11	R. Australia (Melbourne)	0714-0845 1014-1115
Cook Islands	4965	ZK1ZA	R. Rarotonga (Rarotonga)	2300-0300 Th
Fiji Islands	3980	VRH4	Fiji B/C Comm. (Suva)	0200, 1915, 2015
Gilbert & Ellice Islands	6050	VSZ10	R. Tarawa (Tarawa)	0230-0400 F
Hawaii	9650	—	V. of America—Relay (Honolulu)	0630-1100
	11775	—	V. of America—Relay (Honolulu)	
New Guinea (Australian)	6130	VLT6	Austral. B/C Comm. (Port Moresby)	0330-0730
New Zealand	6-, 9-, 11-, 15- and 17 mc. bands		N. Z. Calling (Wellington)	1500-0500
Philippines (Rep. of)	15300	DZH9	Call of The Orient (Manila)	0100, 0230, 0900, 1830, 2330
	17805	DZI6	Call of The Orient (Manila)	
	21515	DZI8	Call of The Orient (Manila)	
Solomon Islands	5960	VQO2	Solomon I. B/C Svce. (Honiara)	0200-0300
Tahiti	6136	FO8AA	R. Tahiti (Pateete)	0230-0245

CENTRAL AMERICA

British Honduras	3330	—	Brit. Hond B/C Svce. (Belize)	1920-2240
Costa Rica	6037	TIFC4	Faro del Caribe (San Jose)	2300-2400
	9645	TIFC	Faro del Caribe (San Jose)	
Brazil	6085	ZYK2	Brazil Calling (Pernambuco)	2030-2100
British Guiana	3255	ZFY	R. Demerara (Georgetown)	1445-2145
	5981	ZFY	R. Demerara (Georgetown)	0410-1445
Chile	6190	CE619	R. Corp. de Santiago (Santiago)	1745-1800
	15150	CE1515	R. Corp. de Santiago (Santiago)	
Colombia	6195	HJEZ	V. De Cali (Cali)	2100 Su
Ecuador	9745	HCJB	V. of The Andes (Quito)	2100-2400
	11915	HCJB	V. of The Andes (Quito)	
	15115	HCJB	V. of The Andes (Quito)	
Falkland Islands	3958	—	Falkland I. B/C Sta. (Stanley)	1815-1930 2245-0200 Sa
Paraguay	6025	ZPA10	R. Paraguay (Asuncion)	0515-0800
Peru	5990	OAX4V	R. America (Lima)	0810-0900
	9415	OAX4W	R. America (Lima)	
Surinam	15405	PZC	Avros B/C Sta. (Patamaribo)	0730-0800 Su
Uruguay	15385	CXA60	R. Sarandi (Montevideo)	2000-2100
Venezuela	4970	YVLK	R. Rumbos (Caracas)	1800-1900 M F
	5040	YVMA	Ecos de Zulia (Maracaibo)	1530
	9640	YVSC	Rdfsn. Nacional (Caracas)	1830-1900 M F

NORTH AMERICA

Canada	9585	CKLP	This Is Canada (Sackville, N. B.)	0055-0220
	15190	CKCX	This Is Canada (Sackville, N. B.)	
United States	9570	KCBR4	Armed Forces Radio (Delano, Calif.)	0200-0700
	15315	KCBR5	Armed Forces Radio (Delano, Calif.)	0715-1000 2000-0100
	17710	WRUL3	Armed Forces Radio (Boston, Mass.)	1230-1745

By I. C. CHAPEL

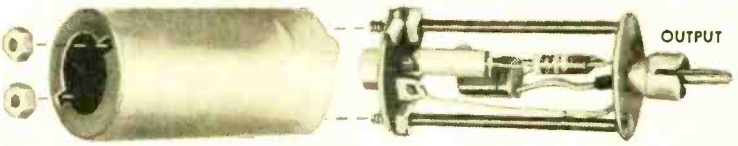
Transistor Microphone Preamplifier

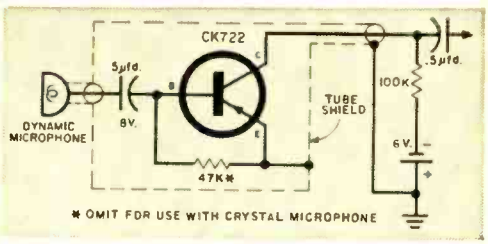
THE problem: how to get more gain from a remote microphone pickup which has only a single shielded wire connecting it to the basic amplifier. The answer: connect a one-transistor amplifier as shown between the remote pickup and the basic amplifier. The only modification necessary to the input circuit of the amplifier is the addition of an input capacitor, a 6-volt battery, and a 100,000-ohm resistor.

The center wire of the mike cable carries both the signal to the amplifier and the power to the transistor, with the shield of the wire being used for the positive lead and ground. The collector load resistor has a higher value than would be necessary if it were connected directly to the transistor; however, this higher value has an advantage since it permits a lower current to be passed through the cable.

Assembly of the mike preamplifier is shown clearly in the photo. The phono plug is soldered to a thin metal washer and two 3" threaded spacer rods are secured to the washer using the same spacing as the mounting holes in the phono jack. A free space about 1¾" long remains between the input jack and the plug, which allows sufficient room to mount the three components of the preamplifier.

The capacitor and resistor in the preamp unit are soldered together and their junction connected to the base lead of the transistor. Solder the other end of the capacitor to the hot terminal of the jack. The free end of the resistor is soldered to the shield terminal of the phono plug.



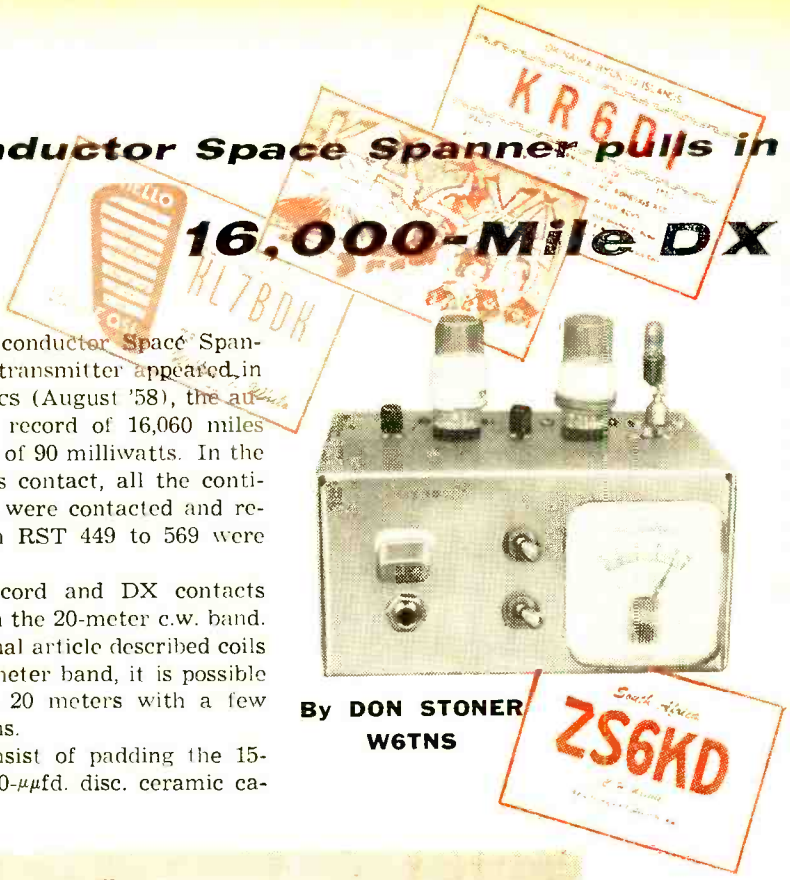


Preamplifier assembly is enclosed in dotted line. The battery, 100,000-ohm resistor and 0.5-μfd. capacitor are installed in the amplifier. An on-off switch should be installed in the battery circuit.

Solder the collector lead of the transistor to the center of the plug and the emitter to the outer terminal of the plug. The shield can is 'grounded' by screwing it down to the threaded ends on the jack side. Two notches cut out of the shield will enable a close fit. Be sure that the 'base to capacitor' connection and the 'collector' terminals of the transistor do not short to ground.

After the modification to the basic amplifier, the unit is ready to plug in. Make certain that the negative supply is on the center wire of the shielded cable and that the outer shielded braid is positive. Then connect the preamplifier to the microphone and cable. After the volume and quality of the signal coming from the pickup microphone have been noted, adjust the value of the 100,000-ohm resistor for optimum results. —30—

Semiconductor Space Spanner pulls in 16,000-Mile DX

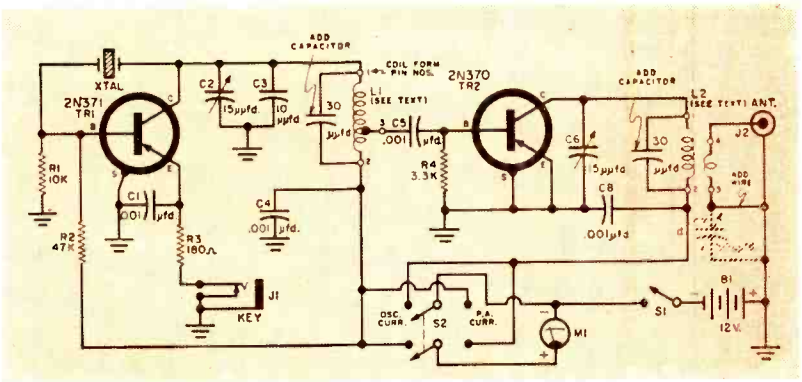


By DON STONER
W6TNS

SINCE the "Semiconductor Space Spanner" transistor transmitter appeared in POPULAR ELECTRONICS (August '58), the author established a record of 16,060 miles with a power input of 90 milliwatts. In the week following this contact, all the continents of the world were contacted and reports ranging from RST 449 to 569 were obtained.

The distance record and DX contacts were established on the 20-meter c.w. band. Although the original article described coils for the 10-and 15-meter band, it is possible to use the rig on 20 meters with a few simple modifications.

The changes consist of padding the 15-meter coils with 30-$\mu\mu$fd. disc. ceramic capacitors. These capacitors can be soldered permanently into the circuit, or placed inside the coil forms of an extra set of 15-meter coils. If the capacitors are to be placed in the coil forms, solder them in between pins 1 and 2. It's a bit of a trick to get the wires into the pins and still keep the coil tight, but it can be done.



Modified schematic of the SSS unit for conversion to the 20-meter band. See original article for complete construction details.

To increase the loading on 20 meters, short out capacitor *C7*. There will be no control of loading on the 20-meter band, but with a 52- or 72-ohm dipole, the final will draw approximately 6 ma. in the bottom of the collector current dip. Thus, 20-meter power input will equal 90 mw.

Fundamental frequency crystals on 14 mc. work very nicely in this circuit. If you have a stock of war surplus 4700-kc. crystals, these will be satisfactory also. The Semiconductor Space Spanner will work on any band with crystals that are one-third the desired oscillator frequency. Thus, a 4700-kc. crystal will oscillate in the SSS circuit at approximately 14.1 mc., a 7000-kc. crystal will oscillate at 21 mc., etc.

An increase in efficiency of the oscillator circuit can be had by replacing the 2N371 transistor with a 2N247. The 2N247 seems to produce about the same amount of drive while drawing less power. —30—

My Misguided Missile

By CARL KOHLER

THE ONLY TROUBLE with my gorgeous, intelligent wife is that she has unwittingly fallen victim to this Togetherness nonsense. If she had been busying herself with cooking, cleaning up the house, or any one of the half-hundred jolly little labors of love that marriage provides instead of coming poking around my workshack, she wouldn't have had anything to be worried *about*.

"Holy Toledo!" she gasped, running a distraught hand through her thick tresses, *"now* what are you building?"

"Chores all done?" I asked evenly.

"Why, that looks like a *rocket!"* she peered wonderingly at my latest project—the Kohler *Komet*. "Yes, sir, that's exactly what it looks like! One of those . . uh . . . guided thingamuhjigs!"

"Leaves all raked? Hearth-fire laid?" I inquired firmly. "We like to run a tight house around here, don't we, dear?"

She swung a pair of nervous eyes on me.

"You're building a guided whatchmuhcallit!" she yelped, accusingly. "You know what the city regulations say about fireworks, yet you're calmly sitting in your little workshack building a guided whosis!"

"Missile," I said, grinning boyishly for effect. "And I care not *that,"* I snapped my fingers for effect, "for city regulations! A guided missile is *not* fireworks, no matter how far one stretches the concept."

She glanced at the not-yet-installed radio-control equipment still laid out upon the bench. If there's *anything* in the way of electronic equipment my wife can recognize, it's R/C components.

"Oh, *no!"* she softly moaned.

"Heh-heh-heh!" I said, chuckling merrily. "I can't fool *you,* can I!"

"Every time you've built *anything* that's been R/C-run, we've had nothing but near tragedy!" she wailed. "When I think that you're actually planning to combine that awful-looking—"

"All us genius-type engineers have a mild history of trial and error behind us," I said confidently. "It makes for nice contrast when the triumphs start popping up," I did a brief waltz-clog in one spot. ". . . or, I should say, when the triumphs begin *shooting* up!"

"B-But *why* a guided missile?"

"Not *all* the important innovations or improvements have come out of government laboratories," I said quietly. "In fact, the scientific history of our glorious land is rooted in many, many electrical and electronic advancements which have sprung from homespun workshops, as it were—unsung notions first painstakingly studied and worked up in the unglamorous basements and backyard labs of modest men of genius similar to—heh-heh—myself!"

I teetered back and forth on my heels for effect.

"You once told me your R/C transmitter wouldn't send a signal for more than two miles." She turned a face pinched with anxiety to me. "Assuming that nothing goes wrong with the controls *this* time, how are you going to manage this thing after it goes beyond the two miles?"

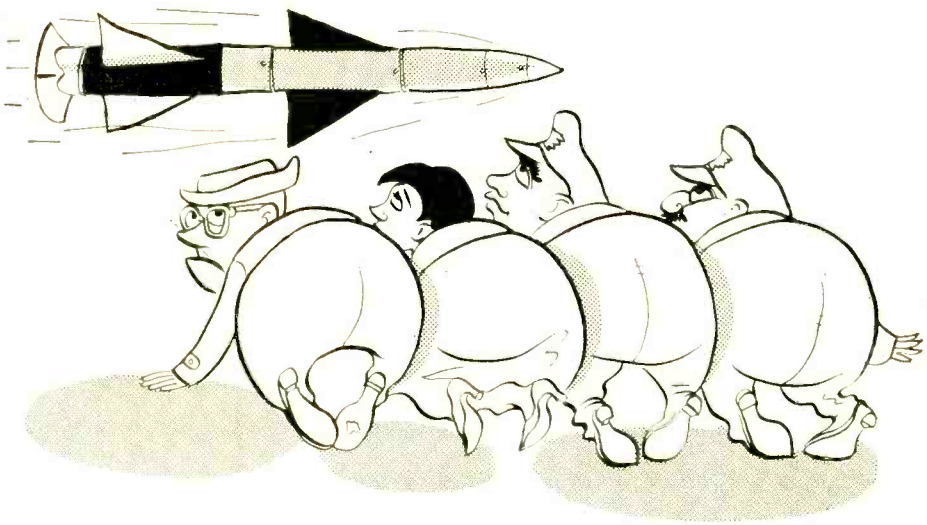
"Ah, that's a good question. And I have a good answer for it," I assured her. "First,

I keep the missile in a orbital course inside two miles after blast-off. Secondly, it will only carry enough fuel for a four-minute flight—so I hardly think it could go very far even if something *should*—"

"And how do we pay for the house it smashes when it comes crashing back to earth?"

I tapped a small, ingeniously designed device.

"The moment the fuel cuts out, this relay system activates another device which releases a large parachute." I smiled somewhat snidely. "The large parachute then slowly, easily floats the missile back down gently . . . gently . . . gently!"



"What if the large parachute fails to open?"

"We go on the lam, honey bun," I said harshly.

She favored me with a long, penetrating stare. "And to think I wouldn't marry Jasper Flugleman because *he* was nuts about *speedcar racing!*"

When she went out, she slammed the door.

A WEEK LATER, I brought the car to a halt on the desolate sands of the Bonneville Flats. There was nothing but empty distance in all directions for quite a spell. Rubbing my hands in anticipation, I removed the Kohler Komet from the trunk and began assembling the dismantled sections.

"I'm willing to bet—right here and now —that thing manages to hit *something!*" declared the wife gloomily.

"Absurd!" I chortled. "Look around. Nothing but sand flats. Nothing but barren ground. Nothing but nothing!"

"I can wait," she admitted.

After setting the Komet on its launching platform a decently safe distance from my car, I hooked up the electrical firing system I'd cleverly designed. Then, viewing the slender waiting missile with great satisfaction, I picked up the R/C transmitter and rejoined the wife.

"I've set the firing device," I said, glancing at my watch. "It should go off within twenty seconds. Brace yourself. I imagine that special liquid fuel I mixed will create quite a blast."

"Here comes a car," she said evenly. "It looks like a police car. It *is* a police car. Better put out the fuse on the rocket, darling."

I glanced at my watch.

"Not enough time! It's due to let go any second now! I wouldn't have enough time even to—"

Suddenly, the Komet blasted off. The air was filled with thunder, the earth trembled and pitched underfoot. Thrown off balance, I landed smack-dab on top of the transmitter. I could *feel* the delicate components inside tinking to smithereens.

For a couple of minutes we—the wife, the two police officers and myself—stared up into the sky, watching the Komet climb-

(*Continued on page* 117)

an editorial

Only YOUR Ears are Golden

POPULAR ELECTRONICS has followed, for some years now, the evaluation of hi-fi equipment by various consumer report type magazines. This is an area where we have a little more experience than most people, and we like to see if our opinions agree with those of the testing organizations. Sometimes we have agreed in part with their findings, and sometimes we have been mildly upset by what the consumer magazines recommended. Never, however, did we think them serious enough that we should take space in POPULAR ELECTRONICS to comment on any particular report. With the publication of the article on loudspeakers in the December 1958 *Consumers Report,* we feel that comment is obligatory.

The *CU* article on loudspeakers effectively makes two very important points to which POPULAR ELECTRONICS takes exception: (1) there are only four loudspeakers on the market that are truly acceptable for high-fidelity use; and (2) separate loudspeakers, even when installed in cabinets specifically designed for them, are not to be recommended for high-fidelity use.

Perhaps an even more important aspect of the article is its tone of final authority. Nowhere in the article is there conveyed the idea that individual tastes in loudspeakers may differ. The "Report on Whiskeys" on page 652 of the same issue includes the following qualifying sentence: "Taste is, of course, a subjective matter, and your taste may not agree with the expert's." No such statement is found in the article on loudspeakers.

Only Your Ears Are Golden. Although you can run performance curves on loudspeakers until you're blue in the face, the fact remains that the only way to judge a loudspeaker is by listening to it and deciding if it sounds like real music to *you*. Don't forget that if you usually sit in the center of Row 5 in the orchestra section of your favorite concert hall, you and the person who sits in the last row of the balcony will have entirely different ideas of what constitutes good sound. Add to this different acoustical characteristics of different concert halls and the problem of what constitutes *real* sound becomes more complex.

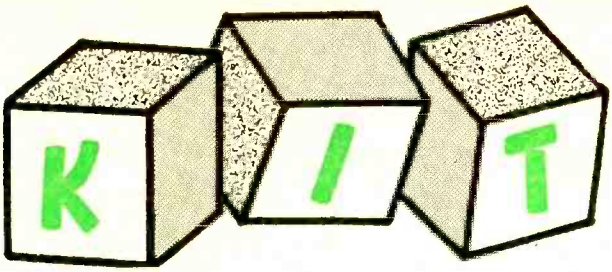
If we had the opportunity to become familiar with loudspeaker reviewers as we become familiar with record and movie reviewers—thus gradually finding out which reviewers like the same things we do—there would be no problem. We would simply sidestep those reviewers whose judgment we had learned to distrust and accept the judgment of our favorite reviewer, whose taste happened to coincide with ours. *CU* shows a photograph of four men who are presumably engaged in making listening tests. How do we know that the hearing and judgment of these four gentlemen agree with ours?

Another problem: any reader of POPULAR ELECTRONICS knows that physical placement of a speaker in a room can alter its sound substantially. Depending on the size and shape of a room, corner placement can sometimes dramatically change the character of a loudspeaker. Judging from the photo of *CU*'s listening judges, optimum placements of the different speakers must have been impossible. The barn-like room in which the listening tests were conducted also raises doubts about the value of *CU*'s findings. Most people have completely different acoustical surroundings from those shown in the photo and therefore should not expect speakers to sound as they did to *CU*'s judges.

Better or Different? As mentioned before, *CU* check-rated only four speaker systems. There is no question but that the check-rated systems are excellent. The only question is: are they *better* than the other speakers tested or others not tested?

A listening test performed by one of our editors is of interest in connection with this question. He uses one of the check-rated systems in his stereo system and one rated only "acceptable-fair." When these speaker systems are switched back and forth on monophonic programs, there is very definitely a *difference* in the sound produced; but as far as having a preference between

(*Continued on page* 100)

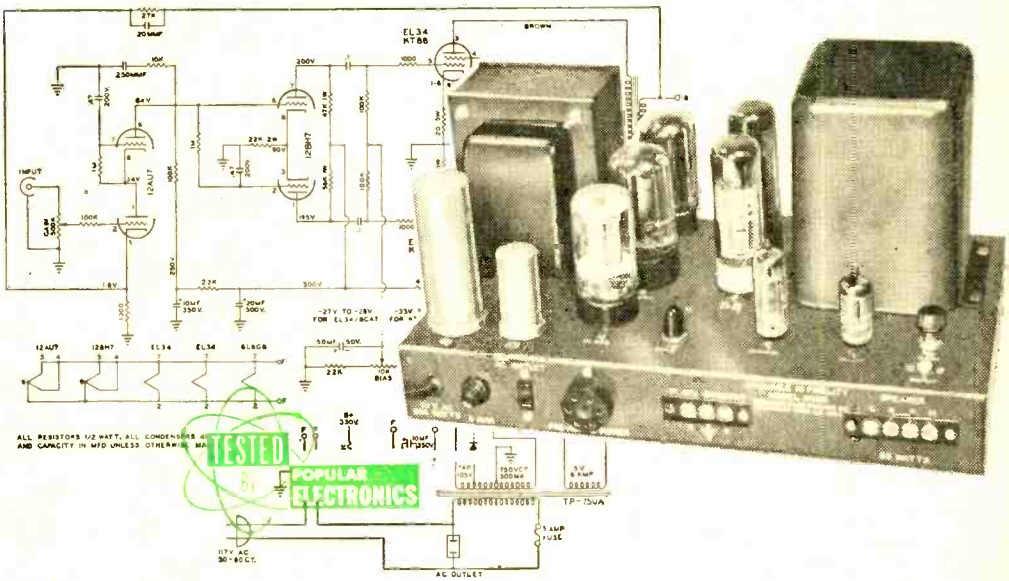


BUILDER'S KORNER

GROMMES 250K 60-Watt Power Amplifier

THE ARGUMENT of high-power audio amplifiers versus low-power circuits continues unabated. Precision Electronics, Inc. (9101 King Ave., Franklin Park, Ill.), with its new Grommes 60-watt 250K basic amplifier kit has produced a strong case for the high power side of the controversy.

