BUILD—Stereo headphone control center

HUGO GERNSBACK, Editor-in-chief

60c ■ NOV. 1967

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

GERNSBACK PUBLICATION

Service Hints On New Color TV Sets

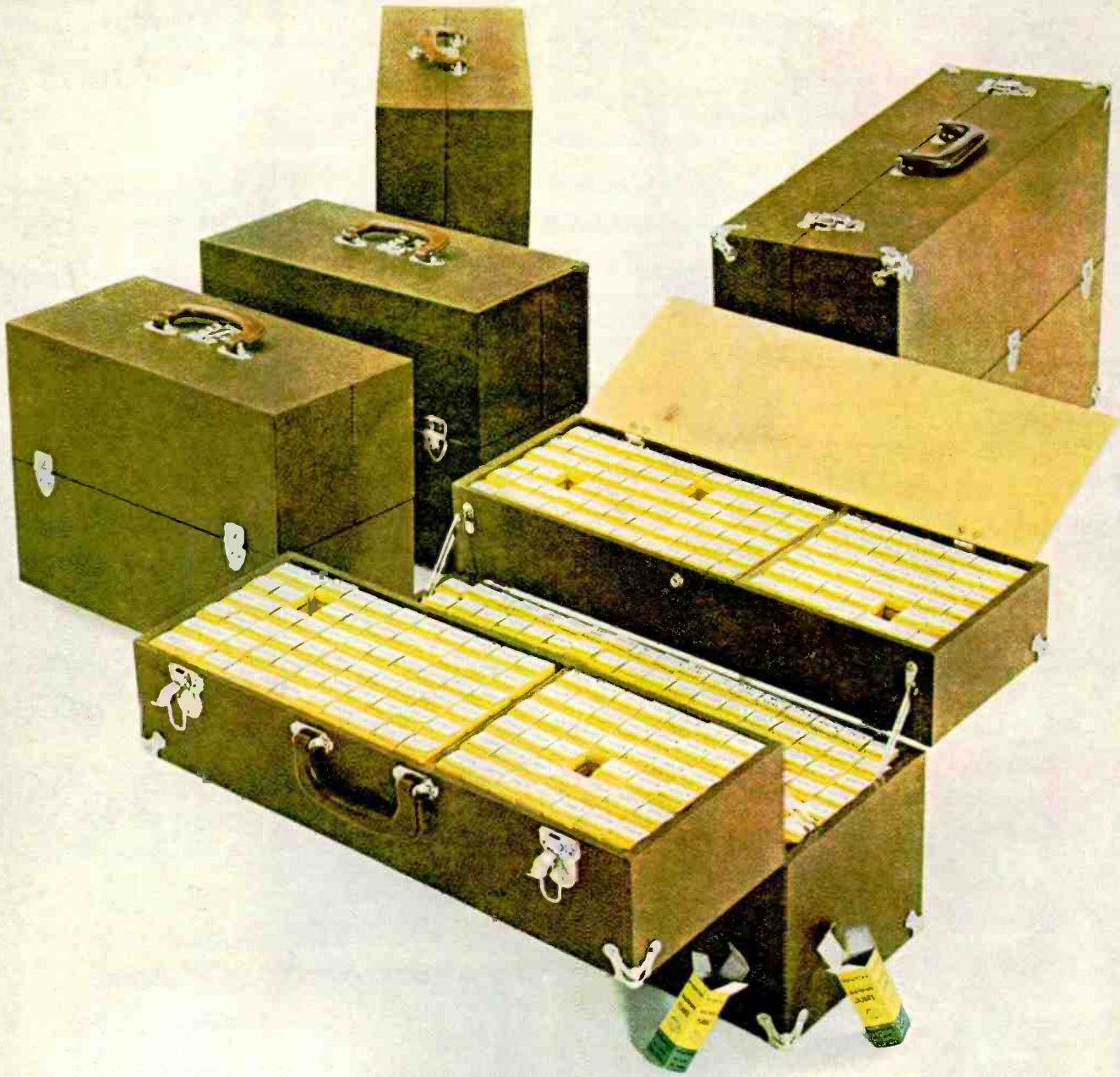
Stepping Relays Unlimited

Build Dummy Load and RF Meter

Make Your Own Printed Circuits

SPECIAL REPORT
TV SET
X-Ray Radiation

BUILD
TREASURE FINDER
(See page 32)

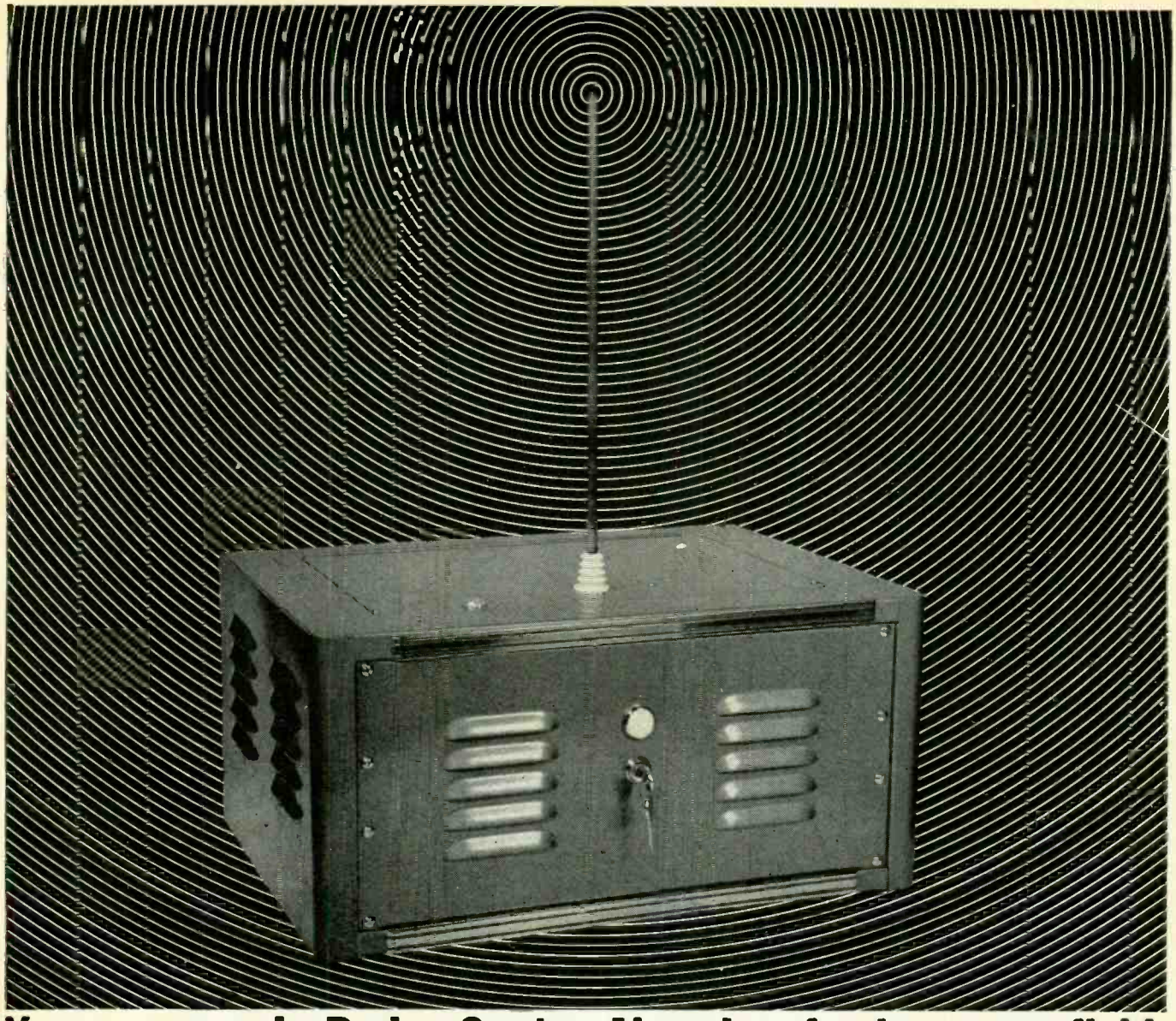


One out of every five professional servicemen has switched to Amperex TV replacement tubes

It takes a lot of quality to change the buying habits of 20% of the most knowledgeable technicians in the business. These servicemen are following the pattern set by the leading TV manufacturers, who are designing more and more of their quality lines around tubes originated by Amperex. The Amperex line of popular types is expanding all the time. Look for the green and yellow cartons at your distributor's or write: Amperex Electronic Corp., Hicksville, L.I., N.Y. 11802.

Amperex

TOMORROW'S THINKING IN TODAY'S PRODUCTS



You are now in Radar Sentry Alarm's r.f. microwave field. Don't move a muscle!

This security system is so sensitive, it can be adjusted to detect the motion of your arm turning this page.

And if this Portable Model Unit were within 35 feet of you and you moved... people up to a half-mile away could hear the siren. Plus with optional equipment, it can detect fire... turn on lights... even notify police.

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Mail to: RADAR DEVICES MANUFACTURING CORP.
22003 Harper Ave., St. Clair Shores, Michigan 48080 **RE-11**

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Circle 8 on reader's service card

← *Circle 7 on reader's service card*

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2

3

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John Doe

the degree of

Associate in Science in Electronics Engineering

with all the rights and privileges thereunto appertaining. In witness thereof this diploma duly signed has been issued by the School Administration upon recommendation of the faculty at the School on this

first day of October, 1965

D. J. Grantham
President

E. C. Watters
Acting Dean

Radio-Electronics

November 1967 VOL. XXXVIII No. 11
Over 55 Years of Electronics Publishing

SPECIAL REPORT

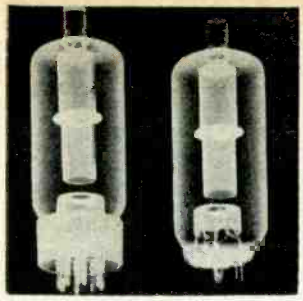
CONSTRUCTION PROJECTS

SERVICING

HAM BANDS

GENERAL ELECTRONICS

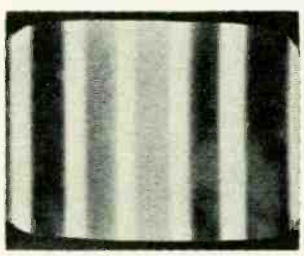
THE DEPARTMENTS



p 54—X-RAY RADIATION

p 35—HEADPHONE CENTER

p 42—MINI WOOFER



p 37—SERVICE COLOR TV

p 43—AUTO ELECTRONICS

RADIO-ELECTRONICS, NOVEMBER 1967, Volume XXXVIII, No. 11, Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302

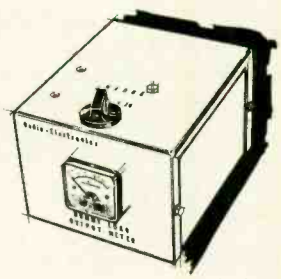
Editorial, Advertising, and Executive offices: 154 West 14th Street, New York, N. Y. 10011. **Circulation Office, Boulder, Colo. 80302.**

Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $5. Pan-American countries, $6. Other countries, $6.50. Single copies: 60c.

POSTMASTERS: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

COVER FEATURE

p 32—Practical instrument "uncovers" all types of metals.



p 50—LOAD & METER

Member, Institute of High Fidelity. Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

Fabian Bachrach

Hugo Gernsback
1884-1967

Hugo Gernsback, founder and editor-in-chief of RADIO-ELECTRONICS, died August 19, 1967. He was 83.

ON AUG. 16, 1892, an 8-year-old boy studied intently an electric doorbell he had just been given for a birthday present. It was not the mechanical equipment in the wooden case nor the fast-moving clapper that held his attention. What he was watching was the tiny spark between the contacts as the armature made and broke the circuit. The career of Hugo Gernsback started at that moment—his life from that day was spent in learning more about things electric.

Learning more about electricity in the famous Technikum at Bingen on the Rhine, the young Gernsback conceived and developed a greatly improved dry battery. He decided to take it to the land of opportunity—America.

Little doubt that the battery was an improvement—the idea was used years later in large heavy-duty B-batteries. But it had one weakness: it cost nearly twice as much to manufacture as the batteries it was designed to replace. So Hugo had to give up the idea of making a fortune from his invention, and took a job as an engineer with a storage battery manufacturer, Emil Grossman.

Bringing the original thinking that had developed the layer-constructed battery to bear, and remembering the economic angles this time, Gernsback shortly developed a cheaper, lighter and stronger battery case than any on the market. But here a typical Gernsback characteristic—one invaluable to him in his future success—got in the way.

The Gernsback urge to brush aside trivial detail and get to the main objective was, he found, a real handicap in practical engineering. Not carefully tested for corrosion resistance, the new batteries started to leak, and were returned in droves by the dealers. Hugo decided that the plodding detail of an engineer's life was not for him, and formed the Electro Importing Co. to bring equipment from Europe and sell it to experimenters.

Within a year he was selling a radio set to the public. Advertised in the *Scientific American* early in 1906, it was "only" a spark set. But it included both a transmitter and receiver, was portable, had a range of one mile, and sold for $7.50, complete with send and catch wires (which we would prosaically call receiving and transmitting antennas). Further, it operated (somewhere in the uhf band) without the trouble of tuning.