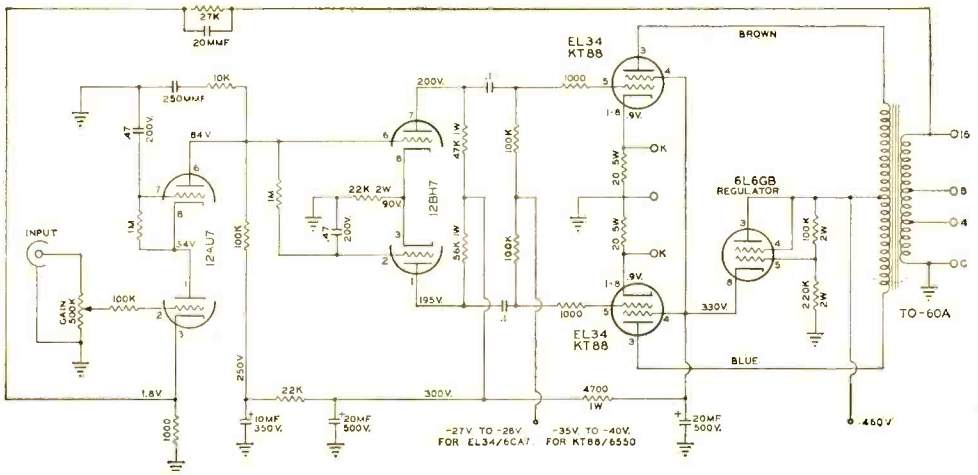
Assembly Instructions. Those of you who have wired other kits may be a bit surprised at the Grommes construction book. Instead of the usual step-by-step instructions, you will find large color-coded wiring pictorials.



The first of these is a well illustrated parts identification and "how to mount components" sheet. This system leaves no doubt as to where and how an unfamiliar component should be mounted.

The second diagram is devoted to mechanical assembly. Parts to be mounted from the underside of the chassis are easily identified, but the information concerning top chassis components (transformers and electrolytics) was slighted. We found it best to mount the transformers first so that they would act as "stand-offs" and keep the chassis above the workbench top, thus avoiding possible damage to the other components during mounting.

There are two punched chassis holes which match the two lead openings in the power transformer shell, but only *one* opening appears on the chassis pictorial. If the yellow and yellow/green leads are put through the unmarked chassis hole, they reach the correct wiring points. Since the output transformer leads were slightly off-



color, care had to be taken in their identification. If you are in doubt, check the leads with a VOM.

All hookup wire and transformer leads are color-coded to the wiring diagram and pre-cut. Taking it slow and carefully, total assembly time came to about 6½ hours.

In general, the construction manual was clear and explicit. A pictorial of the complete unit, however, would have been useful for rechecking and trouble-shooting.

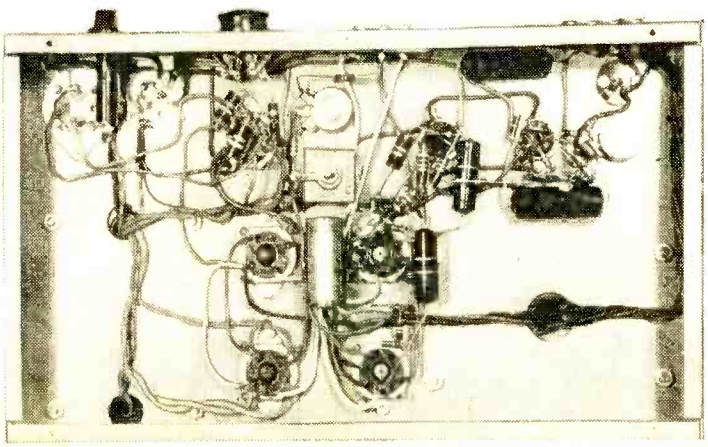
Circuit Design. The Grommes 250K uses a somewhat novel design. The input tube, a 12AU7, is connected in cascode and direct-coupled to a 12BH7 wired as a long-tailed-pair phase inverter. The output tubes are EL34's with fixed bias. A 6L6 tube is employed solely as a screen grid regulator and two 5U4 tubes are used in the power supply.

Features include a bias adjustment and terminals for measuring output tube current, input level control, 4-, 8-, and 16-ohm taps, and a pre-amp power output socket. The unit is fused and has an a.c. convenience outlet.

Damping factor of the amplifier is 15. A kit, the DF-1, is available for installing variable damping if desired.

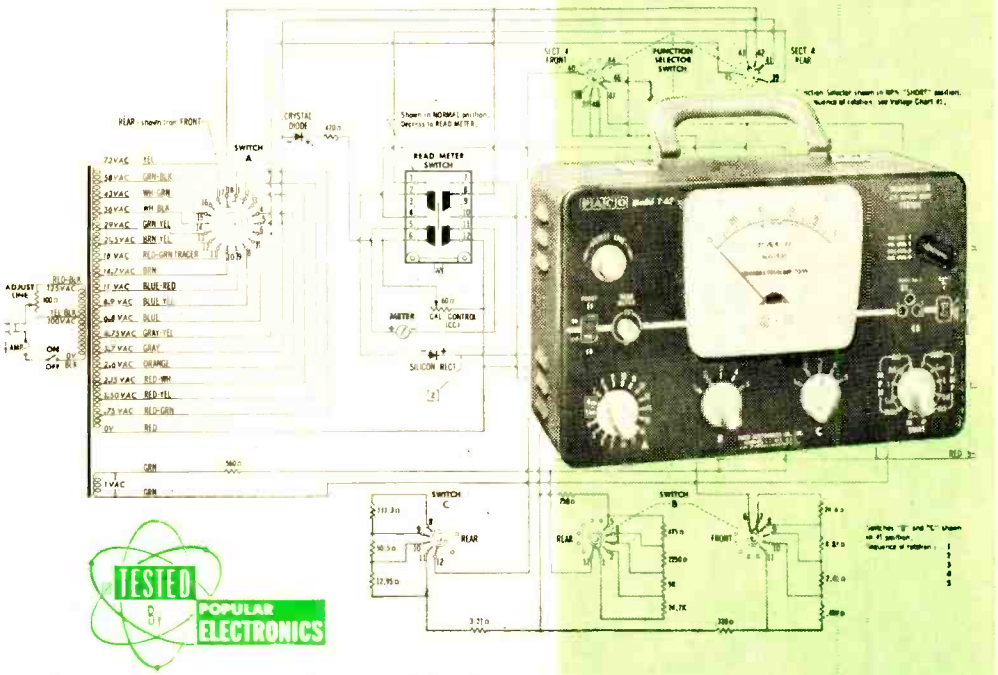
Test Results. Input sensitivity of the Grommes checked out at .97 volts for rated output. The hum and noise level was better than the specified −90 db. At a full 60-watts output, the 250K produced a clean sine wave from 20 to 20000 cycles. This performance is exceptionally good.

It is interesting that the square wave response was the only test that did not meet or better the manufacturer's specifications. The oscilloscope showed some ringing at 10 kc. Further checks indicated that 120-$\mu\mu$fds. shunted across the 20-$\mu\mu$fd. capacitor in the feedback loop would minimize the ringing. The effect of this slight instability was not audible in listening tests; the amplifier is clean sounding and performs well at all power levels. —30—



Underchassis view of completed amplifier. Large chassis and careful layout design simplify soldering.

PACO T-65 Transistor Tester



MANY READERS who experiment with transistors find on occasion that they need to test the tiny units. Several simple transistor tester circuits have been published in past issues of POPULAR ELECTRONICS and these do a good job for most transistor types. However, the number of types and the different mountings and connections have increased to the point where a wide range of test and accurate measurements are often necessary. For a full check of the characteristics of *all* existing transistors, a professional-type transistor tester is vital.

All current transistor types can be tested in the Paco Model T-65 transistor and crystal diode tester (Paco Electronics Co., Inc. 70-31 84th St., Glendale 27, N. Y.). The T-65 tests *n-p-n* and *p-n-p* types of low, medium and high power ratings. As an extra feature, crystal diodes can be checked for both forward and reverse currents.

Transistors are tested in four ways: (1) for shorts between elements; (2) for collector cutoff current (I_{CBO}); (3) for leakage current between the collector and the emitter with the base circuit open; and (4) for gain. The latter is read in current gain (*beta*) of the transistor under test.

Pre-Assembly Steps. Three main function switches are pre-wired before any of the other wiring is done.

Wire the switches carefully, keeping the red positioning mark in mind. Make sure the switches are held toward you or away from you during wiring as required to match the drawings in the manual. Recheck your work before mounting the switches.

Your particular kit may include switches that are slightly different mechanically from those in the diagrams. They may have crimped metal tabs holding the contact wafers to the assembly or nuts and bolts as in the manual illustration. In either case they are directly interchangeable and will present no problem.

It is a good idea to check all soldered connections. Remember that unless a joint is well soldered it may add resistance to

the wiring that will upset some critical test circuit.

It might be found that the 4-pin-in-line transistor socket won't quite fit into its cutout hole in the panel. In such a case, don't try to force the socket but use a small file to enlarge the hole.

After you have completed all construction steps in the manual, there will be three extra resistors. Their values are 33, 390 and 4700 ohms. Clipped to the test leads, these resistors provide a means for checking out the finished instrument as described in the instruction manual.

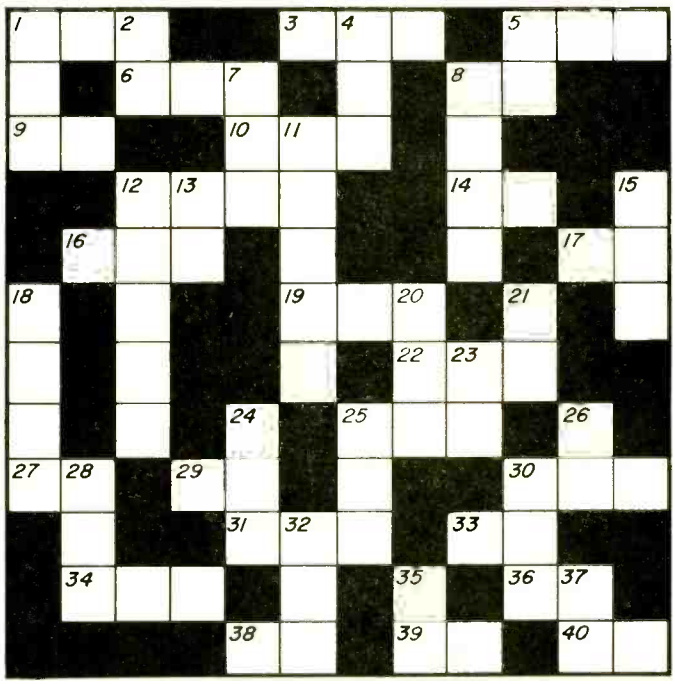
Wide Voltage Range. Some transistor testers are battery-operated but a wide range of voltages is needed for testing many of the newer transistors. The Model T-65 provides 17 different voltages, allowing front-panel selection of collector voltages from 0.5 to 100 volts, d.c. These voltages are also used for diode back-resistance tests. Diode forward tests are made in current ranges from 5 ma. to 500 ma. at any of the 17 voltages from 0.75 to 75 volts.

All transistor test readings are made on a large plastic-cased D'Arsonval-type meter. This meter is also used to adjust the input line voltage. A similar line voltage control is used in tube testers to compensate for power line voltage variation.

Transistor and diode test data sheets accompany the kit. They give an outline drawing of each transistor type and the proper settings of each switch on the tester panel. Complete data is given for testing 411 transistor types and 123 diode types. —30—

ELECTRONIC ABBREVIATIONS PUZZLE

By John A. Comstock



ACROSS

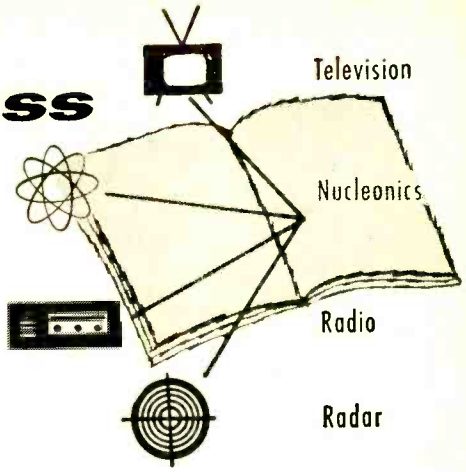
1 Clipper.
3 Electronic generator of frequencies.
5 Type of radio circuit.
6 Number of cycles completed in one second.
8 Circuit consisting of resistance and capacitance.
9 No connection exists.
10 Symbol for d.c. screen grid voltage.
12 Unilateral device that converts a.c. to pulsating d.c.
14 Type of electron beam modulation.
16 Cell which generates voltage when exposed to light radiation.
17 Electrical effect produced by light.
19 Sensitivity rating given to meters.
22 Governmental agency that regulates radio and wire transmissions in the United States.
25 In audio frequency circuit, power expressed in vu or db.
27 Transmission and reception of pictures by means of r.f. waves traveling through space or over wires.
29 In electron tube terminology, output power of tube.
30 Single cotton-covered wire.
31 System of reducing channel width in radio broadcasting.
33 In radar terminology, width of pulse.
34 Audio stage in transmitter that superimposes intelligence signal on carrier frequency.
36 Microgroove record or record with extended play.
38 R.F. band from 30 to 300 kc.
39 One-thousandth of a volt.
40 Class of amplification.

DOWN

1 TV receiver service control that adjusts scanning.
2 Million cycles.
4 In communications, that which carries intelligence from point to point.
5 Product of capacitance times resistance in circuit.
7 Second winding of transformer.
8 Receiver.
11 Flashes from this device may be used to measure rotation speed of turntable.
12 Method of obtaining increased gain from amplifier.
13 Wire covered with varnish-like substance.
15 Package of interconnected electronic components.
18 Switch having single pole and two different throw positions.
20 Variable frequency oscillator.
21 Circuit etched on insulator plate.
23 Element in transistor that receives electrons transmitted from emitter.
24 Opposite of negative.
25 Electromechanical device used in auto radios to convert d.c. to a.c.
26 Circuit consisting of coil and capacitor.
28 Familiar type of meter used in servicing electronics gear.
30 Short-wave listener.
32 Frequency band immediately above u.h.f. region.
35 Modulation very similar to FM.
37 Electronic addressing system.

(Solution on page 115)

After Class



WHEATSTONE BRIDGE

By HARVEY POLLACK

ASIDE FROM the simple series and parallel circuits, the Wheatstone bridge arrangement probably appears in more electronic applications than any other circuit. Invented in 1843 by the English scientist, Charles Wheatstone, the original bridge has been modified countless times to make it suitable for thousands of different uses in control circuits, testing, and radio and television.

Just what is a Wheatstone bridge? What principles are involved in its operation? What is it used for?

Operating Principle. The fundamental bridge circuit is given in Fig. 1. The arrangement comprises *Rx* and *R2* in series, *R3* and *R4* in series, with the two series groups in parallel with each other across the voltage source. A zero-center galvanometer (*M1*) is connected to junctions B and D.

By correctly selecting the four resistance values, it is possible to make the galvanometer read zero regardless of the voltage of the battery (*B1*). When the galvanometer reads zero, the voltage across points B and D must also be zero. There is only one way that this can happen:

(a) The voltage drop across *Rx* (from A to B) must equal the voltage drop across *R3* (from A to D). Designating the current in the upper series branch (A-B-C) as *I1* and the current in the lower series branch (A-D-C) as *I2*, we can write:

$$I1 \times Rx = I2 \times R3$$

since a voltage drop is always the product of the current times the resistance.

(b) Since the voltage across both branches must be equal to the battery po-

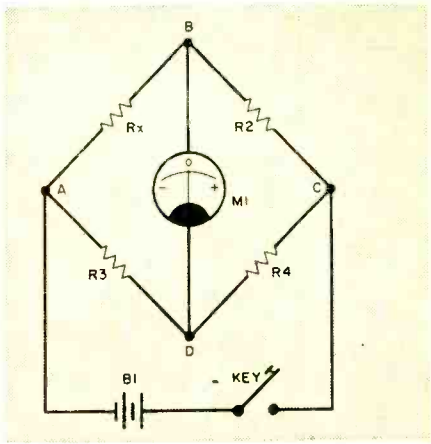
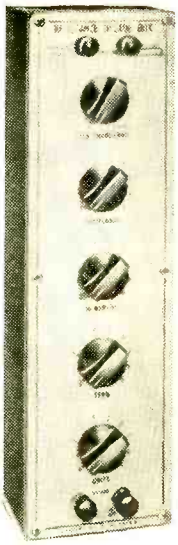


Fig. 1. Basic Wheatstone bridge circuit from which all the other bridge circuits are derived.

Commercial bridge instrument for resistance and capacity measurements available in kit form (Paco C-20).



Precision resistor decade box of the type used to provide a resistance standard (Eico 1171).

tential applied across A-C, then from condition (a) we know that the drop across *R2* must equal the drop across *R4*. The current in *R2* is *I1* since *R2* and *Rx* are in series. Similarly, the current in *R4* is *I2*. Thus:

$$I1 \times R2 = I2 \times R4$$

(c) If the first equation is divided by the second, all the currents cancel out and we are left with the simple relation:

$$Rx/R2 = R3/R4$$

If we now multiply both sides of this last equation by *R2*, we arrive at the final form:

$$\boxed{Rx = R2 \times (R3/R4)}$$

What this final equation really says is that the value of an unknown resistance *Rx* may be obtained if the other three resistances are known. Using the correct value of *Rx*, the bridge can be "balanced," that is, the galvanometer will show no deflection. Measurement of resistances on the Wheatstone bridge can be extremely accurate—much more so than by VOM or VTVM.

Building Your Own Bridge. An amazingly precise Wheatstone bridge can be constructed in an hour or two from some inexpensive materials and any zero-centered sensitive meter. (Many of the surplus mail order houses can supply inexpensive microammeters of this type.) The construction details are illustrated in Fig. 2.

A slide wire consisting of about three feet of #28 Nichrome or similar material taken from an old wire-wound rheostat forms *R3* and *R4*. A test probe can be slid along the Nichrome wire so that *R3* measured from A to D is varied as *R4* (D to C) is simultaneously changed in the opposite sense.

The actual resistance of *R3* and *R4* need not be known. Since resistance of a uniform wire varies directly as the length, the ratio of the length AD to the length DC as read on the yardstick or meter stick is the same as *R3/R4*. Hence, all you have to know accurately is the resistance of *R2*.

You might build up a supply of 1% resistors of different values for substitution across the *R2* binding posts, or if you own a resistance decade box, this can be used.

Using the Bridge. Suppose you want to find the resistance of an unknown resistor with good precision. If you know the approximate range of resistance that you're dealing with, choose a value for *R2* of about the same range. If you have no idea of the value of *Rx*, use a hit-or-miss system.

Touch the test prod to the slide wire near

(*Continued on page* 108)

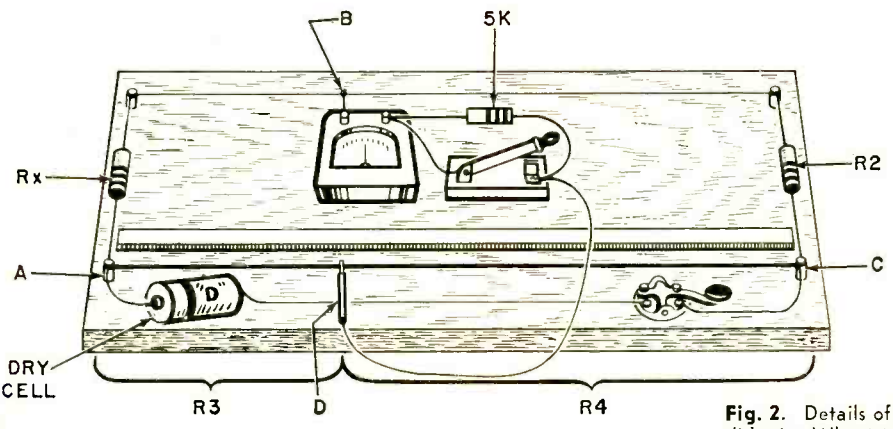
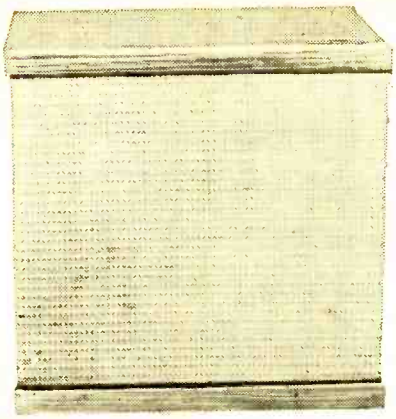


Fig. 2. Details of homemade slidewire Wheatstone bridge.



TESTED By POPULAR ELECTRONICS

The Duo-Flex Speaker System

A small hi-fi speaker system, ideal for a second stereo channel or extension use

By DAVE GORDON

BASS-REFLEX cabinet design has been the source of more conflicting claims in the hi-fi field than perhaps any other subject. Partisans of the design swear by it; others, at it.

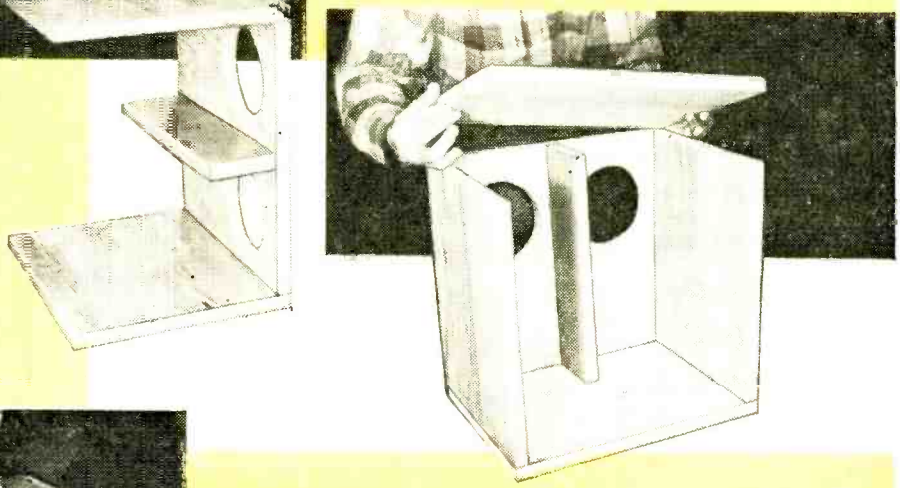
There is no question but that many bass-reflex systems do sound pretty bad. A cabinet with too-thin panels and a mis-tuned resonance will cause even the best speaker to seem muddy and boomy. However, a well-constructed enclosure properly tuned to the speaker not only can sound extremely good but is exceptionally easy and economical to construct.

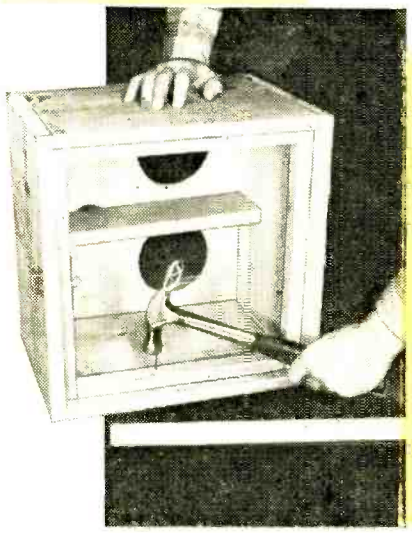
Acoustic Theory. What are the acoustic facts behind the bass-reflex design? In simplest terms, the bass-reflex enclosure can be considered as a specially adapted Helmholtz resonator.

What is a Helmholtz resonator? Anyone who has ever blown across the mouth of an empty bottle has been experimenting, as it were, with a Helmholtz resonator. Varying either the cubic content of the bottle or the size of its mouth will change the tone produced by the air vibrations within the bottle.

Consider the bass-reflex speaker enclosure as a Helmholtz resonator—but with a speaker (or speakers) mounted in it. The speaker has its own resonant frequency which is determined by the mass of the cone and the stiffness of its suspension. By tuning the cabinet's resonance to that of the speaker, cancellation of the speaker's resonant peak can be achieved. Cancellation takes place because the cabinet, when excited to resonance, absorbs energy from —and hence damps—the speaker cone. Lower distortion and a greater power-

Precut all sections of the cabinet to the sizes specified in the dimensional drawing on page 105. Install the front panel divider exactly between the speaker cutouts and then butt the two side pieces to the plywood front panel. Use 2" finishing nails and a good grade of wood glue on all joints.





Top and bottom panels are installed next. Use glue and nails every 2" along joints. For best bass response, it is important that completed box be as airtight (before drilling port holes) as possible. Use wood putty to seal any cracks that may result in air leakage.

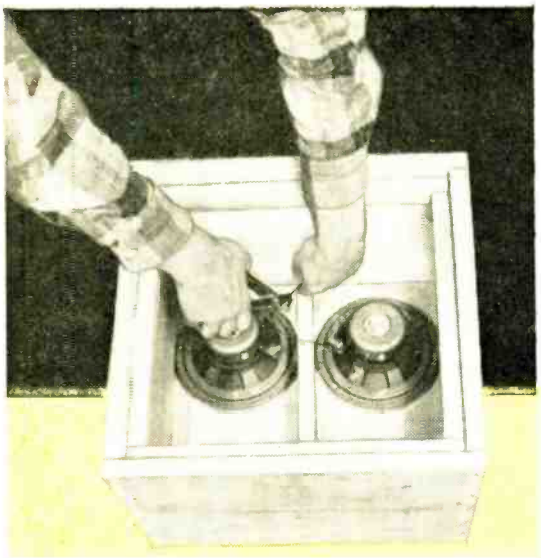
Cleats for the back panel mounting are installed with 1¼" nails and a liberal amount of glue. The cleats should be spaced in from rear of cabinet to a depth sufficient to allow flush-mounting of the back panel. An airtight seal can be insured by tacking felt weather stripping on the cleats where they meet the back panel.

handling capacity are immediate gains from the lower cone excursion.

A Practical System. How do we go about designing a practical bass-reflex system? To answer this question, it was decided to build a small experimental system. Two Lafayette SK-97 6½" coaxial speakers were chosen to be the drivers of the system, dubbed the "Duo-Flex."

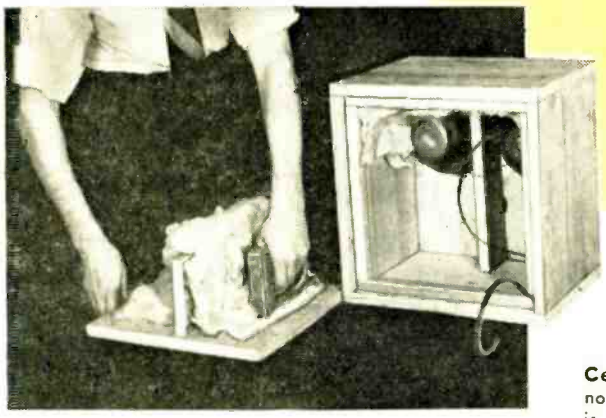
The SK-97 speakers were selected for the Duo-Flex because they were inexpensive ($12.95 for two), and therefore presented a challenge to the enclosure designer. However, the tuning technique to be described would be suitable to almost any speaker and cabinet combination.

Rather than attempt to calculate the cabinet dimensions by one of several math-



The two coaxial speakers are mounted with #4 screws, 1¼" long. Do not overtighten screws as speaker frame warpage may result. Wire speakers in series (total impedance will be 16 ohms), and check phasing by momentarily connecting a 1½-volt dry cell to the leads. At the moment of contact, both speaker cones should move in or out. If the two cones move in opposite directions, reverse connections to one speaker. A 6' length of TV flat-line can be used for the speaker input lead.

Using a ½" wood bit, 36 holes are drilled in the front panel in the area shown in the photo. The exact pattern and spacing of the holes is not important. It is most convenient to locate the holes a little lower than halfway between the speaker openings and the bottom of the cabinet. Avoid drilling into the front panel divider.



Center the back panel divider so it will not interfere with the cleats when the panel is installed. Nail and glue the divider in place and cover it with a 2"-thick blanket of glass wool. Staple the glass wool to the top and sides of the cabinet. When the cabinet is assembled, the back panel divider will be horizontal and the front panel divider will be vertical. The back panel is mounted with about a dozen 1½" #6 wood screws.

ematical formulas (there are *several* formulas but the experts don't seem to agree on *one*), it was decided to build a cabinet to a convenient size and then pragmatically tune it by drilling ½" holes in the front panel. As we shall see, both cabinet *and* speaker resonances are reflected in an impedance curve of the speaker voice coils.

Figure 1 illustrates the impedance-meas-

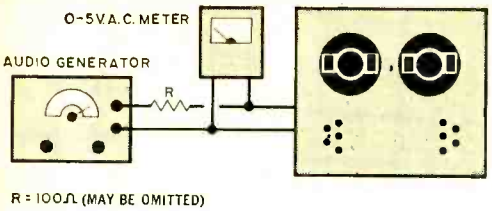


Fig. 1. Setup used to measure the impedance curve of the Duo-Flex speaker system. Only a few of the 36 holes to be drilled are shown.

Two Lafayette SK-97 6½" coaxial speakers were used in the Duo-Flex.

Fig. 2. In these impedance curves, the numbers running horizontally represent frequency. The vertical numbers represent volts developed across the voice coil and are not significant except on a comparative basis.

uring setup that was used and Fig. 2 graphically charts the electro-acoustic changes that occur during tuning.

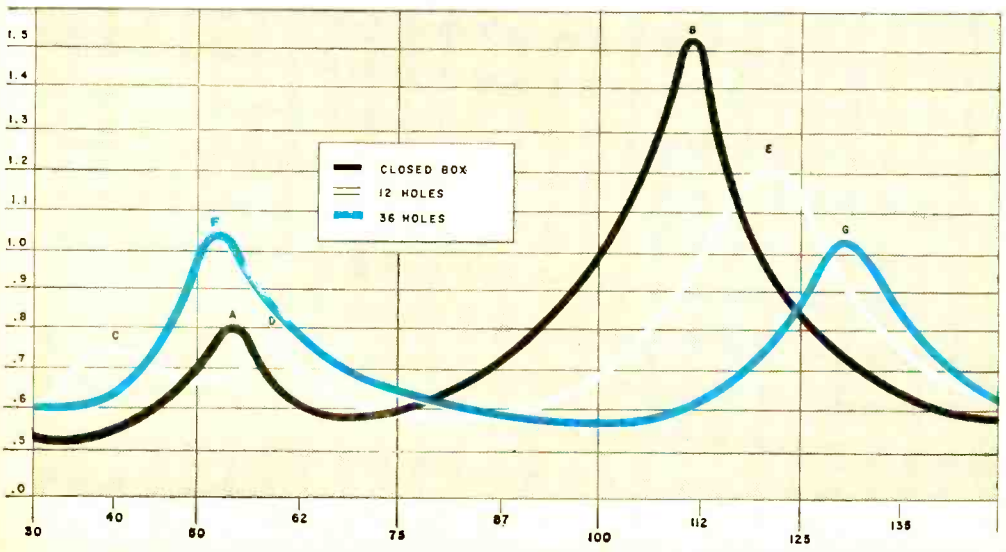
The SK-97 has a free air resonance of approximately 85 cycles. When installed in a sealed cabinet 15¼"x14"x11½", the resonance moves up 25 cycles and appears as peak *B* (in Fig. 2) at about 110 cycles. The smaller bump at *A* shows the main resonance of the speakers being excited by 55 cycles, a "subharmonic" of 110 cycles. In general, the "closed-box" curve suggests a muddy, boomy bass, which was confirmed by listening tests.

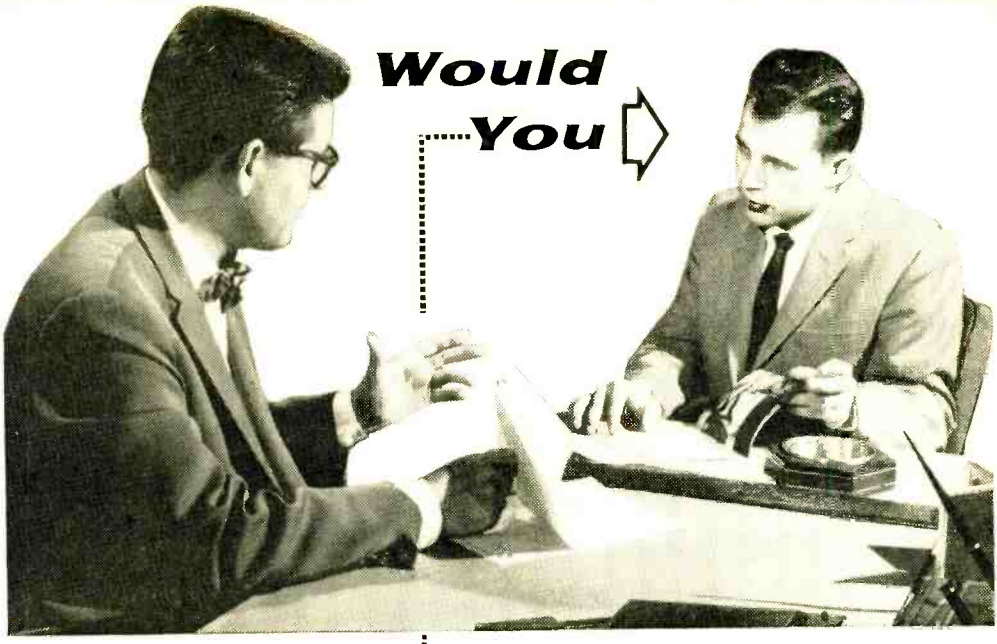
Holes Improve Performance. Drilling 12 holes in the front panel turns the sealed enclosure into a Helmholtz resonator —resonant at about 50 cycles. The resonance of the enclosure is out of phase with peak *A* and produces the *C* and *D* peaks. Peak *B* has slipped down in amplitude and up in frequency and has become *E*.

Applying the drill once more and raising the number of holes to 36, we achieve nearly perfect tuning. Bump *C* has grown to *F*, *D* has disappeared, and *E* has slumped down to become *G*.

The 36-hole curve represents the ideal bass-reflex tuning curve. It's important to remember that the curve represents only *impedance* changes in the speaker voice coil, which reflects speaker and cabinet resonance and *not* speaker output. G. A. Briggs of Wharfedale has demonstrated that at the cabinet resonant frequency

(*Continued on page* 106)





Would You ..... Like a Technician's Job?

By
SIMON DRESNER
Associate Editor

TO FIND OUT exactly how technicians are hired, and what personnel people look for in a technician, POP'tronics went directly to Frank W. Jensen, Employment Manager for Remington Rand Univac's Electronic Services Department. For several years Mr. Jensen has been searching for qualified technicians to maintain his company's multi-million-dollar computers. Here are his answers to basic questions about hiring electronic technicians.

Q. When you hire a technician, what kind of job do you train him for?

A. We train our technicians to run and maintain our large computer installations. Since the average cost of training a technician for this job is between $6000 and $8000, the opportunity is offered only to well-qualified people.

Q. What kind of background should an applicant have?

A. To maintain a computer, an understanding of electronic fundamentals is a necessity. This should be backed up preferably with several years of experience in pulse circuits, such as those used in radar, fire control, or guided missiles.

Q. What kind of educational background is satisfactory if the man has learned his electronic fundamentals.

A. A man may have gotten his early training through a correspondence course or in the Armed Forces and developed a lot of on-the-job experience and ability. He may be a graduate of an accredited technical institute.

Q. Are his school grades important?

A. Grades do not necessarily reflect how much a man knows. Chances are, though, that if he has received good grades it means he's interested in newer concepts in electronics and would do well in our schools.

Q. Do you test your applicants for technical ability?

A. Yes, we give two tests, one to measure reasoning power, and the other to see how much electronics the applicant knows. In working with computers, the ability to

think logically is very important, and we measure it with the reasoning power test.

Q. How do you score the tests?

A. The applicant must get above a certain minimum score on each test. To some extent, excellence in one test can offset a poor grade in the other. We make allowances for special subjects which he may not know, such as binary arithmetic, which would be taught in our training program. He may have missed some simple questions because he had studied the subject too far back in his schooling and didn't remember it. In addition, we quiz him orally.

Q. What do you ask him?

A. Well, I might confront him with a schematic diagram and say, "See this complex network of relays? If I throw this switch, does this light go on or off?" This would give a quick check on his reasoning power. The so-called "machine logics" places heavy demands on the applicant's ability to think rationally.

Q. How valuable is a knowledge of transistors?

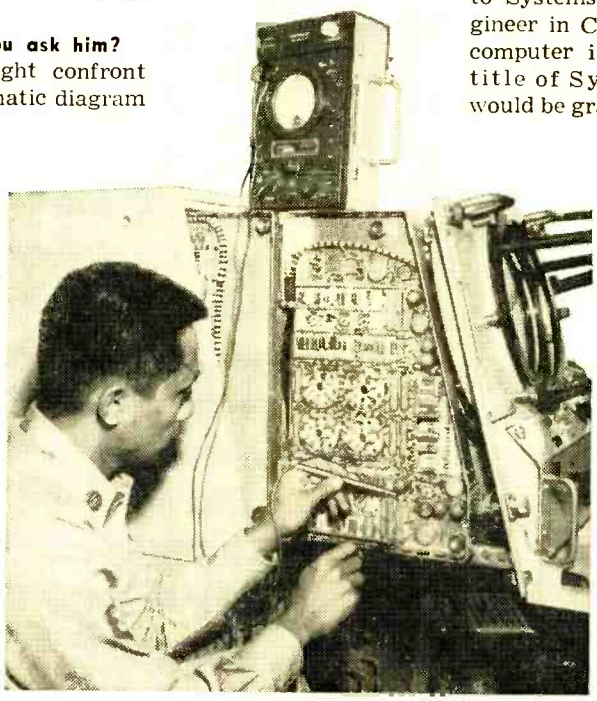
A. Very valuable. A fellow who knows his transistor circuitry makes our training that much easier—our computers are using more and more solid state components, like the transistor. It also means that he is keeping up with the latest in electronics.

Q. How much more does a technician learn in your training school?

A. First, a man must have a good background in electronics theory or fundamentals. You can't build a skyscraper on a weak foundation. Training consists of entirely new ideas in mathematics, electronics, logics, and electromechanical assemblies. These concepts are unique to our computers, which are unique machines. Topics like transistors are thoroughly covered during training.

Q. Can a computer technician become an engineer?

A. The natural path of advancement is from Technician to Engineer, to Systems Engineer, to Engineer in Charge of a specific computer installation. The title of Systems Engineer would be granted, for example, to a man who has gained an overall understanding of the complete computer system.



Many technicians learned the ABC's of electronics in the Armed Forces. This radar specialist is using a voltmeter to check a circuit. His experience would qualify him to work on non-military radar or computers.

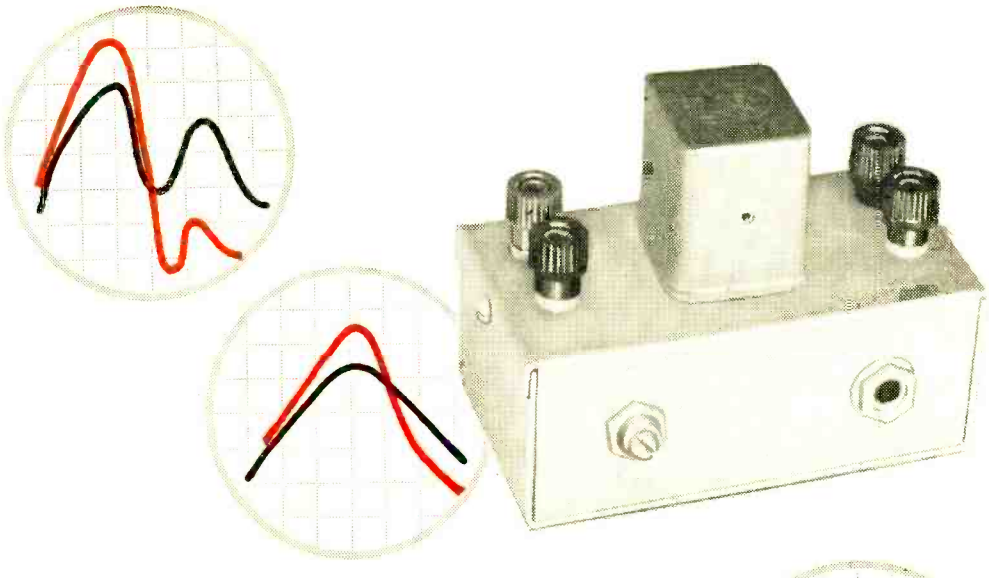
Q. What kind of personality characteristics do you look for?

A. A man's got to be meticulous and responsible. The reason is obvious: repairs on Remington Rand Univac computers have to be done quickly and accurately, and with good reliability. Any "down time" when the computer is not functioning costs both ourselves and our customers money. The applicant must be interested in the machine and have a positive, constructive attitude.

Q. What about his ability to work with people?

A. This is very important. Our techni-

(*Continued on page* 111)



Build This Signal Peaker

A useful accessory for the ham or SWL

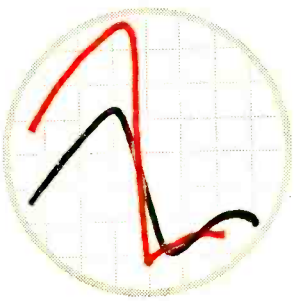
HERE is an easily constructed signal peaker that requires neither tubes nor transistors nor a d.c. power supply. It tunes sharply to pass any selected frequency between 600 and 1100 cycles. Approximately 14 to 1 rejection is provided for frequencies as close as 1 octave on each side of the operating frequency.

While other filters only knock the available signal down, this circuit introduces no insertion loss. Instead, when operating into a high-impedance load (such as an a.c. VTVM, oscilloscope, or crystal headphones), it provides a voltage gain of approximately 10 at signal peak. The graph shows the circuit's performance curve at 1000 cycles.

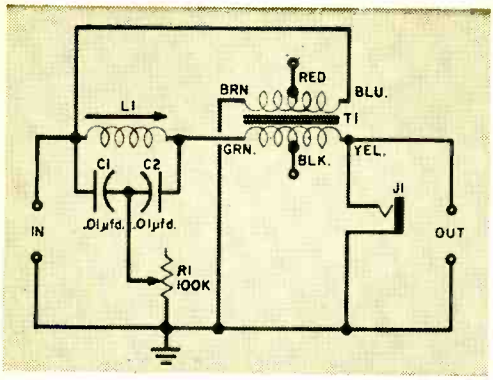
Construction. The device should be built in an aluminum chassis box. Neither layout nor wiring is critical, since the frequencies are low. The only wiring precaution is to connect all ground leads to one soldering lug which should be attached to the chassis.

Mount inductor *L1* and the binding posts on top of the chassis. Mount *R1* and *J1* on the front. All other circuit elements are mounted inside the chassis box.

Follow carefully the color coding of *T1*'s leads as shown in the schematic. If this is not done, the transformer will not be



By
RUFUS P. TURNER



PARTS LIST

C1, C2—0.01-μfd. mica capacitor
J1—Miniature open-circuit phone jack
L1—Miniature 5-henry tunable inductor (UTC VIC-15)
R1—½-megohm potentiometer
T1—Miniature transistor-type transformer: primary impedance, 2000 ohms CT, secondary impedance, 8000 ohms CT (Argonne AR-115)
4—Insulated binding posts, with lugs and fiber washers
1—Solder lug
1—4" x 2⅛" x 1⅝" aluminum chassis box

HOW IT WORKS

The primary winding of transformer *T1* is connected in parallel with the signal input terminals. The secondary winding is connected effectively in series with the *Input* and *Output* terminals. It is wired to buck the input voltage. Because of this phasing, the output voltage would be reduced to zero if the secondary voltage were exactly equal to the input voltage. Thus, the signal through this circuit would be cancelled.

But there is connected in series with the *Input* terminals and the transformer secondary a bridged-T network *(L1-C1-C2-R1)* which removes one frequency (actually, a very narrow band of frequencies) from the signal. This prevents transformer *T1* from bucking out the signal of the bridged-T network frequency. The net result is an output signal at the null frequency of the T network, while adjacent frequencies are attenuated.

Headphone jack *J1* is provided in addition to the *Output* binding post terminals to allow the device to be used directly with headphones for sharpening c.w. signals or balancing a bridge.

phased correctly and the output signal will dip instead of peaking.

By employing an adjustable inductor, *L1*, the response of the network may be changed to any desired frequency within a tuning range governed by *L1* and capacitors *C1* and *C2*. The specified inductor (UTC Type VIC-15) is adjusted by means of an Allen wrench inserted into a tuning screw.

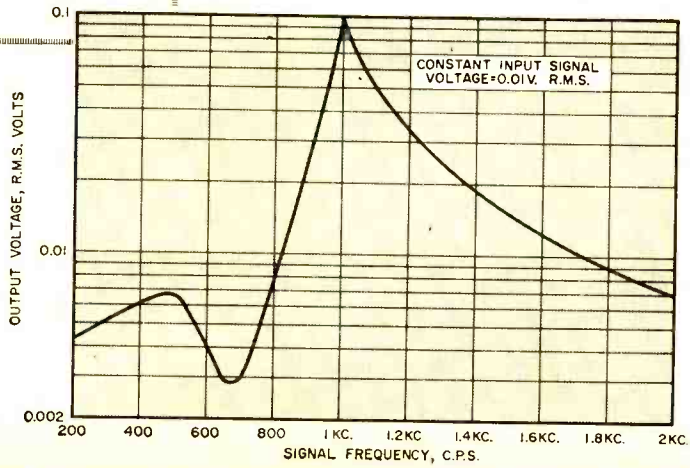
If the builder is not interested in the tuning feature, a conventional, iron-cored choke coil may be used, but it must have high *Q* in order for the output peak to be sharp.

Tuning. Connect an audio oscillator to the *Input* terminals. Connect an a.c. VTVM to the *Output* terminals. Be sure that the ground terminal of the oscillator and VTVM are connected to the grounded binding posts. Tune the oscillator to 1000 cycles.

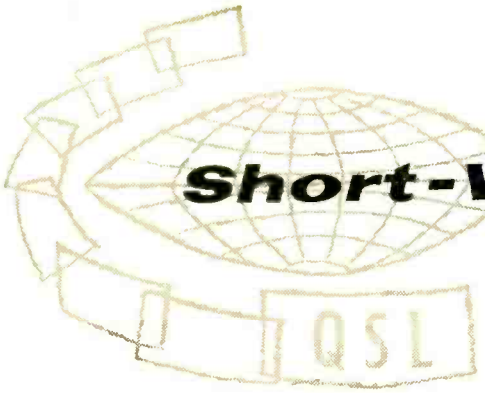
Adjust *L1* for peak deflection of the VTVM. Adjust *R1* for the highest VTVM reading at the peak. Now, without disturbing the oscillator output control, run the oscillator through its tuning range, noting that the output voltage rises sharply at 1000 cycles and falls on each side of this frequency.

The signal peaker can be tuned to any frequency between 600 and 1100 cycles by repeating the above procedure. Just set the signal generator at the desired frequency.