A catalog was published for mail-order customers. It contained numbers of instructive articles on new and unfamiliar equipment. Gernsback decided to put out a regular magazine to carry the instructive material. In April, 1908, *Modern Electrics* was born. Note the name—nobody would have dared to publish a radio magazine in 1908! But the first article in the first issue was titled "Wireless Telegraphy" and the magazine reported all the latest wireless news faithfully, and printed articles on theory and practical construction.

(continued on page 58)

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Correspondence

BRICKBATS AND BOUQUETS

Yes, I have let my subscription lapse and until you make some changes I won't be sorry. I have never written to an editor before and was not going to do so now, but I guess that is the only way things can be corrected. First, I thought it should be a good article on Chet Atkins. Well, I quit on that one about ½ way through. I didn't know that it was a technical article on how short he smoked his cigars. Second, I really think it is stupid that everything in a technical magazine be written in conversation form. Say what you have to say and then shut up. Third, the biggest laugh came on your computer article, three pages of nothing and the most (only) technical thing was how it would work out the parallel resistor formula.

DALE R. BALMER
Ames, Iowa

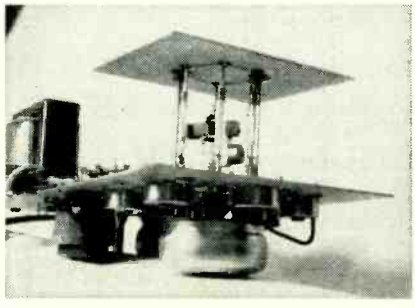
. . . I like your magazine or I wouldn't bother writing. How about using the space taken up by "Coming Next Month" for something *this month.*

F. BUTTERFIELD
Brooklawn, N. J.

THE PLOT THICKENS

I am building the "Transistor Characteristic Plotter" (September, 1967). I'm having trouble visualizing the construction of the reed switch and the placement of some of the parts. Can you publish any additional diagrams or photos?

O. H. MAXWELL
Central Islip, N. Y.



O. H., this photo should help. The reed switches are spaced 60° apart around

continued on page 12

Radio-Electronics

154 WEST 14TH STREET
NEW YORK, N. Y. 10011

HUGO GERNSBACK (1884-1967)
editor-in-chief and founder
M. HARVEY GERNSBACK, *Publisher*
ROBERT CORNELL, *editor*
Robert F. Scott, *W2PWG, senior editor*
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Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo

ADVERTISING REPRESENTATIVES

EAST
John J. Lamson,
RADIO-ELECTRONICS, 154 West 14th Street, New York, N. Y. 10011, 212-255-7755

MIDWEST/N.&S. Car., Ga., Tenn.
Robert Pattis, the Bill Pattis Co., 4761 West Touhy Ave., Lincolnwood, Ill. 60646, 312-679-1100

W. COAST/Texas/Arkansas/Oklahoma
J. E. Publishers Representative Co., 8380 Melrose Ave., Los Angeles, Calif. 90069, 213-653-5841; 420 Market St., San Francisco, Calif. 94111, 415-981-4527

UNITED KINGDOM
Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London W.1, England

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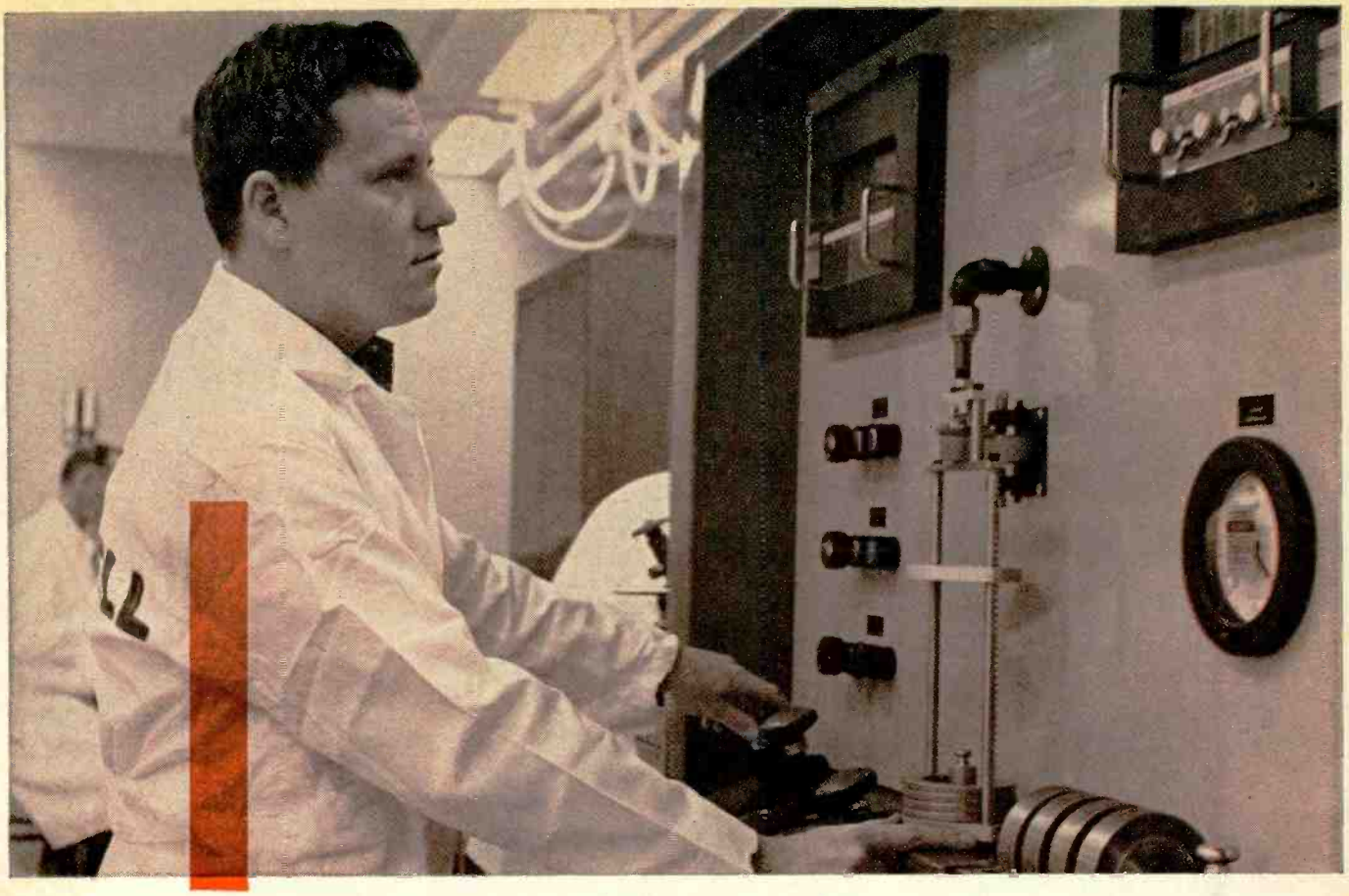

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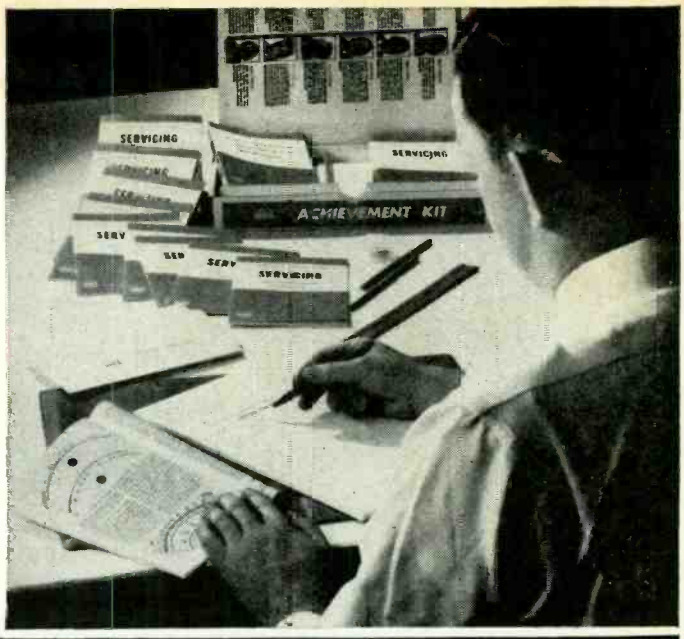

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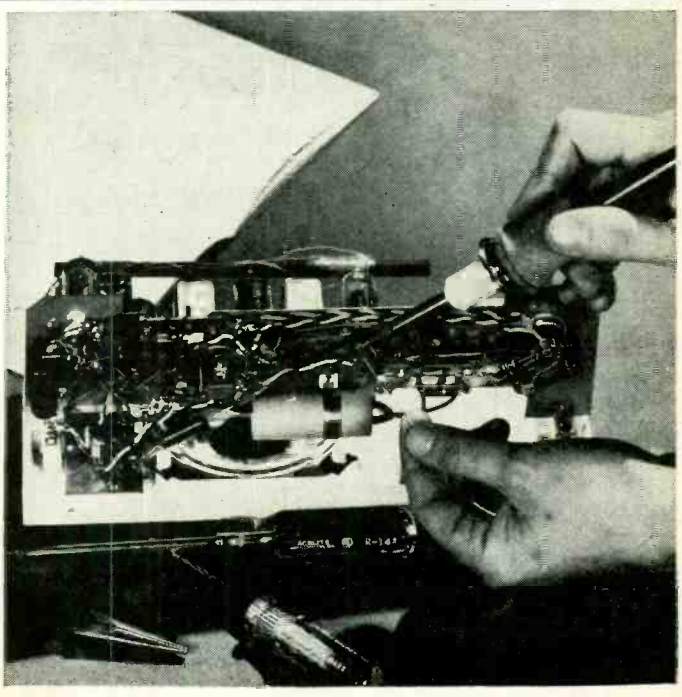


a circle just beyond the physical reach of the rotating magnet, but within reach of its magnetic field. The magnet is offset so that only one end effects the reed switches. The counterbalance just below the magnet compensates for the offset condition.

READERS' PRAYERS

I would like to see more construction projects. I would especially like to see a metal detector project of the receiver–transmitter type in which the receiver and transmitter loops are located in a common search head.

DRUCE BLACKWELL
Long Beach, Calif.

. . . More TV service and technotes to help me cure tough TV jobs. Also, more information about small electronic gadgets.

PETER LEGON
Malden, Mass.

. . . I would like to see articles on repairing guitar amplifiers and other gadgets.

C. WARREN CORBETT
Chicago, Ill.

. . . An article on stereo headphones and amplifiers for them.

STUART SJALUND
Haileybury, Ont.

. . . A lighting-control system using TRIAC's that has six channels, each of 15 amp capacity, with absolutely smooth and linear controls for each channel, plus a master to dim all six proportionally, for stage lighting purposes.

CLARK A. FERGUSON
Kitt Music Co.
Edgewater, Md.

. . . technical and construction articles.

A. F. BUCK
Vancouver, B. C.

. . . A master index which covers issues of several years in one little booklet, so that one can use your magazine as a reference book without having to search through every issue to find an article.

WOLFGANG STIER
Radio & TV Service
Orillia, Ont.

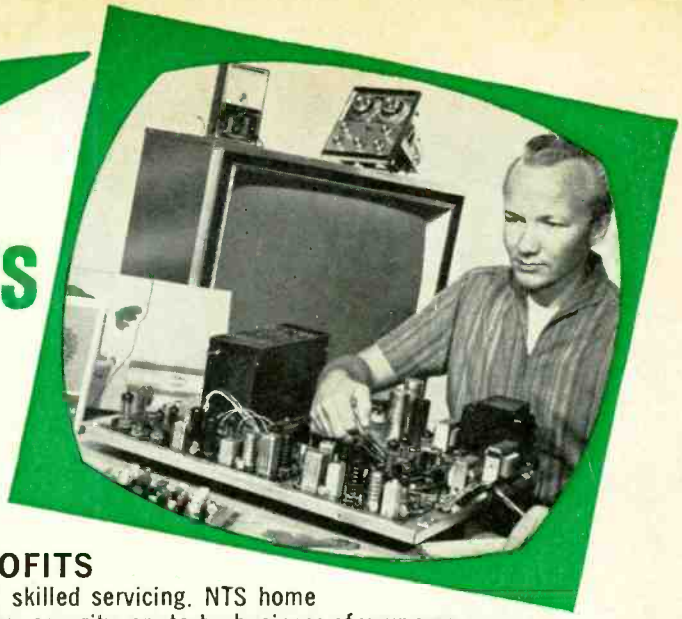
Amen.

STEREO FM IN CANADA

May I draw your attention to the Stereo Station Directory (August 1967) in which you listed CKWS as being stereo in the Kingston, Ontario

NEW! MASTER COURSE IN COLOR TV...

WITH NTS COLOR KITS



Big 25" Color TV kits included in new Master Color TV Home Study program. Learn Color TV; keep the new 25" color TV receiver *you* build with exciting kits we send you.

10 million homes in this country will have color TV by the end of 1967. This industry needs technicians as never before, and NTS-trained men can move quickly into the big money.