The setting of *R1* does not affect the frequency but varies the height of the output signal peak. It is set for maximum peak height. Resetting is required only when the frequency is changed. —30—



Graph of the output voltage with the signal peaker tuned to 1000 cycles and a varying input frequency. In the schematic of the peaker (above), jack J1—for direct phone connection — is optional.



Short-Wave Report

By HANK BENNETT

POP'TRONICS REPORTER Thomas Riley Sundstrom (R. D. #1, Box 98, Stockton, N. J.) began DX'ing in 1955 with a 1930-model RCA receiver which covered 6-18 mc. in addition to the standard medium-wave band. A short time later, Riley, as he is known to many of his DX friends, augmented this with a Hallicrafters S-38.

Riley's antenna is a 50' inside "long wire," of which 40 feet point north-south, and it is inconspicuously installed along a baseboard. Although his best DX is *Radio Japan*, he has heard it only once in its North American Service. He recently acquired a Heath QF-1 Q-Multiplier which is expected to help rectify this situation.

In the three years that Riley has been DX'ing, he has amassed a log covering 25 countries, 22 verified. He has 26 veries in all, the most prized one being from the West Indies Broadcasting Service, Grenada, for the 5000-watt outlet on 3365 kc.

The Sundstrom receivers can usually be found tuned to the 25-meter band. Riley's favorite stations include *Radio Australia* for the "North American Mailbag" and "DX'ers Calling," and the *Voice of Denmark* for the "DX Bulletin."

Riley is 16 years old, a Junior at the Solebury School in New Hope, Pa., and a member of the Newark News Radio Club and the Connecticut DX Club. He will be pleased to see on pages 60 to 63 of this issue of POPULAR ELECTRONICS a *new* list of short-wave broadcast stations somewhat similar to the one that appeared in the November 1957 issue.

Club Notes. The Band and Frequencies Radio Club is currently having a drive for new members. "Ether Echoes," the club bulletin, covers all areas of DX plus some special feature articles. For complete information, write to Vernon G. Packard, President, 810 S. 21st St., Milwaukee, Wis.

The International Shortwave Club is conducting a census to determine the most popular short-wave stations. This census, taken every three years, is open to *all* short-wave listeners. Send a postcard or air letter to ISWC, 100, Adams Gardens Estates, London, S.E. 16, England, listing your five favorite stations or services in order of preference, with a short explanation as to why you consider your first choice to be the most popular station.

Current Reports. This month our station reports will feature new stations, frequency and program changes, and some unidentified stations which you may be able to identify. Times given are Eastern Standard and the 24-hour system is used.

(*Continued on page* 124)

Riley Sundstrom at his listening post in Stockton, N. J. His Hallicrafters S-38 receiver with 10" speaker is at the left, the 1930 RCA receiver right next to it.

How to Build...

A Cascode R.F. Unit

. . . to boost reception on the 2- and 6-meter bands

By
DONALD A. SMITH
W3UZN

HERE is the opportunity for hams and SWL fans to increase the sensitivity and gain of their present receivers by adding a cascode r.f. amplifier. This easily constructed, self-powered unit connects directly to the antenna terminal of your receiver, with no rewiring necessary.

Coil winding, parts layout and neutralization problems have been eliminated by the use of a kit available from International Crystal Company. And a small transformer-operated silicon diode power supply is added to the basic printed-circuit unit for shockless operation.

Construction. A small aluminum box houses the entire unit. Two cutouts are necessary for the power transformer and printed-circuit board.

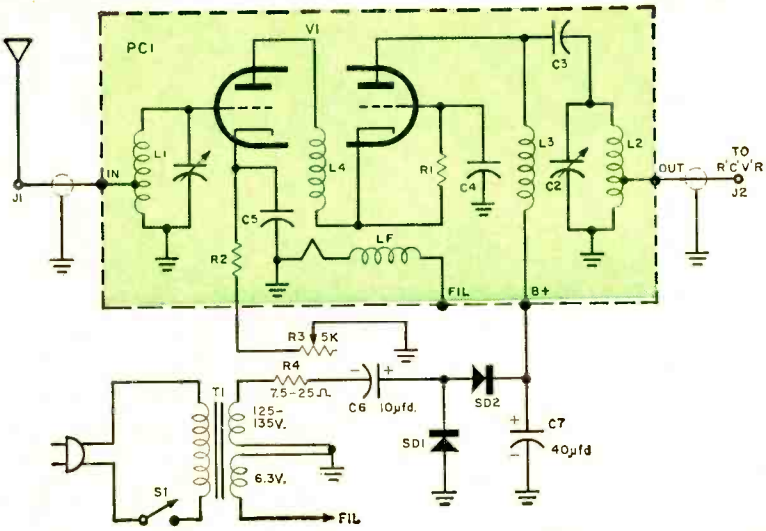
Since the parts received with the amplifier board are not yet mounted, this is the best time to mark off the board chassis cutout. Make it about ¼" smaller than the board. The edge of the printed circuit resting on the chassis provides the electrical ground. It may be necessary to file notches on the cutout to prevent shorting out of the terminals marked *FIL* and *LF*.

After all holes are drilled and the two cutouts made, mount the parts on the chassis. Follow the manufacturer's instructions when mounting components on the printed-circuit board. In the case of the 820-ohm resistor (*R2*), which is connected between tube pin 8 and ground, do not place the resistor as shown. Instead, connect it under the board, from pin 8 to the gain control (*R3*). *R3* permits lowering stage gain when extremely strong signals are received to prevent overload and blocking of the receiver.

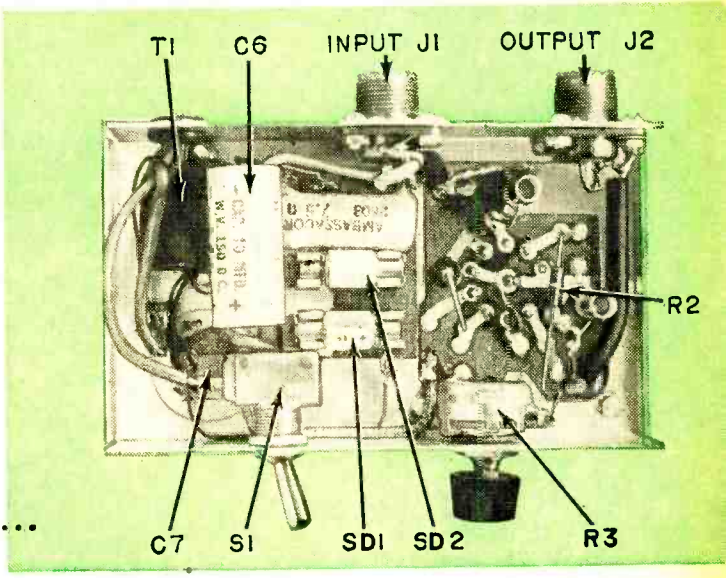
Use short lengths of coaxial cable to connect the input and output jacks (*J1* and *J2*) to the amplifier board. Observe polarity on *C6* and *C7*.

Alignment instructions are included with the kit. Don't be concerned if you find that the adjustment which gives the lowest noise during alignment is not the same as that which gives the greatest gain.

Using the Amplifier. The r.f. amplifier is complete in itself and therefore may be placed anywhere in the antenna lead-in,



Schematic diagram of cascode r.f. unit. Part of schematic shown in color is printed-circuit board.



The r.f. section should not be cluttered by the power supply components. Note that resistor R2 is connected directly to R3. Use coax cables on r.f. input and output leads.

ahead of the receiver or converter. For best results, locate the unit on or near the receiver in order to keep the coaxial cable length short.

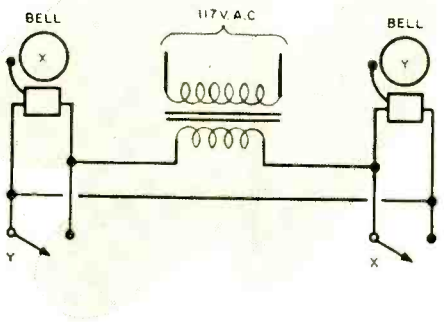
Both 2- and 6-meter amplifiers are available from the manufacturer. Tests made on the 6-meter unit, fed into a converter which already had a cascode front-end, showed good results. The over-all gain was approximately 30 db. The signal-to-noise ratio was improved 3 to 5 db.

When the cascode amplifier was connected to a converter which did *not* have a cascode front-end, gains of 10 to 20 db were not uncommon! And QRM in the i.f. frequency range was greatly reduced. -30-

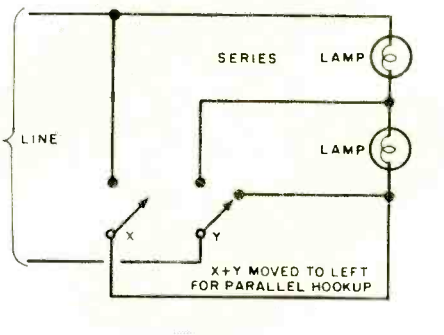
PARTS LIST

C6—10-μfd., 150-volt tubular electrolytic capacitor
C7—40-μfd., 350-volt can-type electrolytic capacitor
J1, J2—Chassis-mounting screw-type coaxial connector (Amphenol 83-1R or equivalent)
PC1—Printed-circuit board and parts (VFA-1, International Crystal Co., 18 N. Lee, Oklahoma City, Okla.—indicate choice of 6- or 2-meter cascode r.f. stage)*
R3—5000-ohm potentiometer
R4—7.5—25 ohm, 10-watt resistor
S1—S.p.s.t. toggle switch
SD1, SD2—150-ma. (or smaller) silicon diode rectifier
T1—Power transformer, 117-volt primary, 125-135 volt and 6.3-volt secondary (Triad R-20 or Stancor PS-8415)
1—5½" x 3" x 1¼" chassis (LMB #139)

** C1—C5, R1, R2 and V1 are on printed-circuit board*



1 To save wire, Mr. Buzz thought he could hook up two bells so that switch X would turn on bell X and switch Y on bell Y. He figured that if both switches were depressed there would be a short circuit across the transformer, and, since the short would be of short duration, it would not harm the transformer. He expected no trouble but ran into some anyway. What happened?

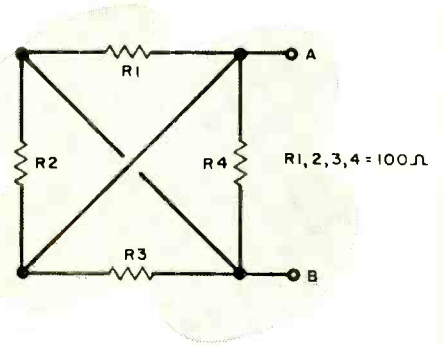


2 Joe Snappit, a photographer, wanted to make a device that would switch two flood lights from parallel to series operation. Joe didn't have a double-pole, double-throw switch, so he used one single-pole, single-throw switch and one single-pole, double-throw switch. And when he plugged the device into the wall outlet, it seemed to work. Was Joe smart or was he just plain lucky?

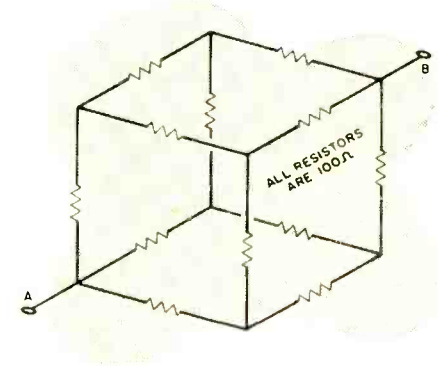
Electronic Sticklers

Here are four puzzles involving simple electrical circuits arranged in order of increasing difficulty

(Answers on page 108)



3 Harold Tinkertoy, an inveterate experimenter, wanted to see what circuit resistance he would get when he connected four 100-ohm resistors as shown. What resistance did Harold find from A to B?



4 After figuring out Stickler #3 at left, Harold Tinkertoy went three-dimensional by connecting twelve 100-ohm resistors to form the cube above. What resistance did Harold find from A to B this time?

This month's Sticklers submitted by

RONALD WILENSKY

Transistor Topics

By LOU GARNER

BECAUSE of its small physical size, circuit designers first thought of the transistor simply as an expensive subminiature substitute for the more popular vacuum tube. For a long while, the terms *transistorized* and *subminiaturized* were used almost interchangeably. Now design engineers are giving more attention to the transistor's other desirable characteristics: its resistance to shock and vibration, its almost infinite life, and its low power requirements.

Heath's Model DF-2 Radio Navigator is an outstanding example of the transistor's application in non-miniature equipment. A two-band superhet receiver, the DF-2 covers both the long-wave beacon and standard AM broadcast bands, and is intended for use as a radio direction finder by boat owners, light plane operators, campers and hunters. Measuring 9½" x 5" x 8" overall, it uses conventional "chassis-type" construction, employing a chassis and cabinet large enough to handle a vacuum-tube receiver with similar operating characteristics and performance specifications.

Transistors were used in this instrument not because of their size, but because their electrical and mechanical characteristics were best suited to the rigorous requirements of outdoor equipment. Their light weight and rugged construction are necessary in equipment that is carried and bounced about in jeeps, station wagons, boats, and light planes. Their low power requirements are mandatory in instruments that must be operated from self-contained batteries far from the convenience of a power line. And finally, their long service life is essential in gear likely to be used in remote locations away from dependable repair and service shops.

Readers' Circuits. Not long ago, David Bradbury (133 S. Bancroft, Indianapolis, Ind.) submitted a collection of the "best" experimental circuits he had developed in

A two-band transistorized receiver, Heath's Model DF-2 uses conventional construction and wiring, with no attempt at subminiaturization.

six months' work with transistors. One of his circuits, a two-transistor broadcast-band receiver featuring a direct-coupled complementary amplifier and reflex operation, is given in Fig. 1.

Radio-frequency signals are picked up by the antenna system and selected by tuned circuit *L1-C1*. Antenna coil *L1* (Lafayette MS-299) is tapped to match the moderate base-emitter input impedance of the 2N229 *n-p-n* transistor (*Q1*). *Q1* serves first as an r.f. amplifier, with an amplified r.f. signal developed across the 0.5-mhy. choke (*RFC1*) in its collector circuit. This signal is coupled through *C4* to a 1N34A diode detector.

The detected audio signal appearing across the diode load resistor, *Gain* control *R2*, is reflexed back through *C3* to *Q1*'s base. Thus, the *n-p-n* transistor serves as an audio amplifier *and* as a common-emitter r.f. stage. The amplified audio signal is direct-coupled to the base-emitter circuit of the *p-n-p* CK722 (*Q2*); this coupling arrangement is made possible by the complementary characteristics of the transistors. As far as audio signals are concerned, *RFC1* acts as a short circuit.

After further amplification in the second stage, the output signal drives the pair of magnetic earphones serving as *Q2*'s collector load. Operating power is supplied by a 3-volt battery (*B1*), controlled by a s.p.s.t. switch ganged to *R2*.

Since layout and wiring are non-critical, and standard components are used throughout, you should have little or no difficulty duplicating Dave's receiver. For best operation use a moderately long antenna.

The receiver circuit shown in Fig. 2 was adapted from a schematic submitted by Bob Geiste (46 Hayes St., Bridgeport 8, Conn.). Designed to tune but a single station, this interesting one-transistor receiver is unique in that it uses the resonant characteristics of a dipole antenna as a substitute for a conventional *LC* tuned circuit. Thus, the basic receiver circuit may be employed at almost *any frequency* from long-wave through v.h.f., depending upon the electrical wavelength of the antenna system used. The antenna, of course,

(*Continued on page* 115)

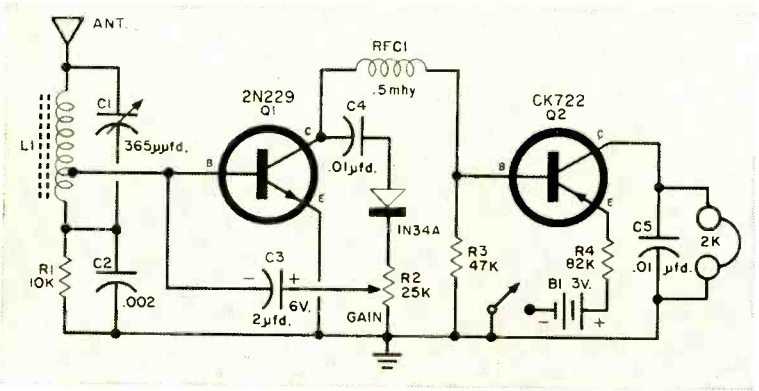


Fig. 1. Dave Bradbury's two-transistor broadcast-band receiver (above) features direct coupling, reflex operation.

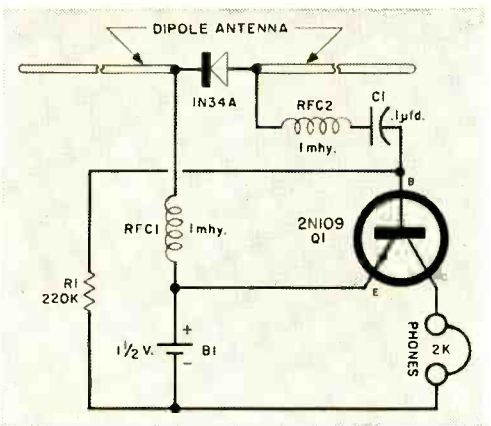


Fig. 2. Bob Geiste substitutes dipole antenna for LC tuned circuit in his one-transistor single-frequency receiver.

By
HERB S. BRIER
W9EGQ

Among the Novice Hams

WHO are hams? Who isn't one? Your doctor, your paper boy, your milkman, your favorite TV personality, the chief of police, the wife, son or daughter of any of these, a nun in a convent, school children, and other people just like you . . . whether you are 9 or 90 years old . . . are hams.

A number of new POP'tronics readers receive their introduction to amateur radio through this column. Do *you* want to know what hamming is all about and how you can get started on the amateur bands? Or perhaps you'd like to brush up on the facts about code requirements and the various licenses available.

What Hams Do. Amateur radio is the art of two-way radio communication pursued as a hobby by over 200,000 licensed amateurs throughout the world. They communicate with each other via their own radio receiving and transmitting equipment installed in their homes, automobiles, airplanes, boats, and even on their bicycles and motor scooters. They converse via the radio telegraph code, radiophone, or even by radioteletype, and some of them even transmit amateur television and facsimile signals.

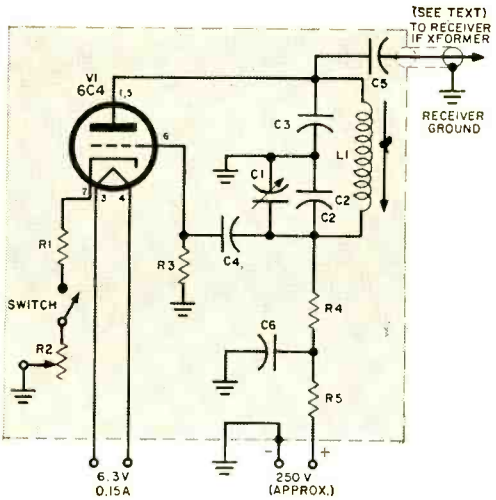
Hams send and receive messages in emergency situations, "rag-chew," chase elusive "DX" from exotic foreign countries, experiment with new equipment and modes of

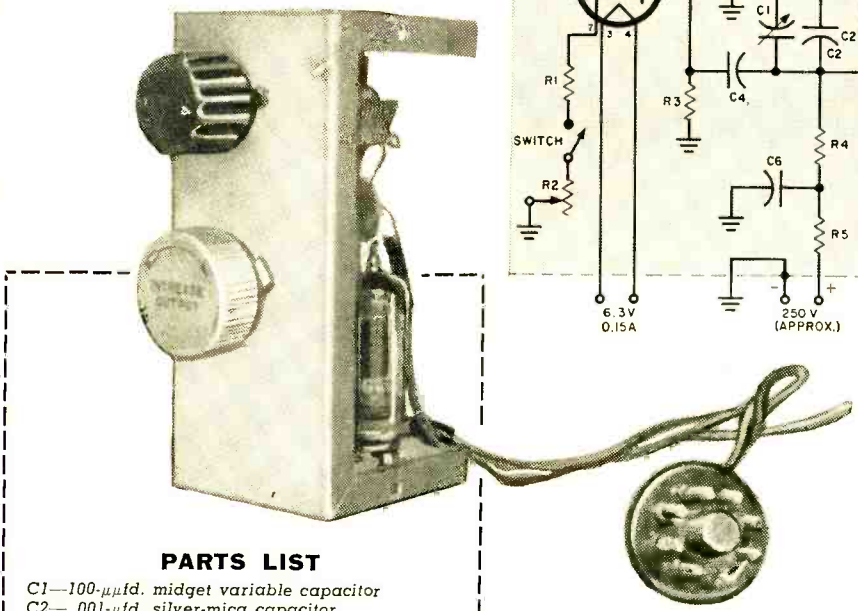
Mike, K7CLS, (ex-Novice), Layton, Utah

"Ron," KN8KPJ, Huntington Woods, Mich.

Art, KN1HQE, Pautucket, R. I.

Construction project for hams: a Q-Multiplier to permit the copying of signals which would otherwise be buried under interference. See details in text on page 120.





PARTS LIST

C1—100-μμfd. midget variable capacitor
C2— .001-μfd. silver-mica capacitor
C3— .0025-μfd. silver-mica capacitor
C4—470-μμfd. mica capacitor
C5, C6— .005-μfd., 600-w.v. capacitor
L1—Broadcast-band "antenna" coil with adjustable ferrite slug
R1—470 ohms
R2—25,000-ohm potentiometer (with switch)
R3—2 megohms — *All resistors*
R4—47,000 ohms — *½-watt composition types*
R5—15,000 ohms
V1—6C4 tube (see text)
1—2¼" x 2¼" x 5" aluminum box (Bud Minibox or equivalent)

radio communication. And they do it all from love of the game.

But because even a simple, low-power transmitter is capable of transmitting a signal halfway around the world and can cause interference to other services if improperly operated, all hams must pass an examination and obtain a government license before they can transmit a single dot.

In the United States, all radio licenses are issued by the Federal Communications Commission in Washington, D. C., and any citizen who passes the proper examination can get his ticket. There are various classes of licenses available to new applicants.

Licenses Available. The *Novice Class* license permits operating up to a 75-watt code transmitter in segments of three amateur bands and a voice or code transmitter in a fourth. The examination consists of a five-wpm code test and a simple written examination. This license is valid for one year, and cannot be renewed.

A Technician Class license grants all amateur privileges. There is a 13-wpm cies above 50 megacycles, except in the 144-to-148 mc. band. The examination consists of a five-wpm code test and a fairly comprehensive written examination on amateur radio theory and regulations. Valid for five years, this license is renewable.

Both the Novice and the Technician Class licenses are issued by mail with the aid of volunteer examiners.

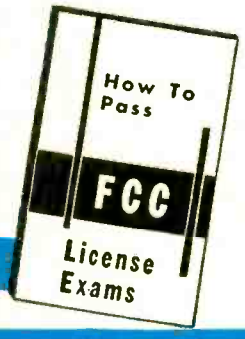
The *General Class* license grants all amateur privileges. There is a 13-wpm test and a written examination of the same scope as required for the Technician license. The General Class license is valid for five years and renewable. The applicant must appear at an FCC examination point to take the examination.

If you live more than fifty miles from the nearest FCC examination point or are

(*Continued on page* 119)

Accredited by the National Home Study Council

How To Pass FCC COMMERCIAL License Exams



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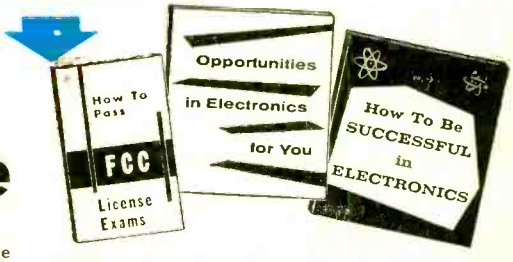
The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.