COLOR TV SERVICING BRINGS HIGH PROFITS

New color sets need careful installation, precision tuning and skilled servicing. NTS home training can put you in this profit picture—prepare you for big pay, security, or start a business of your own.

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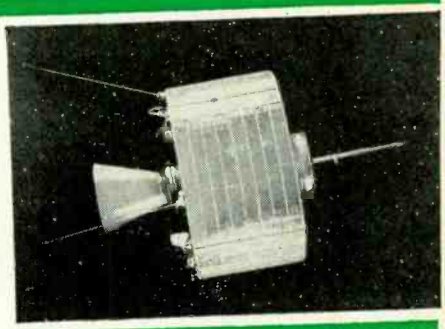

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- ☐ MASTER COURSE IN TV & RADIO SERVICING
- ☐ PRACTICAL TV & RADIO SERVICING
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- ☐ STEREO, HI FI & SOUND SYSTEMS
- ☐ BASIC ELECTRONICS ☐ HIGH SCHOOL AT HOME

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Address _____

City _____ State _____ Zip _____

- ☐ Check if interested in Veteran Training under new G.I. Bill.
- ☐ Check if interested ONLY in Classroom Training at Los Angeles.

area. To my knowledge this is not the case.

However, CKLC-FM (98.3 MHz) has just completed its stereo installation and has been broadcasting in stereo on a limited time basis since July 17, 1967.

ALBERT AUGLEGER
CKLC Radio
Kingston, Ont.

STEREO ADAPTER

Where can I get a printed circuit board for the project, "A Modern FM Stereo Adapter" (August, 1967)?

GEORGE EDWARDS
Teaneck, N.J.

A drilled printed circuit board for this project (MD116) is available from Transitek Co., P.O. Box 205, Des Moines, Wash., 98016, for $4.15, postpaid.

TECHNICIAN SHORTAGE

There is a nationwide shortage of suitably trained technicians to service consumer-type electronic equipment. Isn't it about time that our educational system did something more constructive to encourage and train more young men for an electronics career, particularly those who for one reason or another are unable to go beyond a high-school education? Educators and industrialists have, in the past, combined their talents and money to provide trained specialists to man factories and offices; why not do something for individuals who seek to be independent and to be in business for themselves?

BILL GENDLER
Laurelton, N.Y.

Bill, the Electronic Industries Association (EIA) is working on it.

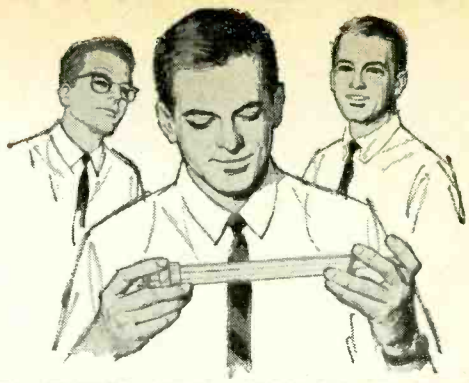
A DOG'S BEST FRIEND

Last fall, you had asked my permission to run a small article in RADIO-ELECTRONICS about a Flashing Neon Collar Lite that I had rigged up for my old dog. I gave you my permission, of course. Since then I have made a few improvements on the collar. The producers of the Lassie TV program in Hollywood, after reading the story, presented me with a beautiful plaque called the "Lassie Gold Award". It is a coveted award in the animal world. It was first given to a solider on Guadalcanal in World War II for saving the life of a dog.

S. A. SIBLEY
Hockessin, Del.

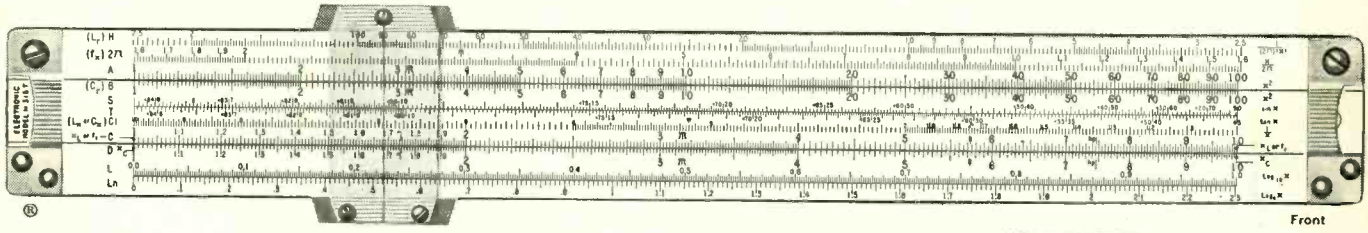
Congratulations, S. A. **R-E**

Be the man who's always first to say: "I've got the answer right here."

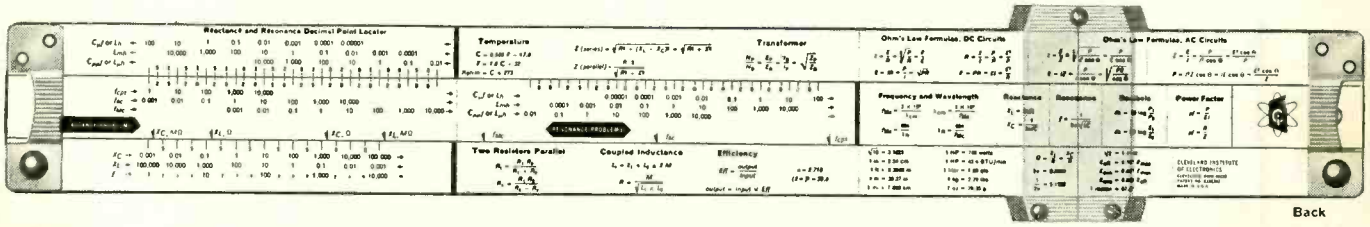


START USING THIS REMARKABLE

ELECTRONICS SLIDE RULE



Front



Back

SOME DAY EVERYONE in electronics may have a slide rule like this. Till then, the man who uses one will seem like a wizard as he solves reactance and resonance problems in 12 to 20 seconds —*without pencil and paper.*

This is a professional slide rule in every detail, a full 10" long, made exclusively for Cleveland Institute of Electronics, to our rigid specifications, by Pickett, Inc. It can be used for conventional computation as well as special electronics calculations. All-metal construction assures smooth operation regardless of climate.

Handsome top-grain leather carrying case has heavy-duty plastic liner to protect slide rule; removable belt loop for convenient carrying. "Quick-flip" cover makes it easy to get rule in and out of case.

You also get four full-length AUTO-PROGRAMMED™ Lessons, which teach you how to use the special electronics scales on the slide rule. These lessons have been carefully designed to meet the same high educational standards as the electronics career courses for which our school is famous. Even if you've never used a slide rule before, you'll soon whiz through the toughest problems with this CIE rule.

Deliberately underpriced. Many men in electronics have told us that this unique slide rule, leather case, and 4-lesson course easily add up to a $50 value. But we have deliberately underpriced it at less than $25. Why? Our reason is simple: we are looking for men in electronics who are ambitious to improve their skills...who know that this will require more training. If we can *attract* you with the low price of our slide rule and course—and *impress* you with its quality—you are more likely to consider CIE when you decide you could use more electronics training.

Send for free booklet. See for yourself why this amazing slide rule and course have made such a big hit with busy electronics men everywhere. No obligation, of course—just an opportunity to get in on the best offer ever made to people in electronics. Just mail coupon, or write Cleveland Institute of Electronics, Dept. RE-146, 1776 East 17th St., Cleveland, Ohio 44114.

CIE **Cleveland Institute of Electronics**
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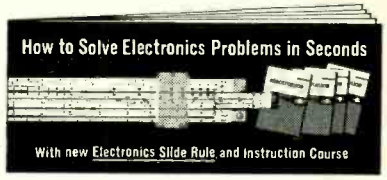

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Circle 17 on reader's service card

NEW FCC RULES FOR HAMS—

Incentive Licensing and Distinctive Call Signs

ON APRIL 1, 1965, THE FCC RELEASED a Notice of Proposed Rule Making to amend its rules to provide for incentive licensing and distinctive call signs in the Amateur Radio Service. In addition to those filed by organized amateur groups, more than 1700 formal comments—representing the views of about 4000 licensees—were received in response to the notice. Each comment was considered by the Commission. Almost without exception, the comments were set forth in an intelligent and thoughtful manner and, as a result, they were considered very helpful by the FCC.

The proposals in the proceeding were extensive and provided for higher classes of licenses with reserved frequency-operating privileges as an incentive to the general "upgrading" of licensees, the revision of the privileges and term of the Novice Class license, the modification of a basis of eligibility for the Conditional Class license, and distinctive station call signs. The primary purpose was to consider the establishment of an incentive licensing program.

A program of this nature was endorsed in two out of every three comments. Essentially, the favorable comments concurred in the Commission's view that, in order to justify the continued allocation to the Amateur Radio Service of a substantial portion of the spectrum in the face of incessant and important demands by other radio services, there must be a continuing movement toward the goals set forth in Section 97.1 of the Rules.

The most frequently presented argument against incentive licensing was not based upon disagreement with the Commission's view but, instead, was based upon the contention that an incentive licensing program would have no long-range effect. It was felt that licensees who trained and educated themselves to obtain the higher classes of licenses would merely fall back to their present level of competence after achieving the higher status.

Early Proposals

The FCC proposed two higher classes of licenses for the incentive licensing program which would include the present Amateur Extra Class license and a new license to be designated the Amateur First Class license.

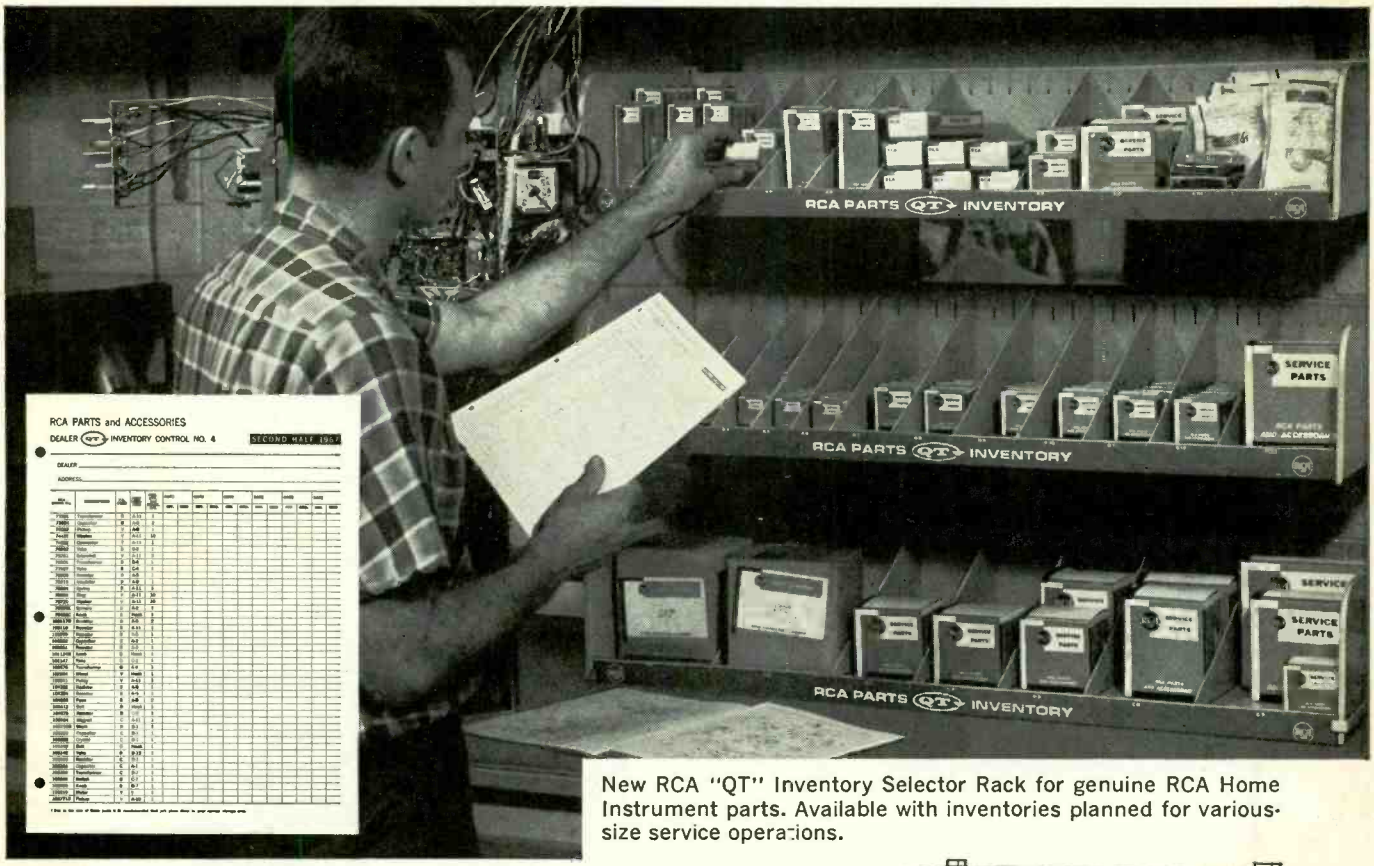
continued on page 56

What's Required to Get an Amateur License

CLASS	ELEMENT I Code speed words/minute	ELEMENT II Basic law and theory	ELEMENT III General theory and practice	ELEMENT IV(A) Intermediate theory and practice	ELEMENT IV(B) Advanced theory and practice
Novice	5	▬			
Technician	5		▬		
General	13		▬		
Advanced	13		▬	▬	
Extra	20		▬	▬	▬

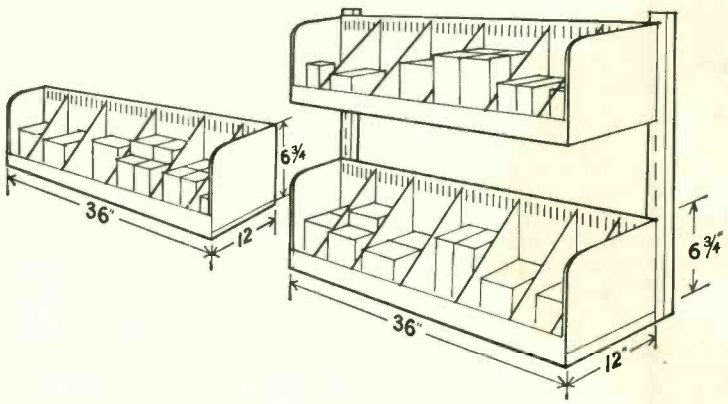
Stock RCA parts the "QT" way

...speed up customer service—increase shop efficiency



New "scorecard" for RCA parts turnover . . . also keys each part to its shelf location.