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Desk PE-48, 4900 Euclid Ave., Cleveland 3, Ohio

Cleveland Institute training results in job offers like these:

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Man needed in Cleveland, Ohio, to service and maintain electronic medical instruments and equipment. Must have a solid knowledge of electronic fundamentals. A car is required. Company benefits include retirement plan.

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Harold E. Phipps, North Augusta, S. C.

Cleveland Institute of Radio Electronics
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- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other

In what kind of work are you now engaged? _____

In what branch of Electronics are you interested? _____

Name _____ Age _____

Address _____

City _____ Zone _____ State _____

PE-48

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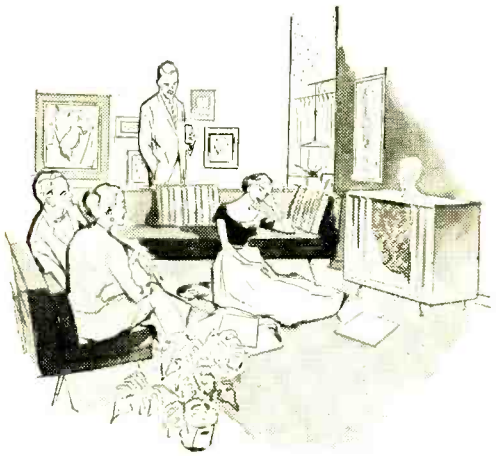

Don't let a lack of experience keep you from enjoying the fun and savings of "Do-it-yourself" kit construction. The easy-to-follow diagrams that come with every Heathkit insure your success. Let our experience be your teacher—and you'll save one-half or more over the price of "built-up" equipment of equal quality.

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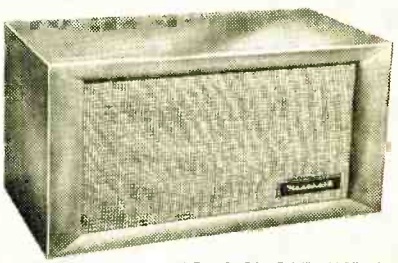
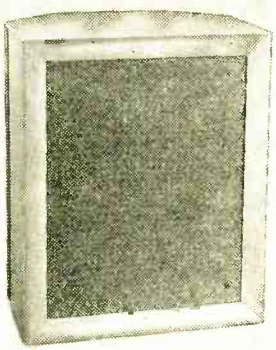


"BASIC" SPEAKER SYSTEM



RANGE EXTENDER

A-9C 20-WATT AMPLIFIER

HEATHKIT "BASIC RANGE" HIGH FIDELITY SPEAKER SYSTEM KIT

This amazing speaker system can fulfill your present needs and still provide for future expansion. Fine hi-fi performance the result of using high quality speakers in an enclosure especially designed for them. Features two Jensen speakers to cover 50 to 12,000 CPS within ± 5 db. Power rating is 25 watts, and impedance is 16 ohms. Enclosure constructed of veneer-surfaced plywood, ½" thick, and measures 11½" H x 23" W x 11¾" D. Precut and predrilled for quick assembly.

Model SS-2
$39.95

Shpg. Wt. 26 lbs.

HEATHKIT RANGE EXTENDING HIGH FIDELITY SPEAKER SYSTEM KIT

Designed especially for use with SS-2 "Basic" system. Contains 15" woofer and compression-type super tweeter. Extends basic unit to 35—16,000 CPS, ± 5 db. Impedance 16 ohms. Measures 29" H x 23" W x 17½" D, and is constructed of ¾" veneer-surfaced plywood.

Model SS-1B
$99.95

Shpg. Wt. 80 lbs.

HEATHKIT A-9C HIGH FIDELITY AMPLIFIER KIT

This model incorporates its own power supply and preamplifier. Plenty of power with full 20 watt rating. Four separate inputs, selected by panel-mounted switch, and separate bass and treble controls. Ideal for home or PA applications. Output transformer tapped at 4, 8, 16 or 500 ohms. Response within ± 1 db from 20 to 20,000 CPS.

Shpg. Wt. 23 lbs.

Model A-9C
$35.50

HEATHKIT HIGH FIDELITY FM TUNER KIT

Now you can have full-fidelity FM performance from 88 to 108 mc at reasonable cost. Features temperature-compensated oscillator—built in power supply, and beautiful cabinet. Components prealigned at factory!

Shpg. Wt. 8 lbs.

Model FM-3A
$25.95
(with cabinet)

HEATHKIT BROADBAND AM TUNER KIT

Tunes standard AM band from 550 to 1600 kc with fine sensitivity and broadband characteristics. Features include built-in power supply and low-distortion detector. All RF circuits prealigned for simplified construction.

Shpg. Wt. 9 lbs.

Model BC-1A
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(with cabinet)

HEATHKIT "MASTER CONTROL" HI-FI PREAMPLIFIER KIT

Provides extra amplification, selection of inputs, volume and tone controls, and turnover and rolloff controls, for Williamson-type amplifiers. Beautiful satin-gold enamel cabinet. Derives operating power from amplifier.

Shpg. Wt. 7 lbs.

Model WA-P2
$19.75
(with cabinet)

HEATHKIT 25-WATT HIGH FIDELITY AMPLIFIER KIT

Outstanding 25-watt Williamson-type amplifier employs KT66 tubes and Peerless output transformer, tapped at 4, 8, and 16 ohms. A fine amplifier for the "deluxe" system. WA-P2 preamplifier required for operation. Express only.

Shpg. Wt. 31 lbs.

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Model XR-1L **$34.95**

Model XR-1P **$29.95**

Note: Prices are with cabinet less batteries.

HEATHKIT MODEL XR-1P TRANSISTOR PORTABLE RADIO KIT

This easy to build transistor radio is designed for lifetime operation. Features 6 name-brand (Texas Instrument) transistors for extra good sensitivity and selectivity. A 4" x 6" speaker for "big set" tone, built-in rod-type antenna, and uses 6 standard size "D" flashlight cells for extremely long battery life (between 500 and 1,000 hours). Cabinet is two-tone blue molded plastic with pull-out carrying handle. Measures 9" L. x 7" H. x 3¼" D. Transformers are prealigned eliminating special alignment equipment. Shpg. Wt. 6 lbs.

MODEL XR-1L: Identical to XR-1P except in leather case. Carrying strap included. Shpg. Wt. 7 lbs.

HEATHKIT BROADCAST BAND RADIO KIT

Covers 550 to 1600 kc with good sensitivity and selectivity. Has 5½" PM speaker for good tone quality. Features transformer power supply and built-in antenna. Signal generator recommended for alignment. Cabinet, as shown, available separately. Shpg. Wt. 10 lbs.

Model BR-2 **$18.95** *(less cabinet)*

HEATHKIT CRYSTAL RADIO KIT

Features a sealed germanium diode to eliminate critical "cats whisker" adjustment. Employs two tuning condensers for good selectivity, and covers the broadcast band from 540 to 1600 kc. Requires no external power. Kit price includes headphones. Shpg. Wt. 3 lbs.

Model CR-1 **$7.95**

HEATHKIT ENLARGER TIMER KIT

The dial of this handy timer covers 0 to one minute calibrated in five-second gradations, so that the timing cycle of a photographic enlarger can be electronically controlled. Built-in relay handles up to 350 watts, and enlarger merely plugs into receptacle of front panel. Also provision for plugging in safe-light. An easy-to-build device that makes a fine addition to any dark room. Shpg. Wt 3 lbs.

Model ET-1 **$11.50**

TABLE-MODEL RADIO

CRYSTAL RADIO

ENLARGER TIMER

HEATHKIT FUEL VAPOR DETECTOR KIT

The FD-1 is a safety device to detect fuel vapor in the engine compartment or other sections of your boat. The detector unit mounts in the area to be checked, and the indicating meter and controls mount on the control panel. Will operate intermittently or continuously, and indicates dangers of fire or explosion to protect your boat and its passengers. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from boat batteries. Kit even includes spare detector unit. Shpg. Wt. 4 lbs.

6-volt FD-1-6, 12-vt. FD-1-12

$35.95 each

HEATHKIT RF POWER METER KIT

This handy device measures the RF field in the vicinity of a transmitter, whether it be marine, mobile, fixed, etc. Requires no electricity, nor direct connection to the transmitter. Provides a continuing indication of transmitter operation. Merely place it in proximity to the transmitter antenna and it will produce a reading on its 200 ua panel meter when the transmitter is in use. Operates with any transmitter between 100 kc and 250 mc. Includes a sensitivity control for meter. Shpg. Wt. 2 lbs.

Model PM-1

$14.95

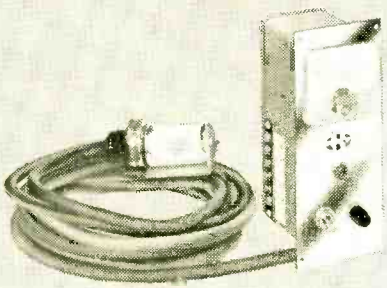
HEATHKIT TRANSISTOR RADIO DIRECTION-FINDER KIT

The Heathkit Transistor Radio Direction-Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit.) The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 4 lbs.

Model DF-1

$54.95

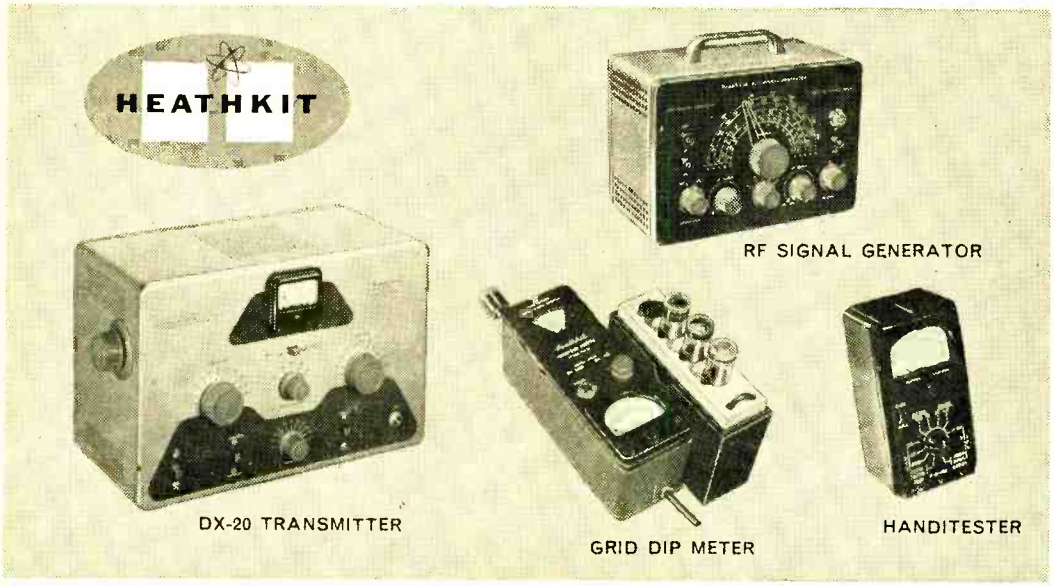
NEW! Heathkits for the boating enthusiast



FUEL VAPOR DETECTOR

RADIO DIRECTION-FINDER

POWER METER



HEATHKIT DX-20 CW TRANSMITTER KIT

This Heathkit straight-CW transmitter is one of the most efficient rigs available today. It is ideal for the novice, and even for the advanced-class CW operator. It employs a 6DQ6A tube in the 50-watt final amplifier circuit, a 6CL6 oscillator and a 5U4GB rectifier. Single-knob band switching covers 80, 40, 20, 15, 11, and 10 meters. The DX-20 is designed for crystal excitation, but may be excited by an external VFO. Pi network output circuit is employed to match antenna impedances between 50 and 1000 ohms.

Model DX-20

Shpg. Wt. 19 lbs. **$35.95**

HEATHKIT GRID DIP METER KIT

An instrument of many uses for the ham, experimenter, or service technician. Useful in locating parasitics, neutralizing, determining resonant frequencies, etc. Covers 2 mc to 250 mc with prewound coils. Use to beat against unknown frequencies, or as absorption-type wave meter.

Model GD-1B

Shpg. Wt. 4 lbs. **$21.95**

HEATHKIT RF SIGNAL GENERATOR KIT

Produces rf signals from 160 kc to 110 mc on fundamentals on five bands, and covers 110 mc to 220 mc on calibrated harmonics. Output may be pure rf, rf modulated at 400 CPS, or audio at 400 CPS. Prealigned coils eliminate the need for calibration after completion.

Model SG-8

Shpg. Wt. 8 lbs. **$19.50**

HEATHKIT HANDITESTER KIT

Measures AC or DC voltage at 0—10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 and 0-300,000 ohms. Sensitivity is 1000 ohms/volt. Features small size and rugged construction in sleek black bakelite case.

Model M-1

Shpg. Wt. 3 lbs. **$17.95**

HEATHKIT ETCHED-CIRCUIT VTVM KIT

Sensitivity and reliability are combined in the V-7A. It features 1% precision resistors, large 4½" panel meter, and etched circuit board. AC (RMS) and DC voltage ranges are 0—1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC ranges are 0—4, 14, 40, 140, 400, 1400 and 4000 volts. X1, X10, X100, X10k, X100k, and X1 megohm.

Model V-7A

Shpg. Wt. 7 lbs. **$24.50**

HEATHKIT ALL-BAND RADIO KIT

This receiver covers 550 kc to 30 mc in four bands, and is ideal for the short wave listener or beginning amateur. It provides good sensitivity and selectivity, combined with good image projection. Amateur bands clearly marked on the illuminated dial scale. Employs transformer-type power supply—electrical band spread—antenna trimmer—separate rf and af gain controls—noise limiter and headphone jack. Built-in BFO for CW reception. Cabinet, as shown, available separately.

Model AR-3

Shpg. Wt. 12 lbs. **$29.95**

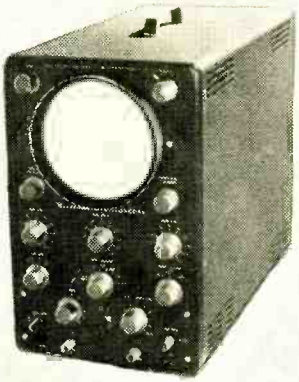
(less cabinet)

HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

This oscilloscope sells for less than the previous model, yet incorporates features for improved performance. The OM-2 provides wider vertical frequency response, extended sweep generator coverage, and increased stability. Vertical channel is essentially flat to over 1 mc. Sweep generator functions from 20 CPS to over 150 kc. Amplifiers are push-pull, and modern etched circuits are employed in critical parts of the design. A 5BP1 cathode ray tube is used. The scope features external or internal sweep and sync, 1-volt peak-to-peak reference voltage, three-position step attenuated input, and many other "extras."

Model OM-2

Shpg. Wt. 22 lbs. **$39.95**



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VACUUM TUBE VOLTMETER

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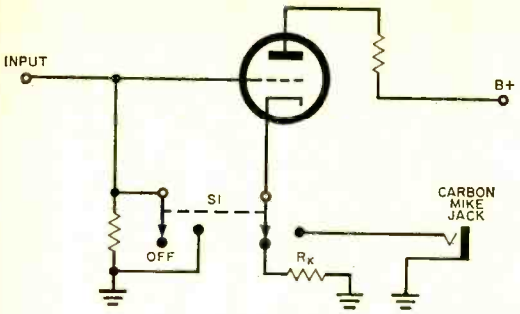


Carbon Mike Input Circuit

That old carbon mike can be put to use without batteries and matching transformers. The secret is to connect the mike in parallel with the cathode resistor (*Rk*) of a grounded-grid input amplifier. However, if the amplifier's cathode resistor should be larger than 100 ohms, it is better to use the carbon mike itself as the cathode resistor.

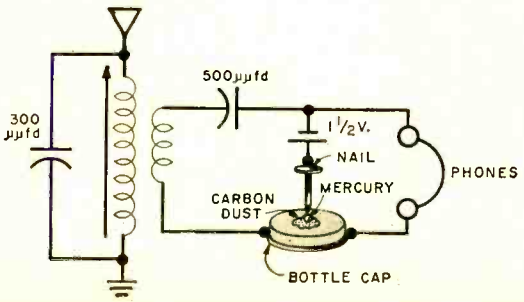
The schematic above shows how a d.p.d.t. switch can be wired into the first stage of an amplifier so that the amplifier can be used with a carbon mike or a conventional input device. When the switch is in the "on" position, the mike will be connected into the cathode circuit. The grid circuit will be grounded, which will permit more gain and less distortion. Remember, the plate current of the tube will pass through the mike—so be sure the mike and connecting cable are well insulated.

—Glenn Towill

Homemade Detector

You can substitute this home-brew detector for a store-bought diode in a crystal radio. First scrape the paint from the top of a bottle cap. Remove the carbon stem from a flashlight battery and scrape a small pile of it on the top of the bottle cap. In the center of the carbon dust, place a small drop of mercury, being careful not to let the mercury touch the metal bottle cap. Make contact to the mercury with a common straight pin or small nail. A 1½-volt flashlight battery is then connected as shown. If the nail or pin is slightly rusty, you will have two rectifying surfaces, one between the carbon and the bottle cap and one between the rust and the nail itself. The tuning circuit can be any standard arrangement.

—Maynard Kernahan



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Rondine—the Hysteresis Line...Engineered for the Studio...designed for the home!

Only Your Ears Are Golden

(*Continued from page* 68)

them is concerned, he must flip a coin. This test, by the way, was conducted in a typical living room. Loudspeakers do sound *different*. Whether one is *superior* to another can only be determined by the ear of the person judging it.

What CU Tested. Out of more than 500 speakers and systems on the market, *CU* tested 31. This small sampling, of course, does not in itself reflect on the value of *CU*'s findings, but it does seem rather presumptious of *CU* to make recommendations without having checked at least a major part of the speakers available.

Out of all the tweeters on the market, *CU* tested only *four* and proceeded to make recommendations on the basis of this incredibly limited range of selection. *CU* rated a low-cost Japanese electrostatic tweeter better than two of the most expensive tweeters on the market. Without going into the merits of this particular tweeter (it may be quite excellent), it is perhaps unseemly for *CU* to go so far "overboard" on it that they refer to it no less than 16 times in the text of the article.

Systems vs. Speakers. *CU* climbs onto an unsteady limb when it says, ". . . none of the separate speakers tested even when optimally enclosed could provide the kind of transparent sound and depth of undistorted bass demanded of a high-fidelity loudspeaker."

In the first place, what does *CU* mean by "optimally enclosed"? We assume that they used the manufacturer's recommended enclosure for each speaker. If so, it is indeed strange that this very vital information is not given in the discussion that accompanies each of the tested speakers. We would think that somewhere in the discussion there would appear something like, "Tested in Enclosure #703 (manufacturer's recommendation for this speaker)." Unless the manufacturers recommendations *were* followed, it is certainly unfair to compare separate speakers with speaker systems.

The editors of POPULAR ELECTRONICS are of the opinion that, because of the complexity of sound, as well as of the human ear, no standards (no matter how complete or thorough) can tell YOU what you will enjoy best. The speaker system you should buy is one that, after careful listening, sounds best to YOU. —30—

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ELECTRONICS HAS GOOD PAYING JOBS FOR *TRAINED* MEN!

And only *trained* men can fill them. You can get your share, if you take time now to gain that indispensable technical knowledge.

> Many of the men currently on the street are there for a reason. "As many as 8 out of 10 are deadwood," estimates the chief engineer of a medium-sized Philadelphia firm; the problem is to find the live ones.
>
> —From ELECTRONICS MAGAZINE

If you're interested in an honest-to-goodness career in the vigorous young electronics industry, here's how you can step ahead of job-competition, move up to a better job, earn more money, AND BE SURE OF HOLDING YOUR TECHNICAL JOB, EVEN WHEN THE "DEADWOOD" IS BEING CLEANED OUT.

Sure you have some experience. But the fellows with only partial technical knowledge move slowly, or stand still while you—the man with advanced technical training—plunge ahead in the golden world of electronics opportunities.

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Use spare-time hobby hours for CREI Home Study as thousands of successful technicians have done since 1927. Get concentrated training in minimum time, then step into a good job and enjoy good pay in the mushrooming electronics industry. CREI courses are being studied *today* on the DEW Line in the Antarctic—in Alamagordo and in Munich—by electronics experts in guided missile development and by telemetering technicians on the missile ranges.

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Thousands of men *before* you have benefited quickly from CREI Home Study training. Thousands of CREI graduates are now employed in industry here and abroad. Here is what one graduate has to say:

"In the time of less than two years, I have almost doubled my salary and have gone from wire-man to engineering assistant and now to junior engineer. I have CREI to thank."

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AUTOMATION AND INDUSTRIAL ELECTRONICS ENGINEERING TECHNOLOGY
Complete course on automation. Special emphasis on theory, functioning, and applications of servomechanisms and computers. Lessons on machine control, instrumentation, data-processing, telemetry, etc.