New RCA "QT" Inventory Selector Rack for genuine RCA Home Instrument parts. Available with inventories planned for various-size service operations.



Having an inventory of fast-moving parts in your shop helps you complete jobs faster and move more jobs through your shop for greater profits.

RCA calls the program "QT"—for Quick Turnover.

Your RCA Replacement Parts Distributor can supply "QT" Inventories designed to suit various-size service operations, with varying quantities of most used RCA Home Instruments replacement parts.

These inventories are reviewed and updated semi-annually in accordance with the most current usage data, based on an analysis by RCA Electronic Data Processing Equipment, of national sales patterns.

Your RCA Distributor can describe many RCA "QT" advantages for you. He'll recommend the Inventory that fits your business. Ask him how you can get the compact "QT" Inventory Selector Rack. Call him on the "QT"... Today!

RCA PARTS AND ACCESSORIES, Deptford, N.J.

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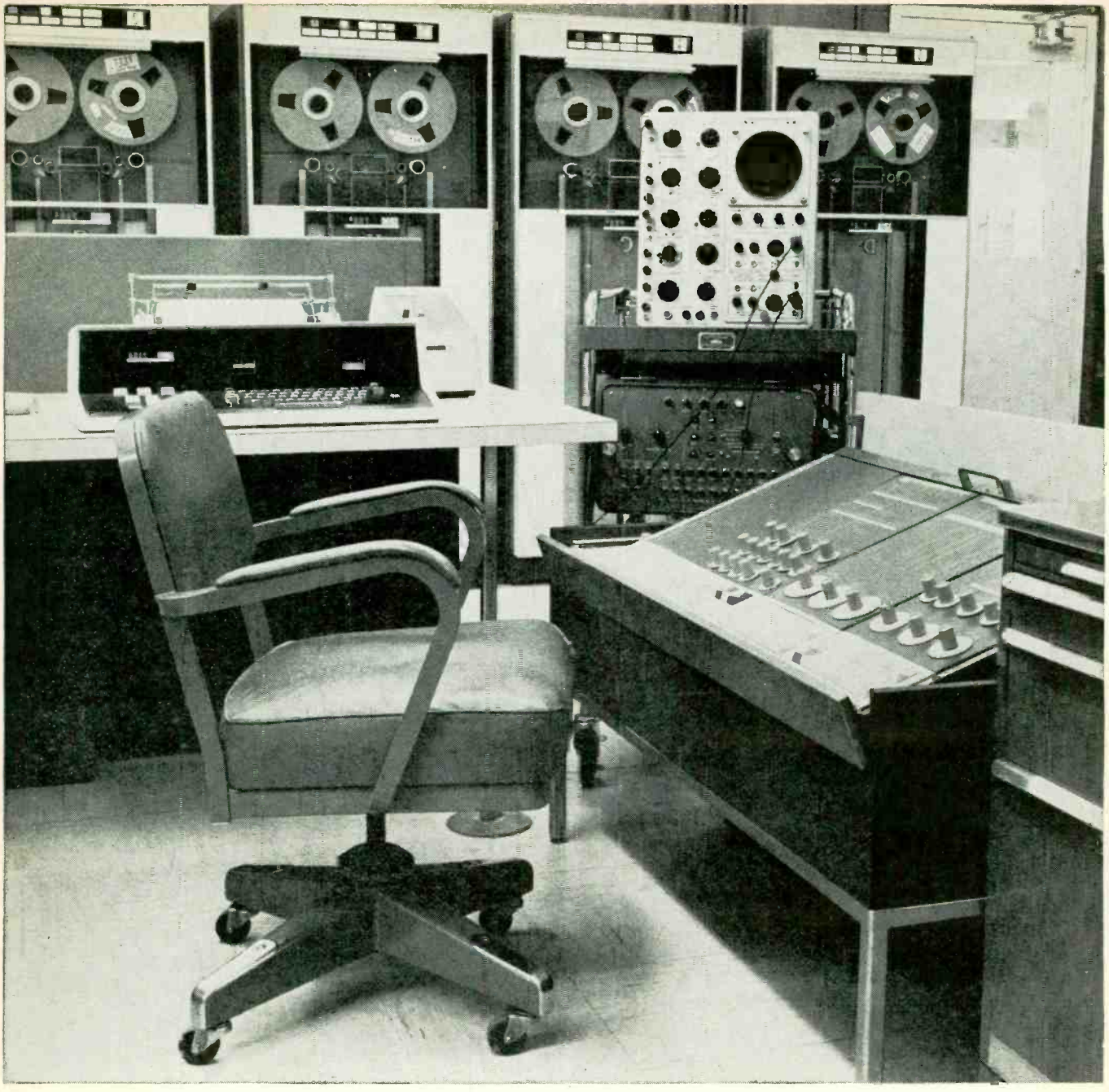

This important job (and its big salary) **is reserved for a qualified electronics technician. It can be you!**

It's a fact. There are *thousands* of jobs like this available *right now* for skilled electronics technicians. What's more, these men are going to be in even *greater* demand in the years ahead. But how about you? Where do you fit into the picture? Your opportunity will never be greater . . . so act *now* to take advantage of it. The first step? Learn electronic fundamentals . . . develop a practical understanding of transistors, troubleshooting techniques, pulse circuitry, micro-electronics, computers and many other exciting new developments. Prepare yourself now for a job with a bright future . . . unlimited opportunity . . . lasting security . . . and a steadily-increasing salary.

Over 23,000 ambitious men are using Cleveland Institute Electronics Training Programs as a stepping stone to the good jobs in electronics. Why not join them? You will learn at home, in your spare time, and tuition is remarkably low. Read the important information on the facing page. Then fill out the postage-free reply card and drop it in the mail today. Without obligation we'll send you all the details. But act now . . . and get *your* high-paying job just that much sooner.

Circle 20 on reader's service card

How You Can Succeed In Electronics

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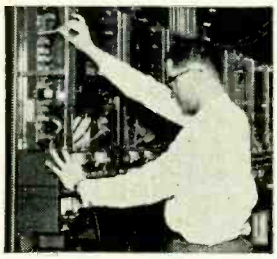
2. First Class FCC License

If you want a 1st Class FCC ticket *quickly*, this streamlined program will do the trick and enable you to maintain and service all types of transmitting equipment.

3. Broadcast Engineering

Here's an excellent studio engineering program which will get you a 1st Class FCC License and teach you all about Program Transmission and Broadcast Transmitters.

4. Electronic Communications



Mobile Radio, Microwave, and 2nd Class FCC preparation are just a few of the topics covered in this "compact" program . . . Carrier Telephony too, if you so desire.

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This exciting program includes many important subjects such as Computers, Electronic Heating and Welding, Industrial Controls, Servomechanisms, and Solid State Devices.

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In addition to providing you with comprehensive training in the area indicated, programs 1, 2, 3, and 4 will prepare you for a Commercial FCC License. In fact, we're so certain of their effectiveness, we make this *exclusive* offer:

The training programs described will prepare you for the FCC License specified. Should you fail to pass the FCC examination after completing the course, we will refund *all* tuition payments. You get an FCC License . . . or your money back!

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NEWS BRIEFS

BIGGEST MICROSCOPE

An electron microscope has more magnification power than an optical one. But image size depends on voltage, which tends to limit resolving power.

Installation was recently completed on the most powerful electron microscope in the US—a 1-million-volt instrument. It's used by United States Steel for research studies on the nature of steel.

The microscope—built by RCA—uses a 1-million-volt accelerator (built by E. Haefely Ltd.) which stands 17 feet high and weighs 15 tons.

ELECTRONIC CURE FOR COLOR BLINDNESS

A Japanese biologist—Prof. Koichi Honkawa—discovered some time ago that electrical stimulation of the head can improve visual sensitivity to color. He found that frequencies of 77 and 42.5 Hz, when applied to the temples through a headphone-like device, stimulate sensitivity to the three primary colors—red, green and blue.

A corrective device called the *Sunvister* has been recently developed by Hayakawa Electric Co. which embodies Honkawa's principle. It corrects color blindness in 3 to 6 months of 20-minute daily sessions. Sunvister is transistorized and battery-operated.

IC VOLTAGE REGULATOR

So small it is mounted on the generator in some 1968 Pontiac autos, this voltage regulator uses integrated circuits. It was developed by Delco Radio Division and has no moving parts.

The system has no external wiring. It uses electronic sensors which remain unaffected by moisture or vibration.

ZIP-CODE MONITOR

Soon post-office mail sorters may simply read aloud the ZIP code from a letter as they drop it into a new device. The device—being developed by RCA for the US Post Office Department—can recognize spoken numbers. It promises to speed mail sorting.

Called the Numeric Speech Translating System, the machine recognizes spoken digits and activates a mechanical sorter. Device uses solid-state operational amplifiers and logic circuits to discern speech patterns associated with numbers.

FM RECEIVER BOOM

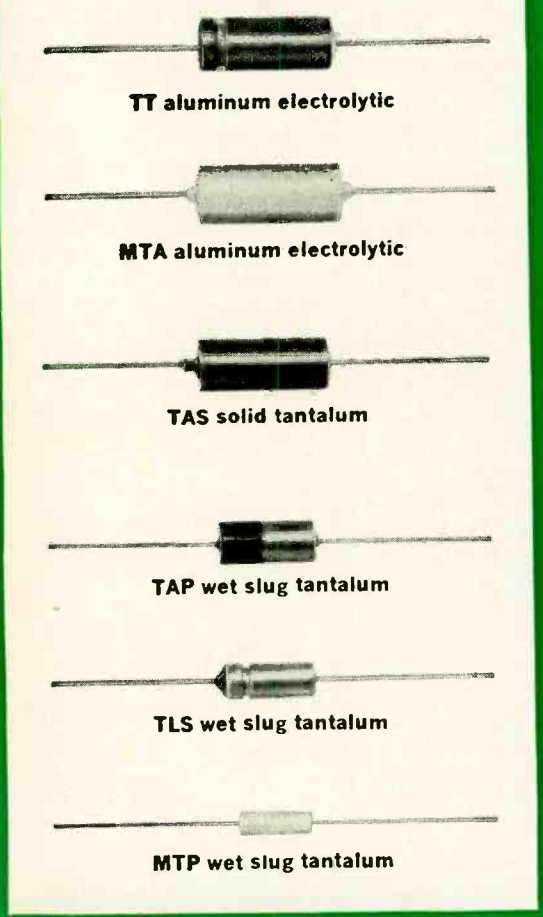
More FM radios are being sold now than ever before; nearly 40% of US radios can receive FM broadcasts. By contrast, in 1961 FM radios accounted for only about 10% of the total US market.

According to the Electronic Industries Association, about 9/10 of all radio-phonograph combinations sold have FM capability. Approximately ⅓ of table models and portable radios are FM-equipped. Even clock radios have FM—nearly ¼ of all units sold are so equipped. **R-E**

MALLORY **Tips for Technicians**

Which miniature electrolytics for transistorized AM-FM radios?

COMPARATIVE SIZES OF CAPACITORS ALL RATED 10 MFD., @ 25 WVDC
(shown actual size)



The new portable AM-FM radios are so compact you wonder how they get all those components into that little box. You wonder even more when you have to replace some of the parts.

Electrolytic capacitors, for example. The original electrolytic usually turns out to be a tiny thing jammed in among a dozen other midget gidgets. Getting it out is a trick in itself. Getting a suitable replacement is even tougher! And unfortunately, you're apt to need replacements, because many of these tiny capacitors just aren't much good. They don't meet the quality specs of good domestic capacitor makers. But high quality domestic capacitors are often just a bit too big to fit in the space available.

What's the answer? Search the town for another "little-bitty" original capacitor? Tell your customer you can't finish the job?

Don't give up. We have a few suggestions.

First, try a Mallory TT aluminum electrolytic. This is a real quality capacitor, rated 85°C, and it's pretty doggone small. Or a Mallory MTA, a revolutionary molded case aluminum electrolytic with excellent quality at low-low price.

If neither of these will fit, try a Mallory tantalum capacitor. The TAS solid tantalum is about the same size as the TT, but it's rated 125°C. Need still smaller size? Take a look at the Mallory "wet slug" tantalum types TAP and TLS—and the super-miniature MTP, which gives you the most microfarads in the smallest size of anything on the market. The pictures at the left show you comparative sizes, all for a 10 mfd, 25 WVDC rating.

Sure, you'll pay a little more for the tantalum capacitor. But not as much as you might think. The TAP only costs 42c more than the TT, in the rating shown. And you get the utmost in reliability.

We certainly don't expect you to use a tantalum capacitor to replace every aluminum electrolytic. But they come in mighty handy sometimes. And you can get them when you need them from your Mallory Distributor. Ask him for our latest catalog, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

DON'T FORGET TO ASK 'EM—*"What else needs fixing?"*

Circle 23 on reader's service card

In the Shop . . . With Jack

By JACK DARR

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

The screen won't light; what to do? Check the high voltage? Not necessarily, and especially not in a color TV set. Because of the dc coupling used in practically all color TV video amplifier circuits up till now, any fault in the *video* amplifiers will cause the screen to go dark. This can happen as far back as the first video amplifier or even the video detector!

Here's what happens: The video-amplifier circuit actually sets the bias on the color CRT (see the simplified diagram). The video (Y) signal is fed to the cathodes of the color picture tube, through a complicated network of resistors and coils. The plate voltage of the last video amplifier is fed through the KINE BIAS control and the BLUE and GREEN DRIVE controls.

What happens if there is something wrong in the video amplifier circuits that affects the current drain? You're right; it upsets the bias on the color CRT. If the dc voltage goes up (more positive) on the cathode of any tube, it is exactly the same as applying a negative voltage to the grid: the tube is cut off and the screen goes dark, and the set owner goes to the telephone!

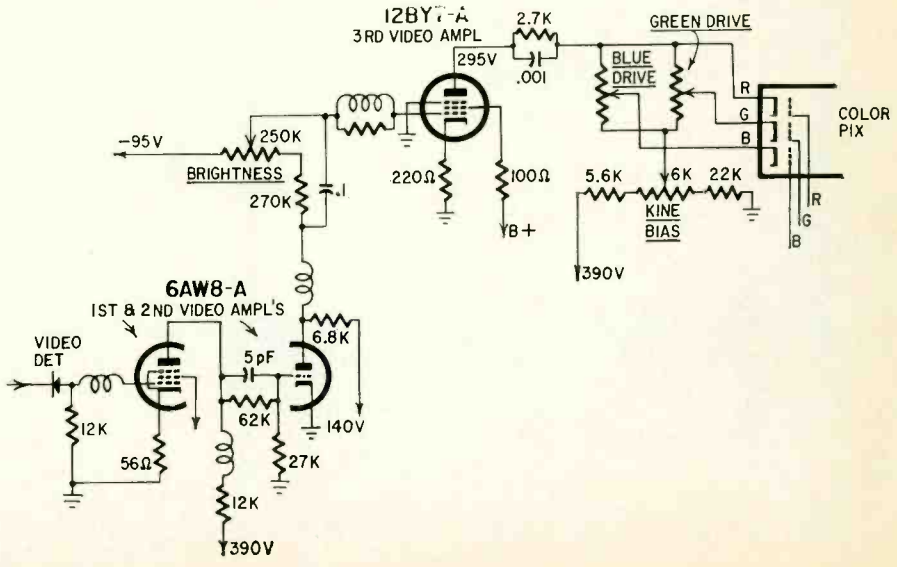
Any of several things can cause this. For instance, in the popular RCA circuits, such as the CTC12 shown in the diagram, the 12BY7 video output tube shows +295 volts on the plate; this comes from the +390-volt line through the resistance network shown. Let's see what could happen.

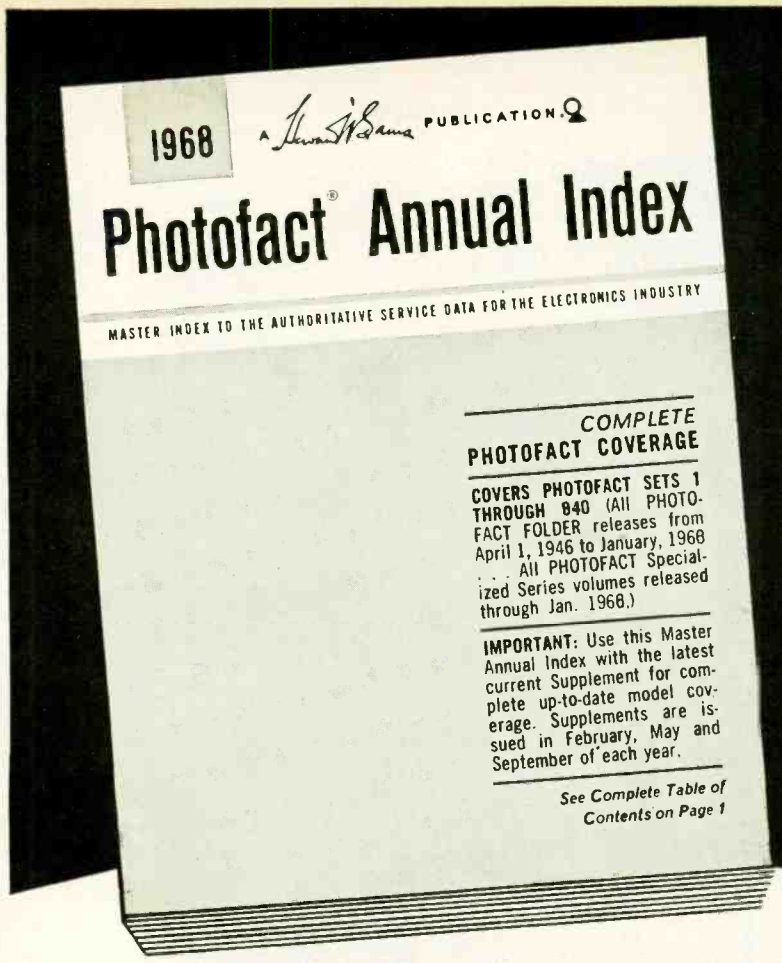
The 12BY7 tube goes dead. No plate current drawn, so no voltage drop across load resistors—up goes the plate voltage (cathode voltage of the CRT) and out goes the raster. The 100-ohm resistor in the 12BY7 screen circuit opens: no screen voltage, down goes the plate current, up goes the voltage and here we are again. The 220-ohm resistor in the 12BY7 cathode circuit opens. Now the plate circuit is broken, and no plate current can flow —see above!

If you find a color-TV set with a black screen, make all the easy checks first: the CRT heater by visual inspection, HV, horizontal output and damper tubes, fuse and so on. Then start checking some bias voltages. (By the way, shoving one of the little neon HV testers up to the plate lead of the horizontal output tube, or near the flyback, is a very good short-cut check for the presence of HV. If you get a good bright glow, the chances are the HV circuits are okay.)

Don't stop too soon, either; this

continued on page 26





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Circle 25 on reader's service card

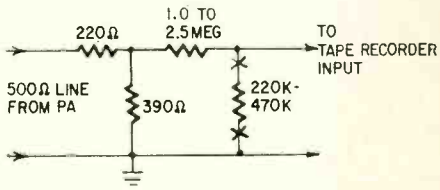
(continued from page 24)

kind of trouble could go as far back as the video detector, as you can see from the partial schematic. Check *all* voltages, and for goodness' sake don't forget to check the grid bias on these tubes—it is very important. A big negative voltage, leaking from somewhere, can cut off one of the video amplifier tubes; you get the same symptoms that you'd find if the plate resistor opened, etc. A change of only a volt or two back down the line can make a big difference, so don't overlook anything!

Tape recording from PA output

I ran into a problem in a church sound system. They want to record (on tape) from the PA system. I tried feeding the tape recorder from the PA output, and got hum and garble. Is this due to an impedance mismatch? It should be; I was using the high-impedance input. Can I rig up a low-impedance input on the tape recorder?—C.F., Wilbur, Ore.

The impedances are badly mismatched, but this isn't the main problem. You're feeding a very-high-level signal—several volts at least—into an input that is designed to work from only a few *millivolts*. Consequently, you're simply beating that poor little input tube to its knees from the overload!



I ran into exactly the same problem (in a church job, too) and solved it simply by adding a matching pad. The pad actually isn't primarily for matching, but mainly for knocking down that voltage. Use good-size series resistors and fairly small shunt resistors, and you'll find that you can get good recordings in this way.

Set up the pad (see the diagram) so that you can get good recording volume with the tape-recorder record gain control set at about half-open. Then watch the recording indicator (eye tube or meter) for your level. The pad resistors do not seem to be too critical. If you can't get enough reduction with a single section, add another section. The input values shown will make a pretty good match to a 500-ohm line; for a 70.7-volt line, raise the values just a little. **R-E**

Are you eligible for the Bright Guy Awards?

It's easy to get them—and to get all the business they'll bring you. New customers. More sales. More money.

The Bright Guy Awards is the big program Sylvania's running this year to boost your sales.

Your Sylvania distributor can put your name and address in TV Guide ads in your area. The ads call you "the brightest serviceman in town"—and tell people in your town why they should call you.

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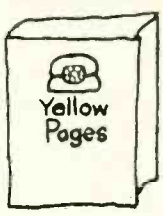
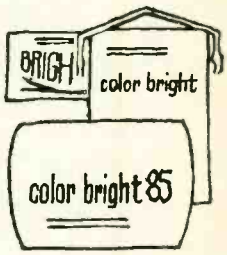


Once again this year you'll be eligible for over one hundred valuable, interesting SMB-Bright Guy gifts, just for buying the Sylvania TV replacement parts you normally buy anyway.

And you'll get window displays proclaiming you "the brightest"—the TV serviceman everyone's reading about.

You're eligible for the Bright Guy Awards just by buying Sylvania's famous *color bright 85*® picture tube. And our other picture tubes, and our receiving tubes. So see your Sylvania distributor.



Sylvania Electronic Tube Division, Electronic Components Group, Seneca Falls, New York 13148.

SYLVANIA

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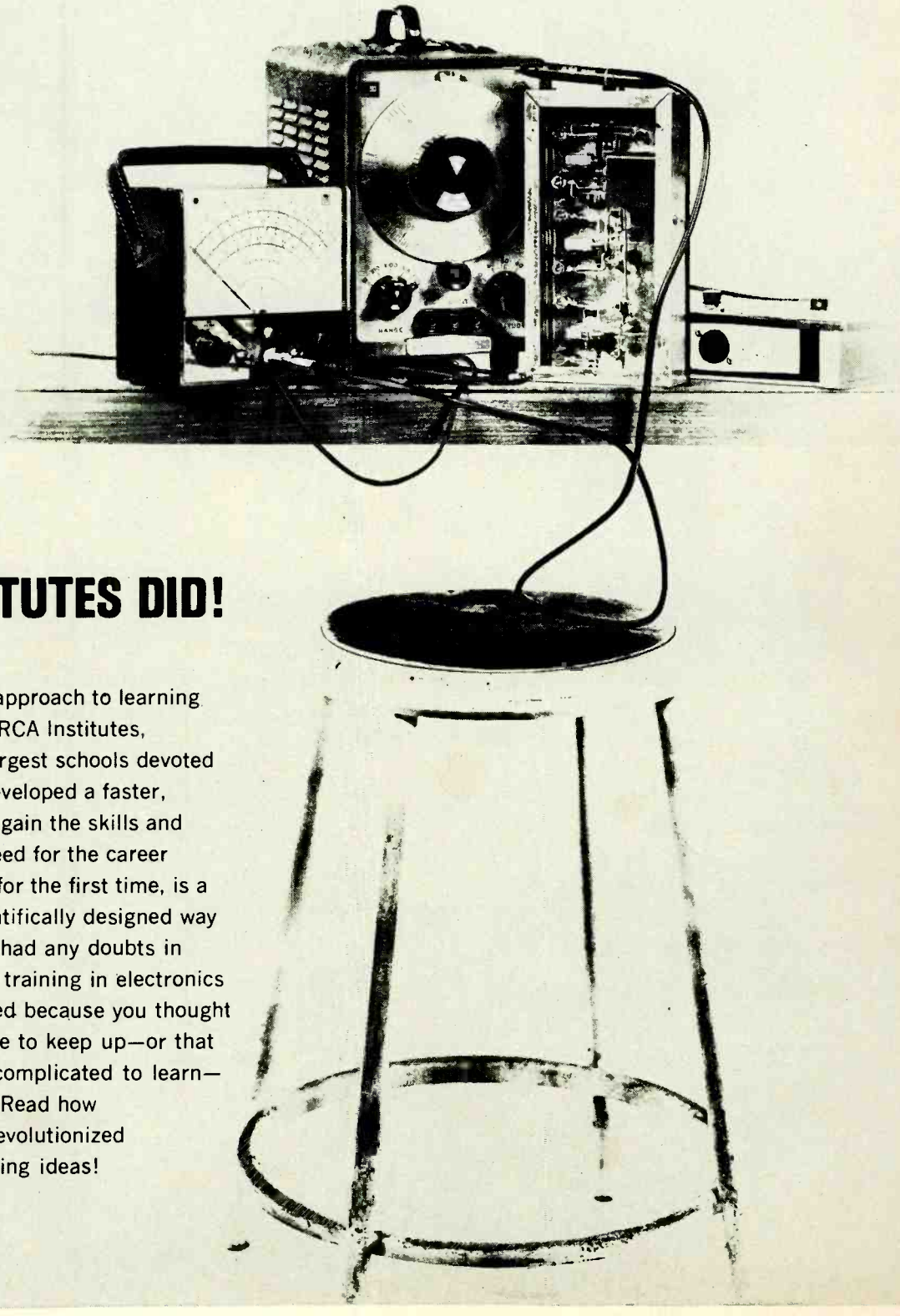
Circle 27 on reader's service card

SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



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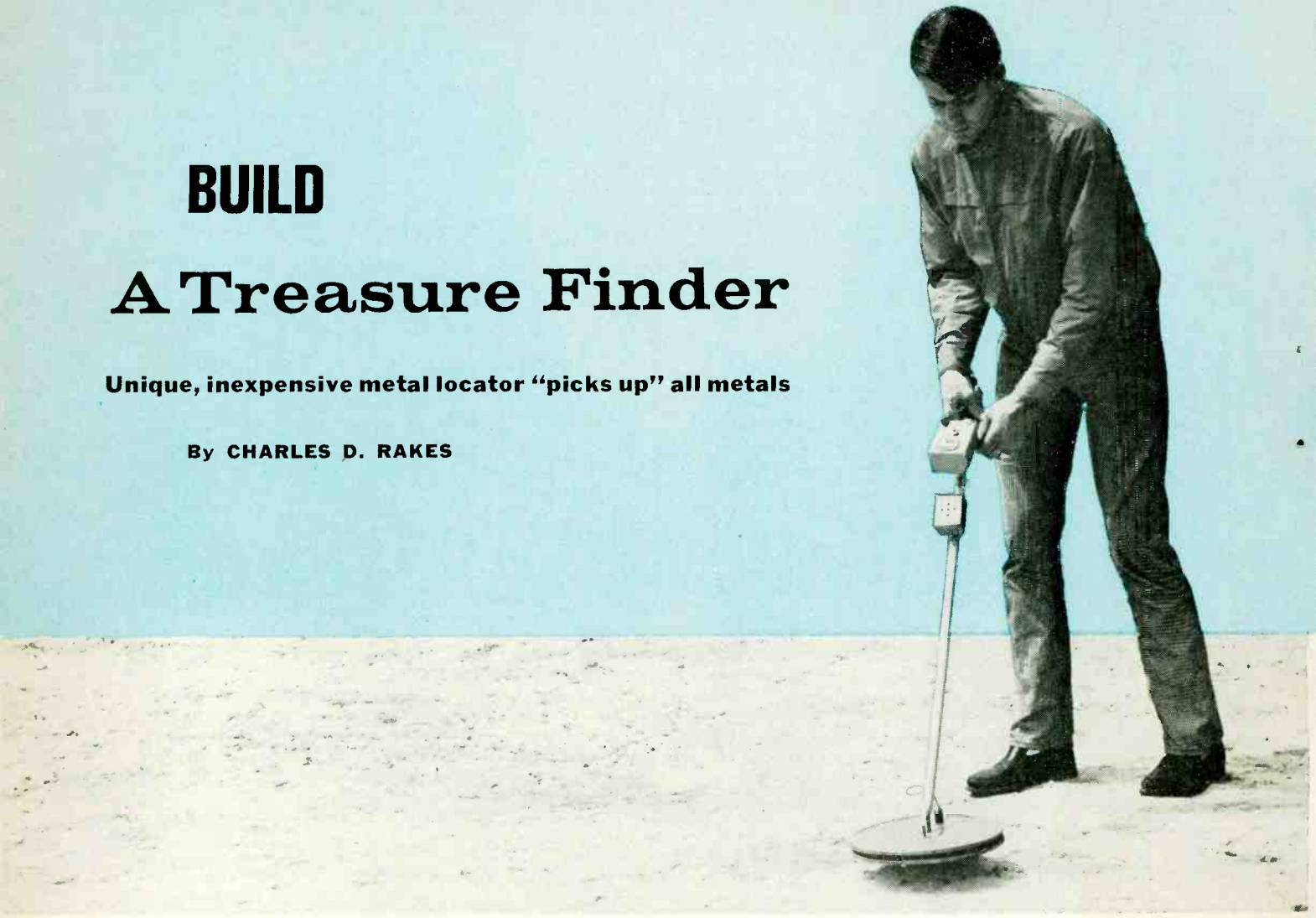
COVER STORY

BUILD A Treasure Finder

Unique, inexpensive metal locator "picks up" all metals

By CHARLES D. RAKES



FINDING BURIED TREASURE can be fun. This construction project can lead you to lost coins on the beach, keys dropped in a snowdrift, water pipes, electrical wiring and just about any type of metal object. It will detect the presence of coins and other small objects 4 to 8 inches from the search loop, and larger objects at a range of several feet.

Two popular types of metal locators are the beat-frequency and transmitter–receiver models. This one is different. It is a tuned-loop oscillator and a crystal filter acting in combination to provide sensing and indicating signals. It is simple, stable and sensitive and is easy to build and operate.

Theory of operation

As shown in Fig. 1, transistor Q1, search loop L1 and associated components form a Colpitts oscillator circuit. The frequency of operation is determined by C1, C2, C3, C4 and the inductance of the loop. Oscillator output is loose-coupled from the collector of Q1 to the base of Q2, through C5 and R4. Operating as an emitter follower amplifier, Q2 has a voltage gain of less than one. From the emitter of Q2, the signal is fed through potentiometer R8 to Q3 through the 1-MHz crystal, XTAL 1.

If the oscillator is operating within the narrow passband of XTAL 1, the rf signal will pass through the crystal (in the series-resonant mode of operation). The rf is then rectified by D2 and the base–emitter junction of Q3. The resulting dc is amplified by Q3 and indicated on milliammeter M1.

Now let's see how the circuit operates as a sensitive metal locator. Assume that no metal is near the search loop and the power is on. Adjust the oscillator to the low-frequency end of the crystal bandpass and set R8 for a meter reading of about 0.2 mA.

If you bring the search loop close to a metal object, eddy currents will be induced. These currents decrease the loop inductance, changing the oscillator frequency. The crystal filter "looks" at this slightly higher frequency with a lower impedance; passes a greater amount of rf energy to the base of Q3. The result is an increase in the meter reading.

If the oscillator had been adjusted to the high-frequency end of the crystal bandpass curve, the meter reading will drop when the loop nears metal. More about this later.

Construction

I built the crystal-filter metal locator in a deep drawn aluminum box measuring 5" x 3" x 2". All parts are mounted on the cover (Fig. 2). An aluminum utility box could be used but the mechanical stability of the deep-drawn box is preferable. Most components are mounted and wired on a section of perforated board 2⅝" x 3⅜" with push-in terminals. For best results your parts layout should follow Fig. 3 as closely as possible. Trimmer capacitor C4 is mounted facing one end of the case, as you can see in Fig. 2.

I used a removable hole plug to allow fine adjustment after the device was assembled.

Since the metal locator will be carried around, the wiring should be well fixed in place. The mechanical assembly must be rigid and free of mechanical vibrations. If not, you will be inviting instability and random operation.

Mount the perforated board on the front panel with two metal spacers 1¼" long (Fig. 2). The front panel is held in position by a 10-32 x 2¼" machine screw. For a handle, you can use a 3-foot piece of ⅞" aluminum electrical conduit. The box is attached to the handle with a bracket made from ⅛" x ⅜" aluminum stock.

Search loop

Form the ⅜" copper tubing into a 10½"-diameter circle with a gap of about 1 inch between ends. Push approximately 36" of 6-wire cable through the circle of tubing. Let the cable extend out each end about 1 inch, and cut off the remaining wire. Then strip the plastic cover from the ends of the cable, exposing the 6 wires at each end of the tubing, then connect, solder and tape the connections to form a single 6-turn coil, as shown in Fig. 4. Ground only one end of the copper shield to the ground end of the loop—that is, the end of the loop connected to the shield of the coaxial cable.

The search loop is sandwiched between two 11½" discs of ¼" plywood (or similar nonmetallic material —see Fig. 6). I used a wing nut to mount the sandwich on the handle, so the loop angle is adjustable. A length of coaxial cable runs through the handle, from the control box to the search loop. The cable connects to the loop through J1 and P1.

Calibration

With the wiring completed, the loop connected and the battery in place, you can tune up the circuit. Position the search loop so that it isn't located near any metal objects, turn the power on and set potentiometer R8 about ⅛th turn clockwise from the end. Adjust the TUNE capacitor C1 so the plates are approximately half-meshed; then remove the hole plug and slowly adjust trimmer capacitor C4 until the meter swings up scale and pegs itself. Try to leave the trimmer set so there is a meter indication of greater than half scale. Replace the hole plug and adjust the TUNE capacitor for a meter reading of about 0.2 mA.

With the meter still indicating 0.2 mA, slowly bring the loop near a metal object. If the meter reading increases

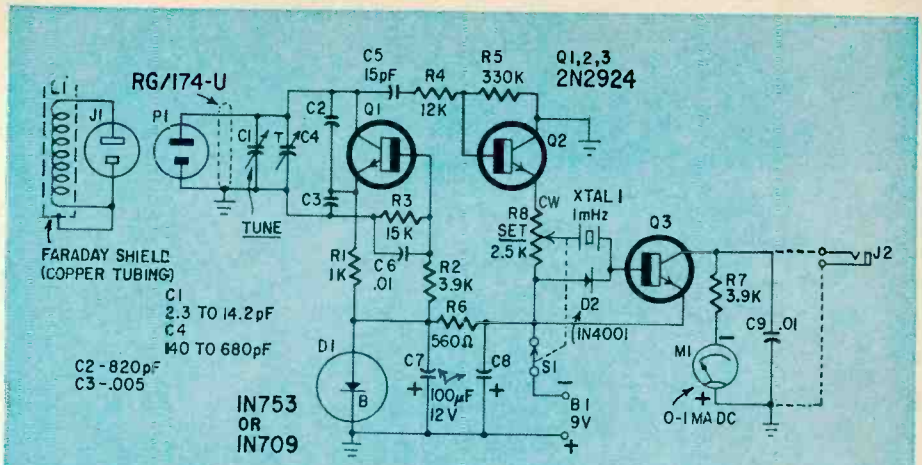


Fig. 1—Frequency of oscillator Q1 varies as search coil nears buried metal. The resulting variation in the rectified output of crystal filter shows on the meter.

Parts List for Metal Locator

B1—9-volt transistor battery, (NEDA 1604)
C1—2.3-pF to 14.2-pF miniature variable capacitor, (E. F. Johnson 160-107, or equivalent)
C2—820-pF silver mica capacitor (or better grade of disc ceramic)
C3—0.005-μF disc ceramic capacitor
C4—140-pF to 680-pF trimmer capacitor, (Elmenco 468 or similar)
C5—15-pF silver mica capacitor
C6, C9—0.01-μF disc ceramic capacitor, (Elmenco 468 or similar)
C7, C8—100-μF, 12-volt electrolytic capacitor
D1—6-volt Zener diode, (1N753, 1N709, or equivalent)
D2—Silicon diode (1N4001, 1N4002, 1N4003, etc.)
J1, P1—Two-conductor polarized connectors, one male and matching female, (Cinch-Jones or equivalent)
L1—Search loop, (see text)
M1—0–1 mA dc milliammeter, (Micronta miniature panel meter or equivalent)
Q1, Q2, Q3—Silicon transistors, (2N2924 or equivalent)
R1—1000-ohm resistor
R2, R7—3900-ohm resistor
R3—15,000-ohm resistor
R4—12,000-ohm resistor
R5—330,000-ohm resistor
R6—560-ohm resistor
R8—2500-ohm potentiometer with switch S1
All resistors ½-watt unless otherwise noted
S1—S.p.s.t. switch (part of R8)
xtal 1—1000 kHz crystal
1—34" length of ⅜"-diameter copper tubing
1—36" length of 6-conductor cable
1—41" length of ⅞" aluminum conduit or material
2—11¼" diameter loop covers made out of plywood. Masonite or similar material
1—Unit mounting bracket (see text)
2—Aluminum "L" brackets for loop and handle assembly
2—1¼" metal spacer, circuit board support
1—2⅝" x 3⅜" section of perforated phenolic board
25—Push-in terminals
1—6 foot section of RG-174/U (Belden 8216 coaxial cable or similar)
1—3" x 5" x 2" Deep-drawn aluminum box, with a matching tight-fitting outside cover.
Misc. Knobs, screws, hookup wire, solder, plastic bicycle handle grip, battery holder and snap-on terminals, etc.