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70 TUBULAR CONDENSERS Paper, molded, oil, pore. .0002 to .5mf. to 1000V. 2 lbs. Reg. $14. **88¢**

2 VARI-LOOPSTICKS Adj. 540-1500 Kcs. Transistor radios, etc. 1 lb. **88¢**

2 TRANSISTOR IF'S Double-tuned. Only ½" square. 456 kcs. **88¢**

60 SUB-MINI RESISTORS ¼" long. 20 values: 1/5W to 10 megs. Reg. $6. **88¢**

5-IN-1 DRILL BIT Reams, saws, shapes, drills, copes. Fits hand or electric drill. **88¢**

30 MOLDED CONDENSERS Asstd. Finest made! Wt. 2 lbs. **88¢**

1500 PCS. HARDWARE Nuts, screws, washers, etc. 1½ lbs. Reg. $6. **88¢**

20 CAMEL HAIR BRUSHES 100% pure bristle, sizes 1-6. Reg. $2.50. **88¢**

100 HALF-WATTERS Asstd. value carbon resistors, incl. 5%! Reg. $12. **88¢**

WIRE STRIPPER Strips & cuts hook up wire, sizes No. 16 thru No. 22. Wt. 1 lb. **88¢**

70 HI-Q RESISTORS Carbon, IRC, Ohmite, 1%, too! ½, 1 & 2 W; 10 ohms to 10 megs. 2 lbs. Reg. $13. **88¢**

2 MIKE TRANSFORMERS Carbon. Imp. 100 to 100K ohms. Leads, encased. 2 lbs. Reg. $10. **88¢**

70 ONE-WATTERS Asstd. value carbon resistors. 5%, too! **88¢**

4 SUB-MINI VARIABLES Condensers, ½" sq., 1" long shaft. For transistor, sub-mini work. Wt. 1 lb. Reg. $8. **88¢**

0 TO 60 MIN. TIMER For darkroom, lab, shop, kitchen. Loud alarm. 2 lbs. Reg. $6. **88¢**

10 AC/DC LINE CORDS 6 ft. long; rubber, plastic. For appliances, motors, etc. 3 lbs. Reg. $5. **88¢**

20 PILOT LITES 6 V. Mini bayonet; for panels, radios, etc. **88¢**

100 HALF-WATTERS Asstd. value carbon resistors, incl. 5%. Reg. $12. **88¢**

7 ROLLS WIRE 25 ft. each. #18 thru #22. Asstd. insulation, stranding, colors. 2 lbs. Reg. $5. **88¢**

10 ELECTROLYTICS Radio, TV. 10-500 mf to 450 VDC. 3 lbs. Reg. $12. **88¢**

4 POWER WOOD BITS Hi-Q steel, ¾, ½, ¾ & 1". For drills, presses. 5" long. Reg. $3. **88¢**

FILAMENT TRANSFORMER 115/1/60 cycles to 6.3 VCT @ 1.5A. 2 lbs. Reg. $4. **88¢**

5 ROLLS MICRO WIRE Sizes 24 thru 32; for transistor & sub-mini circuits. 1 lb. **88¢**

15 VOLUME CONTROLS incl. duals; some w/switch. To 1 meg. 2 lbs. Reg. $12. **88¢**

MINI-METER 0-6 Amps. AC. 1¾" dia. 1 lb. Reg. $3. **88¢**

40 SUB-MINI CONDENSERS For transistor, printed circuit work. 1 lb. Reg. $7. **88¢**

10 RCA PLUG-N-JACK SETS, matched; most pop. amps, tuners, phonos. Wt. 1 lb. Reg. $2.50. **88¢**

10 TUBULAR ELECTROS Asstd. paper types. AC, DC. hobby. Wt. 3 lbs. Reg. $15. **88¢**

0-15 VAC MINI-METER 1¾" dia. Hundreds of shop uses. 1 lb. Reg. $3.50. **88¢**

TWO N-P-N TRANSISTORS Found in hundreds of radios. $5 value! Top make. **88¢**

5" HOBBY SPEAKER For radios, code osc., etc. Matches 2500 ohms. Wt. 2 lbs. Reg. $5. **88¢**

15 INSTRUMENT KNOBS Brass inserts w/set-screws. E-Z grip, pointer, black bakelite. Wt. 1 lb. Reg. $5. **88¢**

6-PC. HACKSAW SET Asstd. blades. Shop must! Wt. 1 lb. $2.50 value. **88¢**

75-FT. TV TWINLEAD 300-ohm. Flanked, tinned. Wt. 2 lbs. Reg. $4.50. **88¢**

HEARING-AID PHONE Crystal, w/cord set-N-plug. Hundreds of hobby uses. Reg. $5. **88¢**

100 RADIO PARTS Wide variety. 25 types—resistors, condensers, forms, pot. Wt. 3 lbs. $15 value. **88¢**

60 PLUGS-N-RECEPTACLES Audio, power, line, battery, spkr. Wt. 3 lbs. Reg. $7. **88¢**

300-FT. HOOKUP WIRE Tinned, asstd. sizes, colors. 2 lbs. Reg. $5. **88¢**

60-PC. CONDENSER SPECIAL! Molded, paper, ceramic, oil, mica, discs, variable. 2 lbs. **88¢**

75-PC. RESISTOR SPECIAL! WW, precision, carbon, variable, mini types. 3 lbs. Worth $15. **88¢**

20 PRINTED CIRCUITS Built-in RC circuits, incl. integrals. 1 lb. Reg. $7. **88¢**

POSTAGE STAMP MIKE Crystal, 100 to 8,000 cycles-per-sec. 1 lb. Reg. $7. **88¢**

HOBBY BENCH VISE Clamp type, fits tables, too. Steel. 1 lb. **88¢**

40 HI-Q CONDENSERS Finest porcelain; NPO's too! 1 lb. Reg. $6. **88¢**

TV PIC BOOSTER Parallel, 6-wire. Extends picture tube life. 1 lb. **88¢**

6 SILICON DIODES Sylvania 1N22, 1N23. Reg. $36. **88¢**

8 TRANSISTOR SOCKETS Mica-filled; for sub-mini tubes, too. **88¢**

3 AC-DC CHOKES for power supplies. 50 to 200 ma. Open frame. 3 lbs. Reg. $9. **88¢**

4 TRANSISTOR OSC. COILS for printed circuit, transistor portables. Reg. $5. **88¢**

SUN BATTERY Similar famed B2M. 1" long. Reg. $2.50. **88¢**

2 P-N-P TRANSISTORS Popular make. Hundreds of uses. $5 value! **88¢**

TEN 3-SECOND TIMER mechanisms. Precision geared. 2 lbs. Reg. $30. **88¢**

10 PANEL SWITCHES Asstd. 115 VAC, power, multi-circuit & SPST, DPST, DPDT. 2 lbs. Reg. $5. **88¢**

15 ROTARY SWITCHES Asstd. gangs. 3 lbs. Reg. $12. **88¢**

70 TERMINAL STRIPS Solder lug & binding; to 20 terminals. 2 lbs. **88¢**

65 COILS, CHOKES IF, RF, ant., slug-tuned, too. 3 lbs. Reg. $15. **88¢**

15-PC TWIST DRILL SET 1/16" thru ¼" by 64ths, w/calibrated case. Reg. $3. **88¢**

75 MICA CONDENSERS .00025 to .01 to 1200 V; silver, too. 25 values. Reg. $28. **88¢**

60 KNOBS, RADIO, TV Asstd. colors, insulation. Some worth $1 ea. 2 lbs. Reg. $17. **88¢**

4 OUTPUT TRANSFORMERS 501.6, etc. 3 lbs. Reg. $8. **88¢**

SYLVANIA TV MIRROR 10 x 12" stainless steel. 2 lbs. Reg. $4. **88¢**

35 POWER RESISTORS WW, 5 to 50 W, to 10,000 ohms. Vitreous incl. 3 lbs. Reg. $15. **88¢**

8-PC. NUTDRIVER SET $3 value. Plastic handle; 3/16" x 7/16" socket wrenches. 1 lb. **88¢**

$25 SURPRISE PACK! Large, varied assortment radio, TV parts. 3 lbs. **88¢**

8 SCREWDRIVERS & RACK Asstd. screwdrivers w/plastic handles; wall rack. 1 lb. List. $3.50. **88¢**

WORLD'S SMALLEST RADIO 2 x 1 x 1". Kit includes loopstick, jacks, diode, etc., w/ instructions. 1 lb. Reg. $3. **88¢**

HOW TO ORDER: ORDER BY "BLACK TYPE" HEADLINES, i.e. 150 CERAMIC CONDENSERS, 89¢

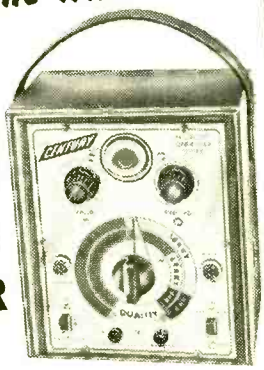
State price with each item. Send check or M.O. including sufficient postage; excess returned. C.O.D. orders, 25% down; rated, net 30 days. INCLUDE POSTAL ZONE in address. (Canada postage, 48¢, 1st lb.; 28¢ ea. addl. lb.)

LEKTRON 131-133 EVERETT AVE. CHELSEA 50, MASS.

SHIPPED ON APPROVAL

an IN-CIRCUIT CONDENSER TESTER *THAT DOES THE WHOLE JOB!*

The CT-1 actually steps in and takes over where all other in-circuit condenser testers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.



IN-CIRCUIT CONDENSER TESTER Model CT-1

Model CT-1 — housed in sturdy hammertone finish steel case complete with test leads only **$34.50** Net

in-circuit checks:

- Quality of over 80% of all condensers even with circuit shunt resistance present . . .(leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of 100% of all condensers . . .(leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale precision readings for both quality and value . . .(in-circuit or out of circuit)
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line

Check all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc. with the

IN-CIRCUIT RECTIFIER TESTER Model SRT-1

Model SRT-1—housed in sturdy hammertone finish steel case complete with test leads.....only **$29.50** Net

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF-CIRCUIT WITH 100% EFFECTIVENESS FOR:

✓ Quality ✓ Fading ✓ Shorts ✓ Opens ✓ Arcing ✓ Life Expectancy

OUTSTANDING FEATURES

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

SIMPLE TO OPERATE

Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales . . .

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

TRANSITOR TESTER Model TT-2

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors go bad the need for TRANSISTOR TESTER is great. They can develop excessive leakage, poor gain, shorts or opens. The TT-2 is an inexpensive quality instrument designed for accurate and dependable tests of all transistors and diodes — quickly and accurately.

OUTSTANDING FEATURES

- Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for current gain, leakage, opens, shorts, cut-off current
- Checks all diodes for forward to reverse current gain
- All tests can be made even if manufacturers' rated gain is not available
- Less than half a minute required for tests of either transistors or diodes
- Large 3" meter is extremely sensitive yet rugged . . . designed for quick easy readings with multi-color scales
- Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads
- Cannot burn-out its own meter or damage transistor or diode under test
- Long test leads and insulated test clips enable tests without entirely removing transistor from circuit
- Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured
- Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

Model TT-2 — housed in sturdy hammertone finish steel case complete with test leads . . . only **$24.50** Net

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished at no cost.

EASY TO BUY IF SATISFIED *see order form on facing page*

FOR 10 DAY *FREE* TRIAL

try them for 10 days before you buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . .

STILL THE BEST SELLING TUBE TESTER IN THE FIELD

FAST-CHECK TUBE TESTER

Model FC-2

The greatest testimonial ever paid an instrument . . . over 20,000 sold in a little more than a year—and still selling as fast as we can produce them. See for yourself at no risk why so many servicemen choose the FAST-CHECK above all other tube testers — regardless of price.

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter . . . only **$69.50** Net

SIZE: W: 14⅝" H: 11¼" D: 4⅜"

Just 2 settings on the FAST-CHECK TUBE TESTER tests over 700 tube types completely, accurately — AND IN SECONDS!

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

No other tube tester made at any price can match the value of the FAST-CHECK.

RANGE OF OPERATION

- ✓ Checks quality of over 700 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

IMPORTANT FEATURES

• No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers • No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement • Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale • 41 phosphor bronze beryllium tube sockets never need replacement • 7-pin and 9-pin straighteners mounted on panel • Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out • Special scale on meter for low current tubes • Compensation for line voltage variation • 12 filament positions • Separate gas and short jewel indicators • Line isolated — no shock hazards • Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

NEW . . . For those looking for a real *ECONOMY* MULTIPLE SOCKET TUBE TESTER without sacrificing *ACCURACY, SPEED and VERSATILITY*

MINI-CHECK TUBE TESTER

Model MC-1

Here is a multiple socket tube tester designed to meet limited budgets. Although low in price it boasts a unique circuitry that enables you to check over 600 tube types — and has a range of operation that far exceeds others in its price class.

Model MC-1 — housed in sturdy wrinkle finish steel case ..... only **$39.50** Net

SIZE: W: 9" H: 8½" D: 2¾"

OUTSTANDING FEATURES

• Checks emission, inter-element shorts and leakage of over 600 tube types. This covers OZ4s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 settings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principle • 3½" D'Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long lasting phosphor bronze tube sockets • Combination gas and short jewel indicator • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

plus these BONUS FEATURES . . . found in no other low price tube tester

✓ Checks for cathode to heater shorts ✓ Checks for gas content ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section ✓ Line isolated — no shock hazard ✓ Variable load control enables you to get accurate results on all tubes ✓ Positively cannot become obsolete as new tube types are introduced.

CONVENIENT TIME PAYMENT PLAN — NO INTEREST OR FINANCING CHARGES

CENTURY ELECTRONICS CO., INC.

111 Roosevelt Avenue, Dept. 302, Mineola, New York

CHECK INSTRUMENTS DESIRED

- ☐ Model CT-1 In-Circuit Condenser Tester.....$34.50 $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester.....$29.50 $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester.....$24.50 $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester.....$69.50 $14.50 within 10 days. Balance $11 monthly for 5 months.
- ☐ Model MC-1 Mini-Check Tube Tester.....$39.50 $9.50 within 10 days. Balance $6 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is undestood there will be NO INTEREST or FINANCING charges added.

Name .....

Please print clearly

Address .....

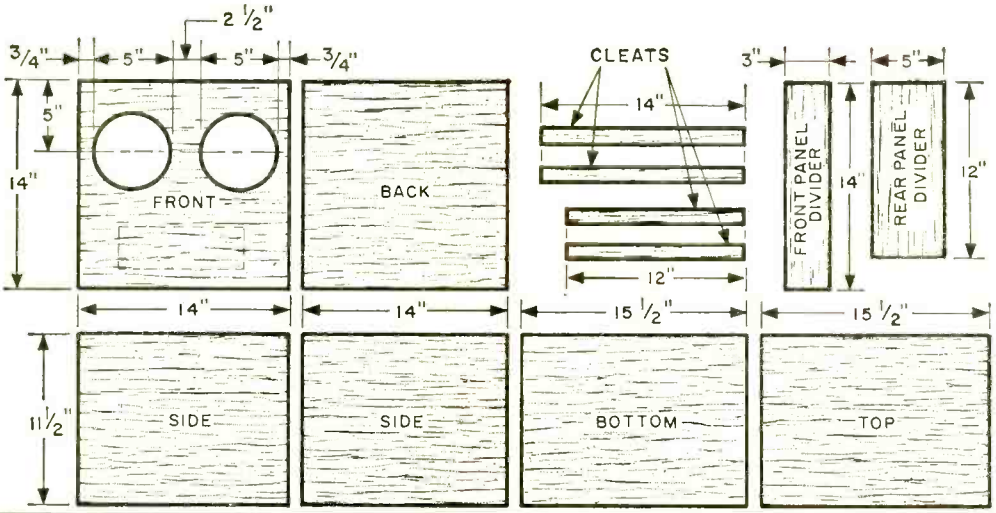
City ..... **State** .....

Duo-Flex Speaker System

(*Continued from page* 78)

(which in the case of the Duo-Flex is about 90 cycles) there is minimum output from the speaker and maximum from the port. Total output of the system remains constant, however, until the system rolls off at about 45-50 cycles. The surprisingly clean tone at 40 cycles testifies to the effectiveness of the bass-reflex design.

The over-all impression of the Duo-Flex, as confirmed by several qualified listeners, is one of clean sound with a clarity in the bass hard to believe considering the size of the system. When you take into account its total cost (under $15.00), the Duo-Flex's performance is really astonishing. —30—



As a former serviceman, your skill could be valuable to the U.S. Air Force. If so, the Air Force has an important job and a guaranteed future waiting for you in this new Age of Space. You'll work with the most modern equipment and learn the newest techniques of your specialty. And don't forget: your previous service counts toward rank, pay and retirement income. Talk it over with your local Air Force Recruiter, or mail the coupon.

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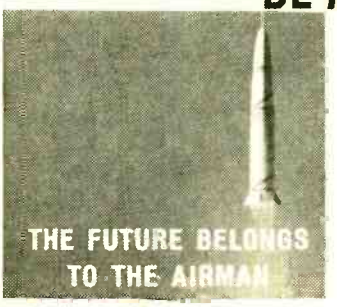
BE A SPECIALIST IN THE U.S. AIR FORCE



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products

(*Continued from page* 34)

monaural applications. Available factory-wired for $99.50, the Stereo 20-20 may also be obtained in kit form for $69.50. (*Acro Products Co.*, 369 Shurs Lane, Philadelphia 28, Pa.)

AUTOMATIC AUTO ALARM

The "Police Auto Alarm" attaches to the inside of your car's hood and sets off your horn when anyone tries to tamper with any part of your car. Easily wired into 6- or 12-volt systems, the alarm stops automatically when tampering is halted. Price, $9.95 postpaid. An optional on-off key switch can be mounted on the outside of the car. Price, $2.50. (*Gregory Sales Co.*, 316 Marion Bldg., Cleveland 13, Ohio.)

After Class

(*Continued from page* 74)

the center and, *making sure that the protective resistor switch is open,* tap the key while you watch the meter. The deflection will probably be large. Now slide the prod along the wire in the direction that causes the deflection to decrease. If you have to go to either end of the slide wire before reach-

Answers to Electronic Sticklers

on page 86

1. Both of Mr. Buzz's bells will ring continuously when the switches are not closed.

2. Joe had better go out and get a d.p.d.t. switch quick. When he forgets to throw switch Y at the same time he throws switch X, the fuses will start popping.

3. Look closely! All 100-ohm resistors are in parallel. It would be better if Harold replaced this mixed-up network with a 25-ohm resistor.

4. Harold found this one too tough to work out. He cheated by using an ohmmeter—the meter read 83.3 ohms.

If you know of a tricky Electronic Stickler, send it to the editors of POPULAR ELECTRONICS. If it is accepted, we will send you a $5 check. Write each Stickler you would like to submit on the back of a postcard. Submit as many postcards as you like but, please, just one Stickler per postcard. Send to: POPULAR ELECTRONICS STICKLERS, One Park Ave., New York 16, N. Y. Sorry, but we will not be able to return unused Sticklers.

48¢ ea. for any tube

$45.00 Per Hundred

STANDARD LINE ELECTRIC COMPANY

FREE POSTAGE IN U.S.A. & TERRITORIES

FREE TUBE BRIGHTENER ON ORDERS OF $10.00 OR MORE

ANNOUNCING OUR NEW PRICE SCHEDULE

Effective July 25, 1958 all tubes (Radio & Television receiving) will be sold and shipped at the fantastic price of only .48c ea. or $45.00 per hundred. Any "on hand" orders at that time will receive credit for future purchases.

THE TUBES ADVERTISED HEREIN ARE NOT NECESSARILY NEW TUBES BUT MAY BE ELECTRICALLY PERFECT FACTORY SECONDS OR USED TUBES AND ARE SO MARKED

All TV, & Radio Tubes are tested by our supplier under actual conditions in Radio & TV chassis or in Hickock Tube Testers Model 533A.

And, of course, the famous Standard Line guarantee remains in effect: All tubes guaranteed to be replaced free if they fail to function efficiently within one year's time. (defective tubes must be returned intact, postage paid. Refunds will be cheerfully made within five (5) days if not completely satisfied.)

0B2	3AL5	5V6GT	6BE6	6S4	7F7	12Q7	32L7GT
0Z4	3AU6	5W4GT	6BF5	6S8GT	7F8	12SA7	35/51
1A5GT	3AV6	5X4G	6BG6G	6SA7	7G7	12SG7	35A5
1A7GT	3BA6	5X8	6BH6	6S87Y	7H7	12SJ7	35B5
1B3GT	3BC5	5Y3GT	6BH8	6SC7	7J7	12SK7	35C5
1C5GT	3BE6	5Y4G	6BJ6	6SF5	7K7	12SN7GT	35L6GT
1C6	3BN6	5Z3	6BK5	6SF765GT	7L7	12SQ7	35W4
1C7	3BU8	5Z4	6BK7	6SH7	7N7	12SR7	35Y4
1H4G	3BY6	6A8	6BL7GT	6SJ7	7Q7	12V6GT	35Z4GT
1N5GT	3BZ6	6AB4	6BN6	6SK7	7R7	12W6GT	35Z5GT
1I6	3C2	6AC7	6BQ6GT	6SL7GT	7S7	12X4	#37
1LA4	3CB6	6AF4	6BQ7	6SN7GT	7V7	17Z3	#39/44
1LA6	3CF6	6AG5	6BR8	6SQ7	7W7	14A7	#41
1LB4	3CS6	6AG7	6BS8	6SR7	7X6	14AF7	#42
1LC5	3DT6	6AH4GT	6BY5G	6T4	7X7	14B6	#43
1LC6	3Q4	6AH6	6BZ6	6T8	7Y4	14F7	#45
1LH4	3Q5GT	6AK5	6BZ7	6U4GT	7Z4	14F8	#47
1LN5	3S4	6AK6	6C4	6U5	8AW8	14H7	50A5
1N5GT	3V4	6AL5	6C5	6U8	12A8	14N7	50B5
1P5GT	4BC8	6AL7GT	6CB5	6V3	12AB5	14Q7	50C5
1Q5GT	4BQ7A	6AM8	6CB6	6V6GT	12AQ5	1457	50C6G
1R5	4B58	6AN8	6CD6G	6W4GT	12AT6	17AX4GT	50L6GT
1S5	4BU8	6AQ5	6CF6	6W6GT	12AT7	17DQ6	50Y6
1T4	4BZ7	6AQ6	6CG7	6X4	12AU6	19AU4	50Y7
1T5GT	4CB6	6AQ7GT	6CG8	6X5GT	12AU7	19BG6G	#57
1U4	5AM8	6AR5	6CH8	6X8	12AV6	19C8	#58
1U5	5AN8	6AS5	6CL6	6Y6G	12AV7	19J6	#80
1V	5AQ5	6AS8	6CM6	7A4	12AX4GT	19T8	#81
1V2	5AS8	6AT6	6CM7	7A5	12AX7	19X8	117L7GT
1X2	5AT8	6AU4GT	6CN7	7A6	12AZ7	25AC5	117N7GT
2A3	5AV8	6AU5GT	6CU6	7A7	12B4	25AV5GT	117P7GT
2A5	5AW4	6AU6	6DG6	7A8	12BA6	25AX4GT	117Z3
2A7	5AZ4	6AU8	6DQ6	7B4	12BE6	25BK5	117Z4GT
2AF4A	5BK7	6AV5GT	6DT6	7B5	12BF6	25BQ6	117Z6GT
2B7	5BR8	6AV6	6E5	7B6	12BH7	25CD6G	807
2BN4	5BQ7	6AW8	6H6	7B7	12BK5	25CU6	9002
2D21	5BZ7	6AX4GT	6J4	7B8	12BQ6	25L6GT	9003
2E5	5CG8	6AX5GT	6J5	7C4	12BR7	25W4GT	9006
2X2A	5J6	6AZ8	6J6	7C5	12CA5	25Z5	
3A2	5T8	6BA6	6K6GT	7C6	12CU6	25Z6	
3A3	5U8	6BC5	6K7	7C7	12DQ6	#27	
3A4	5U4G	6BC8	6L6	7E6	12J5	#30	
3A5	5V4G	6BD6	6L7	7E7	12L6GT	#31	

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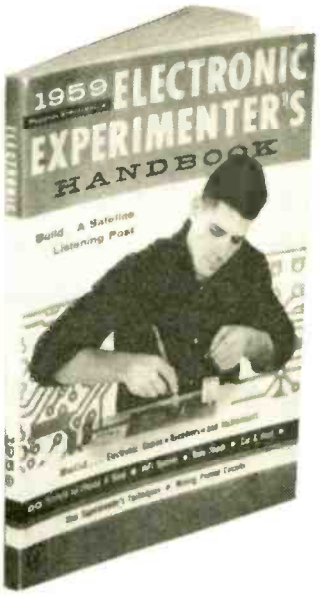

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ing zero, *R2* has been incorrectly selected—try another value.

When you finally obtain a zero reading with the test prod at least 3" away from an end of the wire, close the knife switch (this short-circuits the protective resistor) and again tap the key. The instrument will now be very sensitive, so inch your way along the wire until you again obtain zero deflection. Note the length AD (*R3*) and DC (*R4*) on the yardstick; then merely substitute in the last equation and solve for the value of *Rx*.

For example, let's say that an unknown resistor of about 10,000 ohms is to be measured. *R2* is chosen as 10,000 ohms (1%) and the slide-wire bridge manipulated until the galvanometer shows balance. Length AD turns out to be 46.4 centimeters on the meter stick. Hence, length DC must be 53.6 cm. since one meter contains 100 cm. Thus:

$$Rx = R2 \times R3/R4$$

$$Rx = 10{,}000 \times 46.4/53.6$$

$$Rx = 8660 \text{ ohms} \pm 1\%$$

The Wheatstone bridge principle is not limited to simple resistance measurements. In modified form, it can be used for determining unknown capacitances and inductances, for measuring gain of electron tubes (in the form of a Miller bridge), detection of leakage in insulation, and many other important applications. A modified Wheatstone bridge, the series resistance-capacitance bridge, will be described in *After Class* in the March issue. —30—

Like a Technician's Job?