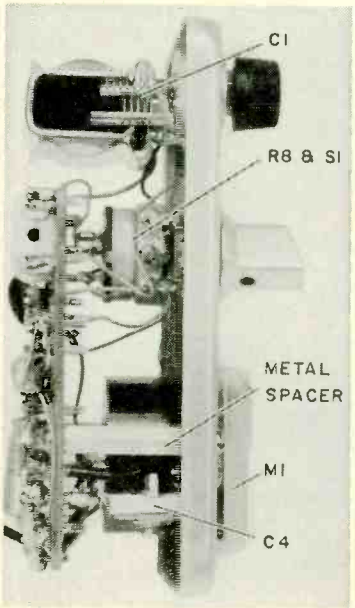


Fig. 2—Use spacers to hold perforated board on to panel.

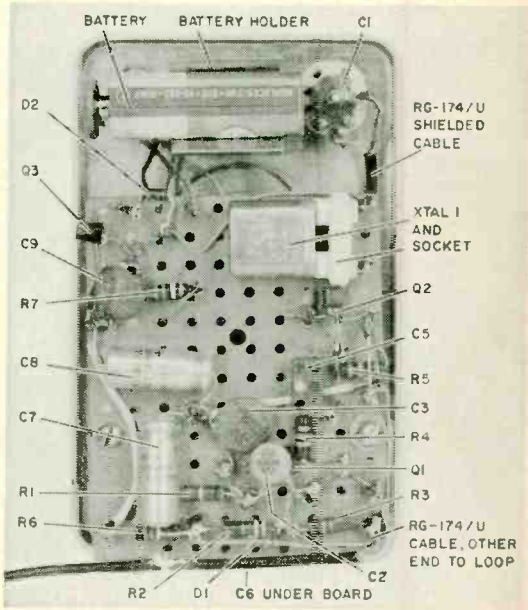


Fig. 3—Secure all components in place and follow this layout for reliable operation and stability.

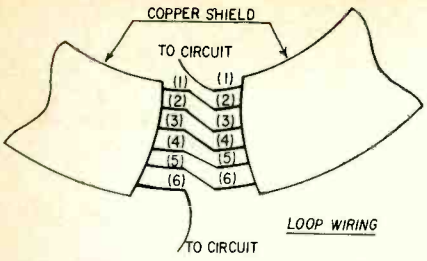


Fig. 4—Construction of the search loop is simplified by using 6-conductor intercom cable. Push it through the copper shield and connect the ends as shown.

To reduce this effect, operate the search loop approximately 4 to 6 inches above the ground.

After a bit of practice, you'll find the most sensitive operation occurs when SET potentiometer R8 is turned almost completely counterclockwise, and the TUNE capacitor C1 is set for a low scale indication.

For locating large objects near the surface of the ground, you may want to adjust the circuit for less sensitive operation. Turn SET control R8 completely clockwise and adjust TUNE capacitor C1 for a full-scale reading. Bring the loop close to a metal object—the meter reading should drop. If it does, the device is ready for large-object searching.

Fig. 5—A meter and only two controls is an indication of the locator's simplicity and ease of operation. The jack at lower left is for the audible monitor.

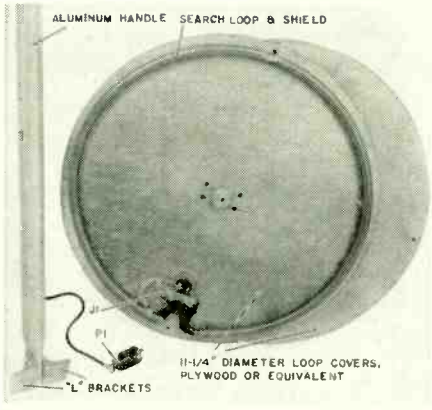


Fig. 6—Search loop is protected by plywood discs. P1 on end of coax cable connects loop (through J1) to oscillator in box on other end of handle.

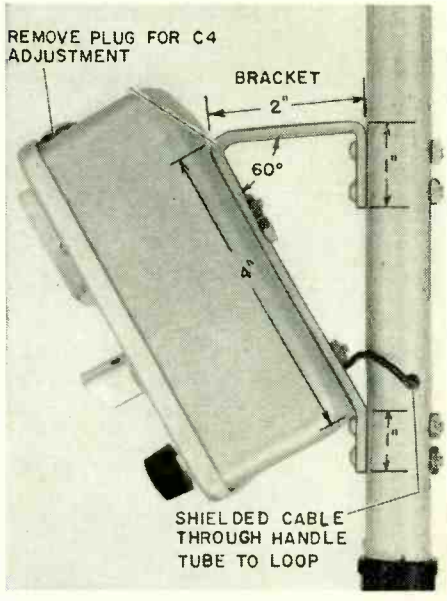


Fig. 7—Mount the oscillator box on the handle with a bracket constructed as shown from ⅛" x ⅜" aluminum stock. The angle is necessary so the meter can be easily read when operating the metal locator. Coax is threaded through handle.

sharply, the locator is adjusted to its most sensitive mode of operation. The oscillator is then working at the low-frequency end of the sharp crystal-filter curve. If the meter indication drops when the loop approaches a metal object, the oscillator is operating on the high-frequency end of the filter curve; it won't be quite as sensitive in this mode of operation.

Operation

Take the metal locator outdoors and set it up for the most sensitive mode of operation. Make these adjustments with the loop pointed away from the ground and any metal object. As the loop is lowered toward the ground the meter reading will drop slightly. This is caused by ground effect—the loop is coupling to the earth.

Sound monitor

While the basic circuit shown in Fig. 1 permits the most sensitivity, an audible indicator is sometimes useful. If you want to add what I call a Piggy-Back Squealer, build the circuit of Fig. 8. I used a 2¾ x 2" x 1⅝" metal box, and mounted it with a battery clip on the handle, below the meter box. You'll have to add jack J2 to the original circuit, connecting it in parallel with C9, as shown in Fig. 1. Any small speaker will do, if it has an 8- or 4-ohm voice coil.

The squealer loads the meter circuit slightly and reduces sensitivity somewhat. While this is no disadvantage for many jobs, you may want to unplug the squealer and go by the meter reading alone when you need all the sensitivity you can get. **R-E**

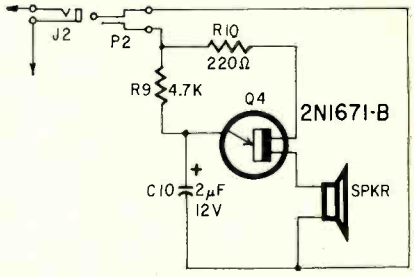


Fig. 8—A unijunction audio oscillator is the heart of the audible indicator.

Parts List for Optional Piggy-Back Squealer

C10—2-μF, 12-volt electrolytic capacitor
J2, P2—Miniature two-conductor phone jack and mating plug
Q4—2N1671B or almost any audio unijunction transistor
R9—4700-ohm, ½-watt resistor
R10—220-ohm, ½-watt resistor
SPKR—miniature speaker with 8-ohm voice coil
Misc.
Case, wire, hardware, etc.

BUILD

Stereo Headphone Control Center

Patch your headphones to your amplifier and adjust blend, balance, bass boost and volume for better listening

By PETER E. SUTHEIM

STEREO HEADPHONES are great—they provide the ultimate in separation and you aren't distracted by room noise. Only trouble is they usually don't match your amplifier output. This stereo headphone control center takes care of the matching; moreover, it gives you full control of volume, bass, blend and balance. And you don't have to disconnect it to use the speakers.

The control center can be used with any stereo headset and any stereo amplifier—unless you have a very unusual headset or an amplifier.

Controls

For controls, it has a three-position selector switch: You can choose speakers only, phones only, or both at the same time. (The third choice may seem a bit strange, but it is much appreciated where one listener is hard of hearing. He can wear the phones and enjoy the music at a suitable volume level. The others can listen at a comfortable volume through the speakers.) The switch is of the shorting (make-before-break) type to reduce switching clicks.

There is, of course, a volume control for the phones, ganged so that both channels are controlled simultaneously. A balance control compensates for uneven tracking between the two sections of the volume control, and for individual differences in hearing sensitivity between the listener's ears.

The blend control corrects for the sometimes excessive stereo separation in headphone listening. At its extreme counterclockwise position, the blend-control resistance is switched out of the circuit, allowing full separation. At the other extreme, the two channels are connected together, producing mono sound.

The bass control provides up to approximately 6 dB of boost at 40 Hz (referred to 1 kHz) to compensate for headsets whose air seal against the sides of the head is not good.

Connections

Leaving aside the convenience this box provides—which may or may not interest you—it might seem that there's a simpler way of connecting phones to an amplifier. The most obvious would be simply to connect the phones across the speaker terminals with a switch in series to turn the speakers on or off. This works, but has a couple of very serious disadvantages. First, earphones require only between

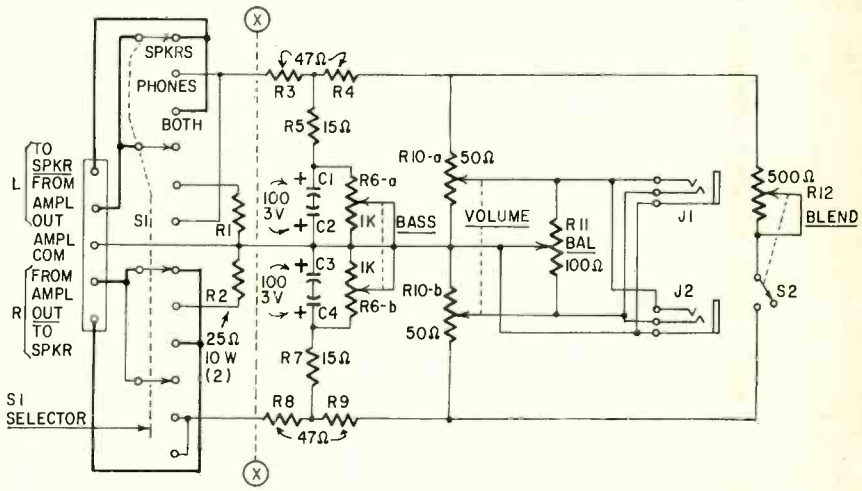


Fig. 1—Unique switching arrangement makes it possible to switch in speaker or phones only, or both. Amplifier is loaded, either by the speakers or R1 and R2.

PARTS LIST

C1, C2, C3, C4—100-μF, 3-volt electrolytic capacitor
J1, J2—Three-contact phone jack
R1, R2—25-ohm, 10-watt wirewound resistor
R3, R4, R8, R9—47-ohm, ½-watt resistor
R5, R7—15-ohm, ½-watt resistor
R6—Dual 1000-ohm potentiometer, log taper (Centralab, F5-1000 & R5-1000)
R10—Dual 50-ohm wirewound potentiometer
R11—100-ohm wirewound potentiometer
R12—500-ohm potentiometer (with S2)
S1—4-pole, 3-position shorting-type (make-before-break) rotary switch
S2—S.p.s.t. switch (on R12)
Misc.—Plastic case with aluminum panel (Lafayette 99 H 6272 or similar); barrier-type terminal strip (5 terminals)

10 and 100 *milliwatts* for quite loud volume levels. This is in the neighborhood of one-thousandth of the power output capability of typical amplifiers.

Not only is the full amplifier power unnecessary for phones, but it can destroy them in a fraction of a second by burning out the voice coils or rupturing the diaphragms. As a result, the volume control on the amplifier can be only just barely cracked open. There has to be some way of cutting the power fed to the phones.

Furthermore, the high sensitivity of the phones results in a good bit of noise along with the music. The normal amplifier hiss and hum, usually inaudible a few inches from a speaker system, become definitely audible in high-sensitivity headphones pressed close to your ears.

The usual way of solving both problems is simple and quite satisfactory: Stick a resistance in series with each "hot" earphone wire. The value most commonly used is around 300 ohms. It cuts down the power to the phones and, of course, cuts back the noise at the same time. It also reduces the damping factor to nearly zero. But, this seems to have little audible effect on phones, which have very small, low-mass cones or diaphragms with little inertia. They are usually pretty well damped by internal absorbents and by close coupling to the ear chamber.

But a load in the vicinity of 300 ohms is almost an open circuit as far as the amplifier output is concerned. It becomes necessary then to provide a dummy load for the amplifier when the speakers are switched out. The value of the dummy load is not critical. It isn't necessary, or even desirable, to *match* the dummy to the amplifier output.