(*Continued from page* 80)

cians may find themselves dealing with company presidents as well as people walking in off the street. They must be able to meet, converse, and associate with people at all levels.

Q. Do your technicians supervise other people?

A. Yes. In fact, leadership qualities are very important. We're looking for people who can supervise a whole maintenance group. Our technicians should eventually be able to handle all situations which arise. A technician is sometimes under heavy pressure. To test his ability in this field, we

may ask him "How would you react if—?" Then we describe various situations which could arise, and analyze his response to these problems.

Q. At what age level are your technicians?

A. The average age is 24. We have men as young as 20 and men well past 40. Age is not the important thing. It's a man's ability that counts. Attitude is most important. We like the person who's looking five years ahead rather than to immediate salary benefits. We like people with the initiative and the ability to plan their lives several years in advance.

Q. In general, what do you think is the future for careers in the computer field?

A. To enter electronics via the large scale computer field is difficult—only one man in fifteen interviewed by our department is hired. Those who make it, however, are well seated in the golden chair of opportunity. This is a young industry and will grow enormously, along with the computer technicians who are the backbone of it. Challenge, opportunity, security, satisfaction, and prestige are all part of the package available. —30—

Inside the Preamplifier

(*Continued from page* 49)

supplies almost invariably have some means of balancing out, or otherwise minimizing, the hum from the filament circuit. The most common means is the use of a hum-balancing potentiometer as indicated in Fig. 2(A). If the two halves of the tube filament circuit are exactly balanced, the hum will be largely cancelled out.

A better way to minimize hum is to apply a positive bias to the filaments. This is done by tapping off, with a voltage divider, about 35 volts of the B+ voltage supply and applying it to the slider on the hum-balancing potentiometer. Biasing provides an additional improvement over that yielded by hum balancing alone.

In integrated amplifiers, where the output tubes are on the same chassis as the preamplifier, you'll frequently come across the circuit shown in Fig. 2(B). Here, the bias developed across the cathode resistor of the output tubes is used as a convenient source of the 20-30 volt d.c. bias.

When a magnetic pickup of medium sensitivity—about 10 millivolts—is to be used, the preamplifier should have at least a hum-

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

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THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, etc.

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

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

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."

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

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balancing control. When the pickup sensitivity is less than 5 millivolts, a d.c. filament supply is to be preferred.

Tube noise is not as great a problem as hum except when the very insensitive pickups are used. However, many of the very finest pickups are rather insensitive. This is particularly true of magnetic stereo cartridges. To reduce tube noise, some preamps use special low-noise tubes such as the 12AD7, the Z729 or, more recently, the

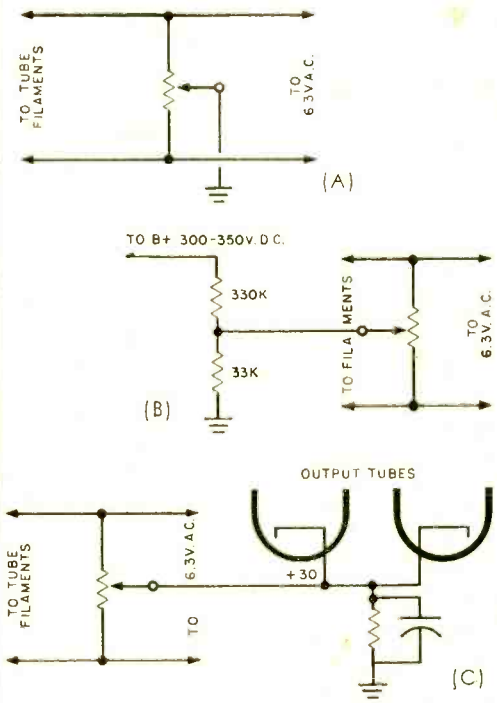


Fig. 2. Three common techniques of hum reduction: (A) balancing potentiometer is connected across the preamp filament supply; (B) B-plus voltage divider applies positive voltage to the preamp filaments; (C) bias developed across cathode resistor of output tubes is applied to the preamp filaments.

EF86. Even when 12AX7's are used, they are specially selected for low noise.

The flow of current through a resistor can also produce thermal noise, and if it occurs in the first stage, it can become annoying. For this reason, the better preamps use special low-noise type resistors in the first stage and sometimes in several stages.

On this note, we leave the first function of the preamplifier/control unit and next month we will move on to the problems of *equalization*. —30—

Transistor Topics

(*Continued from page* 88)

should be a half-wave long at the desired operating frequency.

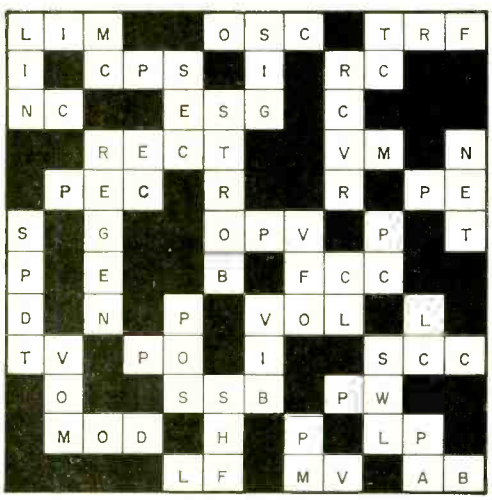
In operation, signals picked up by the tuned antenna are detected by the 1N34A diode. The resulting audio signal is coupled through a pair of r.f. chokes (*RFC1* and *2*) and through d.c. blocking capacitor *C1* to the base-emitter circuit of a single-stage common-emitter audio amplifier. *RFC1* and *RFC2* serve to isolate the antenna system.

The amplified output signal drives a set of standard magnetic earphones. Operating power is supplied by a single penlight cell (*B1*), with the transistor's base bias current supplied through *R1*.

All parts are standard and wiring is not especially critical. For best results, connect the 1N34A diode right across the antenna terminals and the chokes close to these terminals. For slightly more gain, replace *B1* with a 3-volt battery, readjusting *R1*'s value for optimum performance . . . Bob suggests a value of 1 megohm.

Since a half-wave antenna is awkwardly long at broadcast-band and lower frequencies (close to 500 feet at 1000 kc.), this circuit is best suited for operation in the short-wave bands. For v.h.f. operation, for example, you can use a pair of TV "rabbit ears" as an antenna.

Sun Batteries. The International Rectifier Corporation (El Segundo, Calif.) has developed silicon solar cells having conversion *efficiencies of 10% and higher*. The



Solution to puzzle which appears on page 72.

high efficiency is obtained, in part, by minimizing the series resistance between a cell's active area and its electrical contact surfaces. This is achieved with new alloying techniques which permanently bond the contact to the silicon wafer, thus making the contact an integral part of the cell itself, although still allowing individual cells to be soldered. Available for both commercial and military applications, these new cells can provide an output of approximately *9 watts* per square foot of active cell area in bright sunlight. Detailed data are given in Bulletin SR-275, available from the manufacturer.

On the application front, a well-known ham operator, K6LMW, has made a 2000-mile voice contact on the 10-meter band using a transmitter powered by a bank of 72 silicon solar cells. They provided ample power for the rig's 75-milliwatt output.

Still in the development stage are solar cells capable of functioning at ambient temperatures up to 750°C, as contrasted to an upper limit of 300°C for conventional silicon cells. These cells utilize cadmium sulfide and were developed under a research contract awarded by ARCD's Wright Air Development Center.

Overseas News. From France comes news of a semiconductor device which, at some future date, may offer a challenge to the transistor. Termed the "Tecnetron," this is a field effect device consisting of a type *n* germanium rod with an electrode at each end; an indium ring in a groove in the rod serves as the control electrode. According to early tests, the unit can operate at frequencies of from 500 to 1000 mc. with outputs up to several watts.

Velectra, of Bienne, Switzerland, has developed and is manufacturing a transistorized audio amplifier capable of delivering 45 watts when powered by a 12.6-volt battery. Intended for the hi-fi enthusiast, the unit weighs only eight pounds, measures 7½" x 4½" x 5½", and can operate on supply voltages of from 3 to 15 volts. Its distortion is less than 3% at 25-watt output.

In Tokyo, Japan, the Sony Corporation is now producing a fully transistorized AM/FM portable receiver. It uses 15 transistors, is powered by four standard flashlight cells, and weighs only 5½ pounds.

New Products. A series of 50-volt metalized paper capacitors intended specifically for transistor circuit applications has been introduced by the Aerovox Corporation

(New Bedford, Mass.). Constructed in tubular metal cases with glass terminal seals, they are designed to assure maximum service life as well as provide a substantial reduction in case sizes.

General Electric (Schenectady 5, N. Y.) is now producing a heavy-duty industrial photo-relay. Permitting up to 300 operations per minute, the "Transeye" is fully transistorized, and may be used for counting, inspecting, over-travel control, level maintenance, safety control, and similar commercial and industrial applications.

Development of a high-power, high-frequency transistor has been announced by the Bendix Aviation Corporation. Known as the DAP (Diffused Alloy Power) transistor, this unit has a power gain five to ten times greater and switching speeds three to five times faster than standard alloy types. Experimental units can handle as much as 5000 watts (5 kilowatts!) in switching applications.

That's it for now. See you next month . . .

Lou

My Misguided Missile

(*Continued from page* 67)

ing steadily into the clouds until only a fading trail of smoke indicated its progress.

"That gizmo yours, buddy?" demanded the burlier of the two officers.

"Yes, sir," I admitted. "You see, I—"

"LOOK OUT, FRED!" shouted the thinner of the two officers, "HERE IT COMES!"

Horrified, we jerked our heads around, in unison, to see the Komet coming straight across the flats at us, about ten feet above the ground!

"Eek!" chirped the wife.

"Everybody!" yelled Fred, *"on the ground!"*

We bit the dust. The Komet streaked past with a weird shriek of air-slashing sound. Then it was gone again. Cautiously, we raised our heads.

"Can't you *control* that thing?" demanded Fred.

"Nope." I shook my head sadly. "The transmitter is busted. I fell on it when—"

"HERE IT COMES AGAIN, FRED!" yawped the other officer.

I didn't need a slide rule to tell me that if the Komet stayed on its course across the flats it was going to come whamming right

---

into the police car. Morbidly fascinated, I watched it flash toward the vehicle, murderously skimming three feet above the ground.

"Hey, the thing's gonna—" began Fred.

"I *win*," murmured the wife.

The Komet landed neatly, horribly on target. It was almost fantastic to see how much tearing, rending damage it wrought as it plowed noisily into the police car. One wouldn't dream that sixty-five pounds of aluminum and assorted metal components could accomplish that much damage—even at high speed.

We stumbled to our feet, stunned.

"Well," growled Fred ominously, "we can still use *your* car."

"Be my guests," I said in a hollow voice.

They graciously accepted the invitation.

EXACTLY three days later, I shambled up before the stern-faced, dignified old gentleman sitting behind the judicial bench. He finished reading the written details of the report given orally by the officers a few moments earlier. Then he pinned a pair of icy eyes on me.

"I wouldn't actually say this entire, outrageous matter smacks of sabotage," he stated generously, "but it comes mighty close to it. What have *you* to say?"

Painfully I cleared my throat.

Out of the corner of my eye I could see the wife sitting tensely with her purse clutched tightly in her hands . . . the purse containing the assumed amount of the fine, as advised by local legal talent . . . veritably a life's savings.

I cleared my throat again.

"Y-Your Honor," I said, allowing a twisted smile of mingled shame and courage to play across my lips, "Your Honor, I can explain everything."

And I did, too.

Almost. —30—

Among the Novice Hams

(*Continued from page* 90)

physically unable to travel, you can apply for a *Conditional Class* license, which grants the same privileges as the General Class license, but is issued by mail in the same manner as the Novice and Technician Class licenses.

It is not necessary to start your amateur career with a Novice license. If you can pass one of the other examinations, you can immediately obtain a higher class license.

But don't underestimate what you can do with a Novice license. Many Novices make thousands of contacts in all states and many foreign countries with their Novice licenses and equipment. In fact, most of them continue to use their Novice equipment after they become Generals.

Obtaining Your License. Undoubtedly, the best single source of information on exactly how to obtain an amateur license in the United States is the packet of booklets entitled "Gateway To Amateur Radio," published by the American Radio Relay League, Inc. The packet contains three booklets, "How To Become A Radio Amateur," "How To Learn The Radiotelegraph Code," and "The Radio Amateur's License Manual," plus a smaller pamphlet on operating an amateur station. It is available for $1.50, postpaid, from such amateur supply houses as Allied Radio, Burstein-Applebee, Lafayette Radio, Radio Shack, World Radio Labs., etc.

The information contained in this packet is sufficient to permit passing the Novice written examination without additional study material, although a text on electronic fundamentals will clarify many points that might otherwise be confusing. And such a text is needed to understand the questions and answers in the General/Conditional/Technician study guide in the License Manual. An excellent text of this type is "Amateur Radio Theory Course," by Martin Schwartz, published by American Electronics Co. (AMECO), and available for $3.95, postpaid, from most of the amateur supply houses.

Learning the Code. The secret of learning the radiotelegraph code with the least effort is to learn it by sound from the very start. This is best done with the aid of an experienced code man who will introduce the code characters one at a time with the aid of a key and code oscillator, repeating

each one over and over until you recognize and write down the corresponding letter, number, or other symbol immediately.

Next to having a private tutor, the best way to learn the code is with the aid of a code course recorded on phonograph records, recording tape, or on punched paper tape to be used on a special code machine, such as an "Instructograph," which can be purchased outright or rented.

Once you have memorized the code sounds, the only way to acquire receiving speed is daily practice in copying code sent at a speed slightly faster than you can handle perfectly. One way to obtain this practice is with a communications receiver tuned to the amateur code bands. A Novice license allows you to work stations while building up your speed to the General level.

You may not believe it, but time spent trying to learn to send code before you can *copy well* is largely wasted.

BUILDING A Q-MULTIPLIER

With this issue, each *Among The Novice Hams* will contain construction or modification details for equipment useful around the ham shack. Our first project will be a Q-Multiplier. Your contributions are invited.

Adding a Q-Multiplier to an inexpensive amateur receiver makes it possible to copy signals which would otherwise be buried by interference. On page 90 is a diagram of a Q-Multiplier designed for use with receivers with 450-to-470-kc. i.f. channels.

Experience has shown that the "null" function of conventional Q-Multipliers is seldom used with receivers of low selectivity; therefore, we have simplified the circuit by omitting this function. The unit fits nicely in a 2¼" x 2¼" x 5" "Minibox," and parts arrangement is not critical.

To place the Q-Multiplier in operation, connect its output lead to the plate terminal of the receiver mixer (converter) tube or to the control grid terminal of the first i.f. tube. Use RG-58A/U cable and keep it as short as possible. If the leads are very short, you might be able to do without shielding.

When used in conjunction with a receiver utilizing a transformer-type power supply, plate and filament power for the Q-Multiplier can be obtained from the "accessory" socket or from the filament and screen terminals of the receiver's output tube socket. If the receiver employs 12-volt tubes, sub-

stitute a 12-volt tube, such as a 12J5, or use half of a 12AU7A for the 6C4.

The Q-Multiplier can be operated with most a.c./d.c. receivers if powered by a separate transformer-operated supply capable of furnishing about 250 volts, d.c., at a few milliamperes, and 6.3 volts at 0.15 amperes. Connect the case of the Q-Multiplier to the external ground terminal of the receiver and to a good external ground for safety.

To adjust, tune in a steady signal on the receiver with the Q-Multiplier off, then advance potentiometer *R2* to almost its full clockwise position and set the variable capacitor to half mesh. Now, adjust the slug in the Q-Multiplier coil (*L1*) for maximum received signal strength, which should occur with the slug about half in.

As the slug is adjusted, the Q-Multiplier may break into sustained oscillation, evidenced by the receiver suddenly going dead or emitting a steady squeal. If this occurs, turn back the variable resistor as necessary while peaking the slug.

In operation, variable capacitor *C1* is used to "fine-tune" received signals, and *R2* controls selectivity, which is maximum when *R2* is set just below the oscillation point.

News and Views

John Ruiter, KN7COT, Yuma, Arizona, uses a WRL Globe Chief 90A transmitter and a Hallicrafters S-85 receiver. In three months, Johnny has worked 31 states, Mexico, the Panama Canal Zone, and a couple of Canadians. He offers to schedule anyone needing an Arizona contact. Unfortunately, the picture of Johnny's station that he sent us was damaged in the mail, but I hope to obtain a duplicate for next month. . . . **Lloyd J. Peterman, KN9DPJ,** Route 4, Sturgeon Bay, Wis., made his first contact with KN3DII, and he now has eight states worked. Lloyd feeds his Heathkit DX-40 into an 80-meter doublet on 80, 40, and 15 meters. As might be expected, it does not do too well on 40 meters, but he runs 75 watts on 80 and 15. He receives on a Heathkit AR-3 with a Q-Multiplier added to it. . . . **Sanford Hutson, K5QHS,** Box 27, Stuttgart, Ark., has now received his General Class license after working 19 states, all confirmed, as a Novice. San should have his new Heathkit DX-100B together and operating by the time he reads this. He still offers to sked anyone needing Arkansas.

Elton Harper, KN4YWY, 2303 Division St., Jacksonville, Fla., claims "15 was dead when I got my license, so I started slow." In spite of his slow start, he has worked 29 states and five foreign countries, mostly on 15 and a few on 40. Elton's best DX is Japan. His equipment includes a Globe Chief 90A transmitter and a Hammarlund HQ-100 receiver. . . . A

HELP US OBTAIN OUR HAM LICENSES

K1/W1 CALL AREA

Greg Hoisington (15), 12 Fifth Ave., Westover Air Force Base, Mass. (Code, theory, regulations and selection of equipment)

George Cleveland, 24 Fairfield St., Newtonville 60, Mass. (Theory, regulations and selection of equipment)

A/3c Lavert A. Henley, AF19561742, Box 468, Tuslog Det. #3, APO 324, New York, N. Y. (Theory, regulations and selection of equipment)

Howard Feldman, 49 Western Promenade, Auburn, Mass. (Code and theory)

Dana Bennett (12), 40 Waldo Leahy, Townsend, Mass. Phone: 166. (Selection of equipment)

Ernest Richards, Round Pond, Me. Phone: LA 9-2135. (Code and theory)

Geraldine Vanoni, 80 Joseph St., Torrington, Conn. (Code and theory)

K2/W2 CALL AREA

Ted Picker, 113 Brighton Ave., Perth Amboy, N. J. (Code)

Abraham Wagner, 132 E. Hazeltine Ave., Kenmore 17, N. Y. (Code, theory and regulations)

Bob Allen, 8 Gary Rd., Syosset, N. Y. (Theory and selection of equipment)

Martin Halofsky, 2230 62nd St., Brooklyn 4, N. Y. Phone: CL 9-3463. (Code and theory)

George Levy, 2845 W. 29th St., Brooklyn 24, N. Y. (Code, theory and regulations)

Edward V. Daly (14), 462 Eastlake Ave., Massapequa Park, L. I., N. Y. (Theory)

Richard A. Mattner, 240 Carroll St., Brooklyn 81, N. Y. (Code, theory and regulations)

George Bornemann (14), Box 174, Tillson, N. Y. (Code, theory and selection of equipment)

K3/W3 CALL AREA

Robert Eckert, 356 E. South St., Wilkes Barre, Pa. (Code, theory and regulations)

K4/W4 CALL AREA

Charles W. Fentress III, 531 Washington Park, Norfolk, Va. Phone: MA 5-4101. (Theory, regulations and selection of equipment)

Jimmy Foust (15), 108 Virginia Way, Pensacola, Fla. (Code, theory and regulations)

David Gerns (14), 511 Farr Ave., Fairfax, Va. (Code and selection of equipment)

Delbert Greear, P. O. Box 235, Helen, White County, Ga. (Code, theory and regulations)

Jerry Evans, 19540 N.W. 8th Ave., North Miami 69, Fla. Phone: NA 1-7904. (Theory)

K5/W5 CALL AREA

Donald E. Johnson, Box 57, Newhebron, Miss. (Code, theory, regulations and selection of equipment)

Jimmy Winkler, R. #1, Cane Hill, Ark. (Code, theory, regulations and selection of equipment)

John A. Unsicker, 132 W. Okla. St., Walters, Okla. (Code, theory, regulations and selection of equipment)

John Paul Kana (14), P. O. Box 834, Weimar, Tex. Phone: 385J. (Code, theory, regulations and selection of equipment)

Oran Neck, 36 Rentfro Blvd., Brownsville, Tex. Phone: LI 2-7521. (Code, theory, regulations and selection of equipment)

Kenneth Dobbs, 7819 Fir St., Houston 12, Tex. (Code, theory, regulations and selection of equipment)

Kenneth Cornett (18), R. #1, Box 119, Yukon, Okla. (Code, theory and regulations)

Morris E. Wickliffe (14), 512 Walnut St., Benton, Ark. (Code, theory and selection of equipment)

K6/W6 CALL AREA

L. W. Strimpel, 6817 Matilija Ave., Van Nuys, Calif. (Code, theory and regulations)

Don Anderson, 1623 Noe St., San Francisco 14, Calif. Phone: MI 8-0139. (Code and selection of equipment)

John Fred Palmer, 119 East Vista Ave., Daly City, Calif. Phone: PL 6-6780. (Code, theory, and regulations)

John V. Guy, YMCA, 715 S. Hope St., Los Angeles, Calif. Phone: MA 7-4751. (Code, theory and selection of equipment)

Patrick A. Crittenden (15), 352½ E. 236th St., Wilmington, Calif. (Code, theory, regulations and selection of equipment)

K7/W7 CALL AREA

Phillip A. Laine, 3715 N. Main, N. Las Vegas, Nev. (Code, theory and regulations)

Douglas Schroeder, 1212 Darmak, Las Vegas, Nev. Phone: DU 2-6659. (Code, theory and selection of equipment)

John Johnson, W. 2518 Olympic, Spokane, Wash. Phone: FA 5-0549. (Code and theory)

Dieter Kaetel (17), 3251 Belvidere Ave., Seattle 6, Wash. Phone: WE 7-8962. (Code, theory and selection of equipment)

K8/W8 CALL AREA

Paul Davis, 1634 Betz Dr., Akron 6, Ohio. (Code and theory)

Dave Rochat, 118 S. Main St., Chagrin Falls, Ohio. (Theory and regulations)

James Sharpe, 3222 Harry Lee Lane, Cincinnati 39, Ohio. (Code, theory and selection of equipment)

Louis H. Swart, 1544 Hollywood N. E., Warren, Ohio. (Code and theory)

Jerome Nemeth, 9144 Lane, Detroit 9, Mich. Phone: VI 3-0136. (Code, theory, regulations and selection of equipment)

Roger Smith (14), 4777 Furney St., Holt, Mich. Phone: OX 4-2632. (Code and theory)

Richard Silverman, 16159 Indiana, Detroit 21, Mich. Phone: UN 1-8427. (General theory)

James R. Hurayt, 3329 Roehl Ave., Cleveland 9, Ohio. Phone: ON 1-4637. (Code, theory, regulations and selection of equipment)

Xavier F. Turchetta (14), 4444 West 35th St., Cleveland 9, Ohio. Phone: SH 1-1044. (Code, theory and selection of equipment)

K9/W9 CALL AREA

Michael Traham, 4817 N. Kimball, Chicago 25, Ill. Phone: IN 3-8908. (Code, theory, regulations and selection of equipment)

Tom Wendt (29), 3754 S. Iowa Ave., Milwaukee 7, Wis. Phone: HU 3-4620. (Code and theory)

David Daniels, 701 N. Jefferson, Salem, Ill. (Code, theory and selection of equipment)

Mike Friduss, 8109 S. Jeffery, Chicago 17, Ill. Phone: SA 1-2299. (Code, theory, regulations and selection of equipment)

KØ/WØ CALL AREA

Larry Phillips (16), 411 No. West Ave., Bolivar, Mo. Phone: FA 6-4574. (Code)

Mike Schwendeman, Box 165, Benson 3, Minn. (Code, theory, regulations and selection of equipment)

John Resing, 2755 N. Meridian, Wichita 4, Kans. (Code and theory)

Robert Fram, 3230 W. Owasso Blvd., St. Paul 12, Minn. (Code)

Fred R. Welter (14), Maysville, Mo. Phone: 143-4. (Code, theory and selection of equipment)

VE AND OTHERS

Gene Hussack, Lynn Lake Amateur Radio Club, Lynn Lake, Manitoba, Canada. (Theory and regulations)

Gary Helferty, 345 Mary St., Oshawa, Ontario, Canada. (Theory)

Terry J. Tod, 143 Lanside St., Winnipeg 1, Manitoba, Canada. (Code, theory and regulations)

little help sometimes makes a big difference. In seven months on the air, **Dennis Perry, KN6JEN** (13), 8207 Concord, Fontana, Calif., had made only two contacts. Then, with the help of W6RID and KN6PJS, he put up a 40-meter "long wire," and made 96 contacts in a week and a half. After that, he went on 15 meters and worked 14 states with his DX-40 transmitter and Hallicrafters SX-71 receiver. . . . **Jerry LeBow, KN2SMC** (13), 52 Seneca Ave., White Plains, N. Y., has quite an unusual QSL card, which he tries to send to everyone he works. Jerry usually sticks to 40 meters, where he runs 60 watts to a DX-40 to chase r.f. up the feedline of his 40-meter dipole. He receives with a Hallicrafters S-38E. Jerry offers to help prospective hams.

Joe Veras, KN9OCO, 1373 Russell St., Green Bay, Wis., likes 15 meters best. In a month and a half on the air, his Johnson Adventurer transmitter, "long wire" antenna and RME-45 receiver have worked eight states, with five confirmed. Joe's pet peeve is an operator who promises to QSL, acknowledges your address, and never sends the card. . . . **Peter Guidi, WV2BMB** (15), P. O. Box 64, Croton Falls, N. Y., operates on 40 meters, except when the interference drives him to 80 meters. Pete made about 120 contacts in 24 states his first five weeks on the air, using a Globe Chief 90A transmitter at 75 watts, a 40-meter folded dipole about 20' high, and an AR-3 receiver backed up with a Q-Multiplier. Pete plans on trying 15 meters as soon as he builds a "preselector" (r.f. amplifier) for his receiver. . . . The report from **Jim George, K8JPV** (16), 911 N. Walker St., Princeton, W. Va., took so long to reach me that Jim will probably be surprised to see it here. In four and a half months on the air, his Heathkit DX-20 and Hallicrafters S-38C receiver have racked up 1042 contacts in 41 states and a bunch of foreign countries. He works 40 meters most but drops to 20 meters to work DX—one advantage of being a "General." Check with Jim if you need West Virginia.

Gary L. Emory, KN3DPA (14), RFD 5, Towanda, Pa., works 80 and 40 meters at times, but 15 meters is his favorite. He uses a Knight transmitter running 50 watts and receives with an S-38E. His 15-meter antenna is the "Demi-Quad" described in POPULAR ELECTRONICS in January, 1958. It works well, as attested by an RST599 report from England and an RST589 from Spain. His states-worked total is 33, 29 confirmed, in five months on the air. . . . **K4RJM,** 404 Dakota St., Piedmont, Ala., agrees with K2TSW (November "News And Views") that the antenna has much to do with the success of any ham station, but he argues that the main factor is the operator. Give one ham a 50-watt transmitter and a moderate-priced receiver, and he might work 48 states and 50 countries, while another ham might do well to work 10 states with the same equipment. K4RJM also offers to help prospective hams.

How about sending in a picture of your station and news of your activities for next month? Also, how about a contribution for our new section? 73,

Herb, W9EGQ

Short-Wave Report

(*Continued from page* 83)

Afghanistan—*R. Kabul's* new 6005-kc. outlet is believed to operate from 0730 s/on to 1230-1300 s/off. On the half-hour a clock strikes local time. Local news in Pushtu is given at 0830-0840, world and domestic news in Pushtu at 1000 and 1100. The Eng. program is timed for 1200. It is not known at the moment whether this new outlet is replacing or paralleling the 18,634-kc. outlet. (*377,488*)

Algeria—Algiers has returned to 11,835 kc. from 11,715 kc. and is noted at 1100-1715. (*100*)

Angola—CR6SF, Luanda, is heard well on 17,795 kc. at 1605-1730 in Portuguese, dual to the 4955-kc. outlet. (*59, 100*)

Belgium—ORU, the *International Goodwill Station,* Brussels, has taken over for *World's Fair Radio* (which has been dropped) and is sponsoring the Eng. segment at 1930 on 11,850, 9745, and 9655 kc. (*420*)

British Guiana—*R. Demerara,* Georgetown, is noted daily with good signals on 5981 kc. at 0411 s/on with Eng. program summary. A Hindi language program is heard at 0415-0420 with Eng. returning at 0420. (*353*)

Burma—Rangoon can be tuned on 9640 kc. at times and rarely on 15,365 and 11,764 kc. with Eng. news after Korea s/off on 9640 kc. at 1000. Noted to 1015 with weak signals and occasional heavy QRM. (*353*)

Cambodia (Indochina)—*Radiodiffusion Nationale Khmere,* Phnompenh, has been noted on 7185 kc., weak, with Eng. news at 0800. The 6090-kc. outlet is heard from 0915 to 1000 s/off with French language program. QRM from Luxembourg mars the latter xmsn. (*166, 488*)

Cape Verde Islands—CR4AC, *Radio Barlavento,* St. Vincente of Cabo Verde, 3960 kc., is tuned at 1730 with Portuguese news, 1745 with music to fade-out. (*MS*)

Ceylon—The Commercial Service of *Radio Ceylon,* Colombo, 15,265 kc., is usually heard well at 2030-2130 in English. This is an early-morning (Ceylon time) musical program with pop records and commercials. (*BJ*)

Chile—A new station is *R. Diego Portales,* Talca, on 6020 kc. with 10-kw. power, scheduled at 0700-0000. (*465*)

China—The latest schedule for *R. Peking* gives the Eastern N.A. beam at 2030-2130 on 11,820 and 15,095 kc. Channels for the Western N.A. program are 11,975 and 15,115 kc. but no times were given; try for it at 2230-2330. Another xmsn, believed to be beamed to Europe, is noted in Eng. at 1445-1515. (*RG, 420*)

The *China Press Agency,* Peking, 12,124 kc., was tuned at 1715 with a woman giving dictation-speed news in native language. Heard to past 1815, no parallel channel found. (*166*)

Comores Island—*R. Comoro,* Dzaoudzi, 7340 kc., is scheduled Sundays only at 0700-0830. Further details are still lacking. (*363*)

Costa Rica—Here is a partial list of Eng. and German xmsns for TIFC, *The Lighthouse of the Caribbean,* San Jose: in German at 0730-0745 Sundays and at 0000-0015 Mondays; in Eng. at 1500-1600 Sundays, 2200-2300 Sundays and Mondays, and 2300-0000 daily. All xmsns are on 9647, 6037, and medium-wave 995 kc. (*378*)

Cuba—COCO, Havana, is again active on 9531 kc. and is heard at 0700 s/on. (*100*)

According to the Short-Wave Editor for the Universal Radio DX Club, the Cuban outlet on 2440 kc., COCA, as listed by the *World Radio Handbook,* is definitely not on the air.

England—GSK, London, is now on 26,080 kc. and is scheduled at 0915-1315 to N.A., replacing 21,660 kc. (*100*)

Ecuador—Widely heard and reported, the *Voice of the Andes,* HCJB, Quito, now maintains the following schedule: 15,115, 11,915, 9745 and 6050 kc. to the Americas (except Tuesday) at 0000-0015 in Russian, 0015-0030 in Spanish, 0030-0130 in German, and to South Pacific at 0130-0500 except Tuesday and Sunday in English; 11,915 and 9745 kc. to South Pacific at 0430-0500 Sundays in Swedish, 0500-0530 except Tuesday in Russian, 0530-0600 except Tuesday in English; 17,890, 15,115 and 11,915 kc. to the Americas at 0900-1000 except Monday in English, 1000-1030 Saturdays in German, 1000-1100 Sundays in German, 1100-1200 Saturdays in Russian, and to Europe (except Monday at 1400-1530 in English, 1530-1600 in French, 1600-1630 in Swedish, 1630-1700 in Spanish, 1700-1730 in Russian, 1730-1800 in German; 15,115 and 11,915 kc. to the Caribbean at 1830-1900 except Monday in English; 15,115, 11,915 and 9745 kc. to the Americas at 2100-0000 except Monday in English. (*378, 403*)

Fiji Islands—VRH4, Suva, can be tuned on 3980 kc. in Western areas at 0500-0530 with concert music; Eng. ID at 0500. Xmsn closed at 0530. (*61A*)

French Somaliland—*R. Djibouti,* 4780 kc., has extended its schedule and now closes daily at 1545. French programs begin at 1500 with news. Signature is "La Marseillaise." (*488*)

Germany—*Deutsche Welle,* Cologne, can be noted on 21,725 kc. testing a new xmtr at 0930-1230, dual to 17,875 and 21,490 kc. Eng. news is at 1035. (*100, 473*)

The daily evening xmsn at 2130-2140 has been extended to 2150 on 9640 and 11,795 kc. Eng. news is at 2130. German/English language lessons are presented at 2140-2150 on Mondays and Thursdays (beginners) and Tuesdays and Fridays (advanced). Reports go to *Deutsche Welle,* Koln, Funkhaus WDR, Box 239, Cologne, Germany. (*TM, VM, JS, 100, 386, 473, 482, 483, 501*)

Haiti—*R. Commerce,* Port-au-Prince, has been found on 17,954 kc. with a religious program at 1745-1815. All French, this xmsn was also noted later on the 6099-kc. outlet. (*44*)

India—*All India Radio* has recently been noted on 6190 kc. at 0720 with Indian music but fade-out by 0750, and on 9675 kc. at 0715-0730 with Eng. news. (*166, 226*)

Iraq—Baghdad's Foreign Service recently shifted from 6188 kc. to 6030 kc. and is now scheduled as follows: 0800, change from Arabic Home Service; 0800-1200, Kurdish (also on 3297 kc.); 1200-1230, Urdu (sometimes on 3297 kc.); 1230-1300, Persian; 1300-1330, Turkish; 1330-1400, French; 1400-1430, German; 1430-1500, English; 1500-1600, relay of Arabic Home Service, dual to 7180 kc. (*488*)

Japan—Tokyo has opened 21,620 kc. for improved reception to N.A. at 1800-1900 and

operates with 17,855 kc. The new channel replaces 15,325 kc. (*26, 44, 100, 240, 383*)

Laos—Vientiane, identifying as *Radiodiffusion Nationale Lao,* on 6130 kc., is noted from 0800 to 0845/close, with French to 0820 and then Laotian. It closes with a march presumed to be the Laotian Anthem. (*488*)

Lebanon—The Anti-Shamun Clandestine station on 8220 kc. has been noted at 0000 with Arabic. The Phalangist-controlled *Voice of Lebanon* on 6580 kc. and the *Voice of Free Lebanon,* 6028 and 12,000 kc., have both ceased operations. (*166, 488*)

SHORT-WAVE ABBREVIATIONS

Eng.—English	QRM—Interference
ID—Identification	R.—Radio
IS—Interval signal	s/off—Sign-off
kc.—Kilocycles	s/on—Sign-on
kw.—Kilowatts	xmsn—Transmission
N.A.—North America	xmtr—Transmitter

Liberia—ELWA, Monrovia, 21,510 kc., still carries an Eng. program on Tuesdays at 1800-1945 to N.A. parallel to 15,198 kc. Another Eng. segment is noted Wednesdays at 2000-2145 on 11,980 kc. The latter channel also has a French religious program at 0100. (*RD, 39, 61, 442, 502*)

Mauretania—The French station on 4950 kc. is believed to be Atar and seems to ID as *R. Mauretanie* at 1600 s/on, although this is the slogan used by Saint-Louis on 6045 kc. The former is noted to 1625 with French; the latter 1800-1900 Arabic and Maure. (*336, 488*)

Mexico—XELZZ, Mexico City, 11,860 kc., seems to have changed opening of Eng. program to 2055. (*420*)

A new station is XEWW, Mexico City, on 6165 kc. It is noted at 0645 s/on and during the evenings between breaks in xmsns from Berne, Switzerland. It is parallel to the 9500-kc. station. (*100, 420*)

Netherlands—*R. Nederland,* Hilversum, operates to N.A. at 1615-1655 on 21,480, 17,775, 15,220, and 6025 kc. and at 2130-2210 on 11,730, 9590, and 6025 kc. Program changes: "By Request" is now on Thursdays, and the letter-box program on Tuesdays. Watch for "Hobby Corner." (*386, 401, 502*)

Netherlands New Guinea—*R. Sorong,* 3395 kc., is noted with IS at 0428, opening at 0430 with "The Swedish Rhapsody." Programs in Dutch heard to 0450 fade-out. Very careful tuning is needed for this one! (*61*)

Peru—*R. Loreto,* Iquitos, 9590 kc., is heard at 1900-1930 with American pop records; hymns to 1945; native music to 2000. The language is Spanish. (*61*)

Philippines—The Far East Broadcasting Service, Manila, is noted on 15,385 kc. at 0810-1000, 1600-1700, and 2100-2200, alternating with 11,920 kc. every half-hour. The 50-kw. xmtrs are new, reports wanted. (*377, 400*)

Portugal—CSB52, *R. Renascenca,* Lisbon, 6154 kc., opens at 0331 with news in Portuguese, also noted at 0630 with Spanish songs; the schedule is 0230-0430, 0515-0900, and 1230-1800. CSB51, *R. Clube Portugues,* Parede, 6080 kc., is scheduled at 0200-0500 and 0700-2000. (*MS, 166*)

Seychelles—Maha, 4990 kc., is noted from

1030 to 1118 s/off. News from London is relayed at 1100; local news at 1109. Entire xmsn is in English. (*488*)

Somaliland Protectorate—*R. Hargeisa,* 9666 kc., is noted at 0900-0915 in Somali, Eng. ID 0915, Somali to 1015. News from London at 1100; English portion runs from 1015 to 1118. (*61A, 400, 488*)

South Africa—The South African B/C Corp., Paradys, is noted on 11,897 kc. with an all-Eng. program from 2330; news at 0000; weather at 0045. Other xmsns from Paradys are noted on: 11,936 kc. at 0000, Eng. news 0030; 9680 kc. around 1045 with news at 1100. *Springbok Radio,* Johannesburg, is heard on 9720 kc. in Eng. at 1100, and is dual to a station in the 41-meter band (not heard as yet). (*149, 420, 442*)

Spain—*R. Nacional de Espana,* Madrid, has Eng. to the British Isles and Western Europe daily at 1520-1550 on 9363 and 7100 kc. The third channel, 6130 kc., has not been noted on this xmsn. (*501*)

Switzerland—Berne carries Eng. to England and Ireland at 1515-1530 on 7210 and 9665 kc. English to N.A. is noted at 2030-2215

Unidentified Stations

The following unknown stations are being listed by frequency. If you have information on any of them, please let us know.

3222 kc.—Heard from 0245 to 0300/close in French with French and European-type music. This may be *Radio Lome,* French Togo. (*61*)

3960 kc.—Noted from 1748 to 1800/close with native folk instrumental music in either Portuguese or Spanish (possibly Italian). Off at 1800 with Portuguese anthem. (*61*)

3975 kc.—Noted at 0532-0540 in language with chanting, talks, and music. (*353*)

5850 kc.—Heard from 2000 fade-in to 0000 s/off; a Monday program called "Exitos de la Semana." This is not *La Voz Dominicana.* (*RM*)

6075 kc.—An unknown German-speaking station noted at 0000-0100 under the *Nordwest Runkfunk* station. (*23*)

6100 kc.—Heard at 0600 in Arabic; ID given as "Huna Bahrain." (*26*)

6110 kc.—An Arabic station, closing Sundays at 1830 without ID. Not London but may possibly be Tangier. (*420*)

6124 kc.—Arabic speaker noted from 0115 to 0200/close with Arab talks and music; may be a Clandestine outlet. Also noted at 1500. (*166*)

6135 kc.—A USSR outlet, possibly Moscow, noted from 1600 to 1657/close. News in native at 1600. They close with Red Anthem. (*166*)

6172 kc.—English speaker noted to 1430 s/off. This is *not* Madagascar. They close without anthem after giving short-wave and medium-wave frequencies. (*166*)

6213 kc.—Spanish speaker noted just below Cayenne on 6215 kc. from 1945 with improved signal after 2015. Musical commercial ads, Latin-American music. (*61*)

and 2315-0000 on 6165, 9535, and 11,865 kc. The DX program is on the first Friday of the month at 2050 and 2335; the mailbag is on the first and third Sunday at 2115. (*WC, HO, 378, 403, 487*)

Tahiti—Papeete has been noted at 1630-1705 in French with talks on 11,825 kc. (*353*)

Tangier—*R. Eurafrica*, Tangier, has been testing at times on 9275 and 11,520 kc. at 1715-1800 in Eng., German, French, and Arabic. Reports go to 9 Rue de Russie, Tangier, Morocco. (*61A, 353*)

Turkey—A new station is the National Palance Exhibition Radio in Istanbul on 6750 kc. The schedule is 1000-1600 with recorded music and Turkish announcements. (*488*)

USA—KGEI, San Francisco, has returned to the air on 17,800 kc. with 47.5 hours weekly to Central and South America. Reports go to P.O. Box 15, San Francisco. (*100, 377, 477*)

The Organization of American States carries Spanish on weekdays from 1915 to 1930 s/off over WLWO, Cincinnati, 15,160 kc. French to Haiti may replace the Spanish on Sundays and/or Saturdays. (*JC*)

USSR—Kiev, 11,740 kc., relays Moscow N.A. program from 2030 to 2200 when it switches into Ukrainian. The Kiev IS is given three times at 2030. (*JC*)

Venezuela—YVMW, Punto Fijo, a rarely noted station, was found on 4770 kc. at 2200-2230, regular Latin-American program. (*23*)

A new outlet from Caracas is noted on 15,153 kc. evenings around 2200; station s/off at 2230. (*420*) —30—

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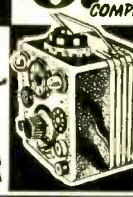

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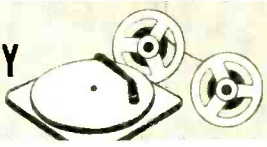

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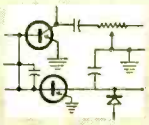

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MADE TO SELL FOR $160 – OFFERED FOR ONLY $47.50 NET

(Much less than cost of Manufacture.)

INDICATES RADIOACTIVITY IN 3 WAYS!

1—BY NEON
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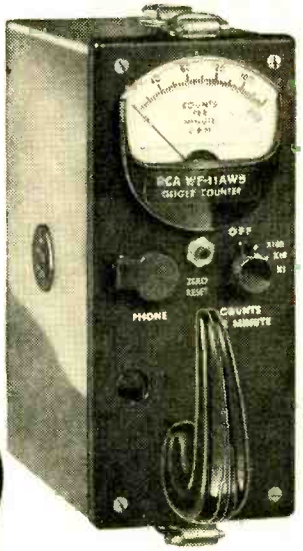

- Employs the extra sensitive 6306 Bismuth Type Geiger Counter tube. Sensitivity is .015 Roentgens per hour (1 MR/HR = 6600 counts per minute).
- Three counting ranges: 0-200/2,000/20,000 counts per minute.
- Handy reset button.
- Ideal for survey work because the complete unit weighs only 5½ lbs.
- Sight and sound indications by neon flashes and headphone. Then when an indication is obtained you switch to meter reading for exact measurements.
- Decontamination easy with damp cloth applied to the weather-proofed aluminum case.
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- Included at no extra charge — U.S. Atomic Energy Commission booklet titled "Prospecting with a Counter."

RADIOACTIVE SPECIMEN

Endless experiments and discoveries in the new exciting field of nuclear energy are made possible when you acquire this finely built and engineered device. In the past, a rugged counter which was suitable for the prospecting of radio-active ores such as uranium, thorium and radium, was unsuitable for laboratory work due to the inability of combining accuracy with ruggedness. Conversely, a laboratory counter, while being extremely sensitive, could not withstand use in the field where it would be subjected to abuse and abnormally hard knocks.

The Model WF-11AWB combines the laboratory and field counter in one rugged instrument. The use of phones and a visible lamp permits the operator greater freedom of operation as he no longer has to keep his eyes on a relatively small indicator.

In the laboratory where determinations of intensity (counts) of a reading are necessary, the WF-11AWB provides sensitivity far surpassing many laboratory counters.

SPECIFICATIONS

Three counting ranges are available:

0-200 counts per minute—used in cosmic ray and extremely low activity determinations.

0-2,000 counts per minute—used for average activity and normal work.

0-20,000 counts per minute — used for tracer and high activity determinations.

High accuracy is assured by the handy reset button, located on the front panel, which permits compensation for variations of battery voltages and background count.

A rugged weather-proof aluminum case houses this light economical unit. The batteries will provide over 200 hours of intermittent operation from the two 67½ volt batteries and 50 hours from the three flash light batteries.

Comes with complete set of batteries, carrying strap, headphone, radioactive specimen and A.E.C. booklet. Only ..... **$47.50 NET**

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SEE FOLLOWING PAGE FOR COMPLETE DETAILS

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Superior's New Model 82

A truly do-it-yourself type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert it into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button —

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

FEATURES:

• Tests over 600 tube types. • Tests OZ4 and other gas-filled tubes. • Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings. • Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence. • Dual Scale meter permits testing of low current tubes. • 7 and 9 pin straighteners mounted on panel. • All sections of multi-element tubes tested simultaneously. • Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82 will outperform similar looking units which sell for much more—and as proof, we offer to ship it on our examine before you buy policy.

Model 82 comes complete, housed in portable, hand-rubbed oak cabinet with removable cover. Only $36.50 Net

Model 82—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 per month for 5 months.

Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.

• Uses the new self-cleaning Lever Action Switches for individual element testing. **All elements are numbered according to pin-number in the RMA base numbering system.** Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. Thus it is **impossible to damage a tube by inserting it in the wrong socket.**

• Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

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

Housed in hand-rubbed oak cabinet **$47.50 Net**

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

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

NO INTEREST OR FINANCE CHARGES ADDED!

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

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Superior's New Model 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

• Extra large meter scale enables us to print all calibrations in large easy-to-read type.

• Employs a 12AU7 as D. C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability. • Meter is virtually burn-out proof. The sensitive 400 micro-ampere meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, Intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS:** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Comes complete with operating instructions, probe leads, and streamlined carrying case. Operates on 110-120 volt 60 cycle. Only..... $42.50 Net

Superior's New Model TV-50A

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7 Signal Generators in One!

- R.F. Signal Generator for A.M.
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- Audio Frequency Generator
- Marker Generator
- Bar Generator
- Color Dot Pattern Generator
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This Versatile All-Inclusive **GENERATOR** Provides **ALL** the Outputs for Servicing:

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R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

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BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

Complete with shielded leads **$47.50 Net**

TRY FOR 10 DAYS

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pay in easy, interest free, monthly payments. See coupon inside.

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