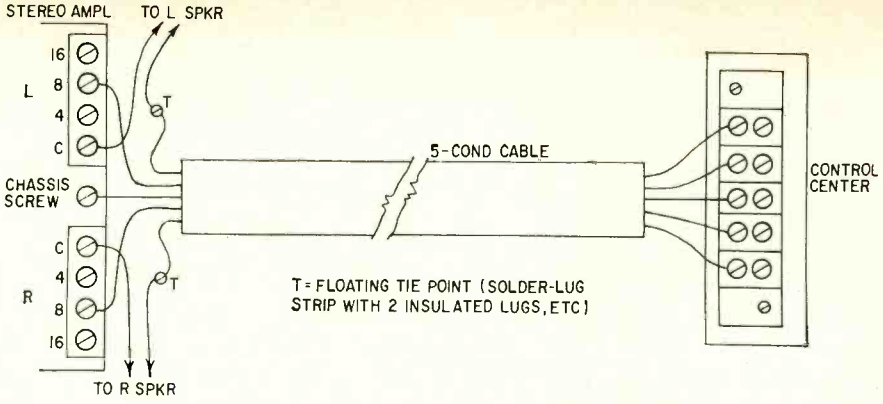
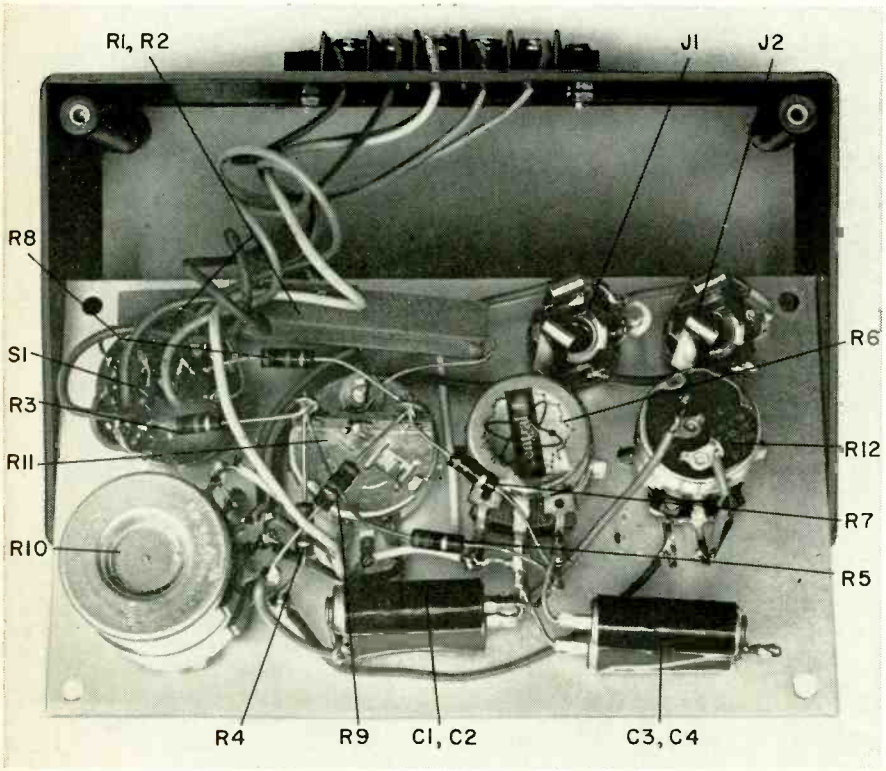


Fig. 2—To avoid undesirable power loss in the speaker wiring, don't use a cable longer than approximately 25 feet. Use impedance taps to match your speakers.

A considerable upward mismatch (for instance, 8-ohm output loaded by 25-ohm resistor) means much less power wasted in the dummy load as heat, since the amplifier will not usually develop nearly as much power into a 25-ohm load as it will into an 8-ohm load. This headphone box switches in a pair of 25-ohm 10-watt resistors (one for each channel) in the PHONES position of the selector only.

It might be worth while to digress for a moment to explain this matter of protecting amplifiers with a dummy load. In general, the dummy is most important with tube amplifiers, principally because the high inductance of an unloaded output transformer can develop peak voltages during loud signals or instability high enough to break down transformer insulation or cause arcs in tubes or tube sockets. Almost any value of load resistance less than 5 or 10 times the nominal output impedance of the amplifier will load the transformer enough to prevent this type of trouble.

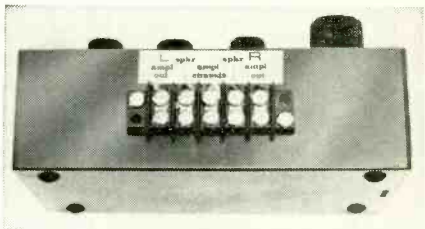
In transistor amplifiers, *shorts* across the output, rather than opens, most often cause trouble. However, it can do no harm to load the output of even a transistor amplifier in the same way. Dummy-loading may even save the output transistors if the amplifier happens to be unstable with no load. Occasionally a defective or poorly designed amplifier will oscillate with no load and damage its output transistors.



The limiting factor in parts mounting is size of the controls on the front panel. Wire position is not important; the circuit is all low impedance and high level.

Construction

Few things could be simpler or less critical to wire than this switchbox.



Shorted output circuits in a solid-state amplifier can be destructive—use a barrier type terminal strip. Note: speaker and amplifier output terminals are shown in reversed order—follow the schematic.

The low impedances and relatively high signal levels make it unnecessary to observe any precautions about wire length, shielding, routing, and so forth. Be sure, though, to use wire no thinner

continued on page 73

SERVICING HINTS ON NEW COLOR-TV SETS

Latest techniques speed troubleshooting

By MATTHEW MANDL

TODAY'S COLOR RECEIVERS are highly superior to older models—greater signal sensitivity, more picture brilliancy, a better black-and-white picture, truer colors and improved tuners. These newer sets are also much easier to set up, and maintenance is simpler.

The innovations of just a few years ago have become regular features in most sets, including automatic degaussing, up-front convergence, simplified setup procedures, and wide-angle picture tubes. There are more solid-state components, integrated circuits, simplified customer controls and tuning indicators.

With the rare-earth phosphors, you no longer have to tolerate light gray for white, or dark gray for black, on the screen. The rectangular color tube is just about standard, showing more of the transmitted picture.

TV programming is almost all in color, and people want color sets today more than ever. This means more color business for all technicians.

In color servicing, some new techniques are called for and many old procedures should be modified to do an A-1 job. There is no question that color servicing takes longer and costs more than black-and-white. The new features, however, provide a number of short cuts which enable the service technician to do a better, faster job.

Automatic degaussing

This feature is now standard on all new color sets, thus reducing callbacks. Formerly, if a vacuum cleaner was used near the receiver, or if the set was moved, color impurities showed up on the screen and a service call was necessary. Now the automatic degausser takes care of erasing the picked-up magnetism.

This doesn't mean you can throw away your degaussing coil. You'll still need it for servicing old receivers or when an automatic degaussing system goes bad.

Basically, the system consists of coils (in either a series or parallel arrangement) mounted on a metal flange around the picture tube. A typical circuit is shown in Fig. 1, where a voltage-dependent resistor (VDR or varistor) is used with a thermistor. When the power is turned on, thermistor R2 has a high resistance and current flows through the lower-resistance coils and varistor R1. The resistance of R1 decreases as the voltage across it increases. The magnetic field set up around the coils demagnetizes the metallic components of the tube.

Some current flows through the high resistance of the thermistor to the low-voltage power-supply circuits. As the power supply draws more current, the thermistor heats and its resistance decreases, permitting even greater current flow through it. As less current flows through the varistor, its resistance increases, thus helping to route all current to the power supply and none through the degaussing coils. (In some systems a thermal switch is used instead of the varistor.

If one of the degaussing coils or the varistor opens, your degaussing job during a service call will be temporary and callbacks will be necessary. If the thermistor opens, it will cut off the low-voltage supply and kill reception.

Quick check for an open condition: turn the set on and get a black-and-white picture; then use your degaussing coil to magnetize screen areas deliberately. This can be done by placing the degaussing coil against the tube face *while energized*, then releasing the degaussing switch while the coil *is still at the tube face*. The collapsing field resulting when current is shut off produces a dc component which magnetizes. (This is why the normal procedure is to keep the coil energized and back away about 6 feet before shutting it off.) Colored areas will appear on the screen and should be quite evident on a b-w picture (or raster).

Now turn the set off and wait 5 minutes or so for the thermistor to cool. Turn the set on and see if the color areas are still visible. If they are, the degaussing circuit is defective or sluggish. (There's insufficient current through the coils or they're intermittent.) If a coil replacement is necessary, make sure you position the new one the same as the old one (so it will be effective over the same area). Use exact replacements for the varistor and thermistor to assure proper resistance values during their hot and cold states.

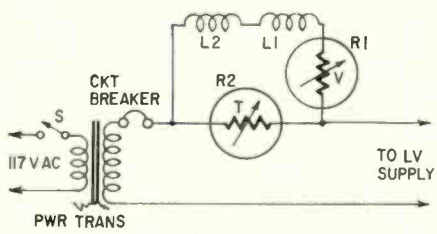


Fig. 1—The usual automatic-degaussing circuit used in a modern color-TV set.

Other VDR uses

Voltage-dependent resistors are found in several circuits of the new color sets. RCA uses one in many of their late color receivers to stabilize vertical scanning. Have you ever set the raster height just above and below the picture-tube mask, only to find later that the picture seems to have shrunk? Often line-voltage variations cause this. Increased voltage stretches the raster; decreased voltage shrinks it. A VDR takes care of this problem in the circuit of Fig. 2.

The grid bias for the vertical output tube is determined by the setting of the HEIGHT control. For normal operation, the cathode is 50/60 volts

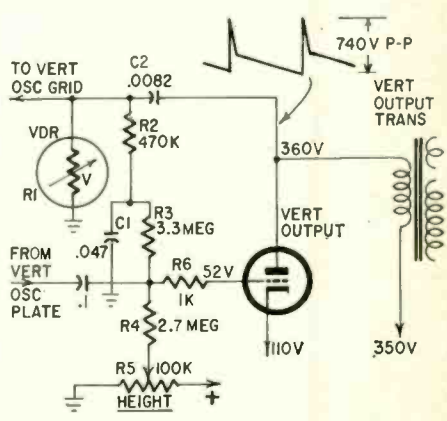


Fig. 2—RCA color chassis (right) uses a VDR to stabilize vertical scanning.

more positive than the grid. The grid bias is developed by a B+ voltage divider consisting of R1, R2, R3 and R4 fed from the arm of HEIGHT control R5. Picture height is stabilized against changes in ac line and B+ voltages by the action of the voltage-dependent resistor (R1).

During each scanning period, the high-amplitude positive-going retrace pulse charges C2 with a negative potential on the plate connected to the VDR. The time constant of C2's charging path is very short, while its discharge time constant is long. Thus, C2 maintains its charge for a period longer than the vertical sweep interval. This negative charge determines the effective value of R1.

If the amplitude of the retrace pulse increases, the higher charge on C2 causes the VDR's resistance to drop. This brings the tube's grid closer to ground, effectively increasing the bias and reducing the gain to restore the amplitude of the vertical output pulse to normal.

Conversely, if the sweep amplitude drops, due to a weak tube or low line or B+ voltage, the VDR's resistance increases. This makes the grid more positive, so the tube's plate current increases and compensates for the loss in height which would otherwise occur.

RCA also uses a VDR to stabilize the focus voltage. As with the vertical circuit, a self-stabilizing function prevails as long as the VDR is not defective. Zenith, Philco, Silvertone and others also use a VDR in their horizontal and high-voltage systems for regulation.

Reducing no-charge callbacks

If you have to go back to a customer's home to replace a defective tube you've installed just a few weeks ago, don't blame the tube manufacturer. Maybe you overlooked some basic facts of life in troubleshooting modern color sets.

Not only is tube replacement what you do the most of, the horizontal and high-voltage systems are often highest on the list of offenders. The reason, of course, is the complexity of these stages, particularly in modern color receivers. There are horizontal-sweep, high-voltage, boost, shunt-regulator, focus-rectifier and damper functions. Add pincushion correction and you have an imposing array of electronic units which can go bad!

It's one thing when troubles develop of their own accord, and quite another when you unconsciously cause them by your service procedure. Then you're in for "no-charge" callbacks.

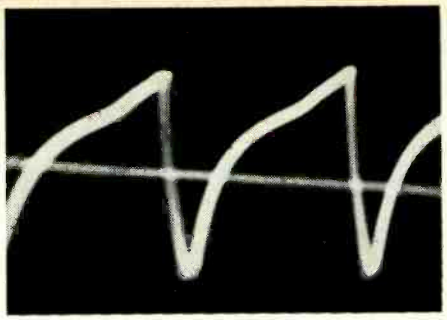


Fig. 3—Horizontal-output grid waveform dip shows nonlinearity due to improper bias. A result can be short tube life.

With the higher voltages used in the new color sets, you must *not* replace a defective horizontal-output tube unless you are sure the horizontal-oscillator section is operating properly. Otherwise, the new output tube may last only a few months, weeks, or even a few hours!

Examine horizontal output circuits and you'll find—in almost all cases—the cathode of the horizontal output tube at ground. The specified dc grid voltage, however, may range from a low of −40 to as high as −70. Since the cathode is grounded, the bias is obviously obtained from the horizontal oscillator system.

In normal operation, the horizontal output tube has a plate dissipation around 15 watts. Decrease negative bias at the grid and plate dissipation shoots up rapidly; it may even exceed 100 watts! If the drive signal is excessively low, the increased plate dissipation may cause the circuit breaker to open or the fuse to blow.

When grid drive is only slightly low, however, plate current may not be high enough to trip the breaker. In this case, the increased plate dissipation overloads the tube and materially shortens its life, causing callbacks.

Some technicians replace both the horizontal oscillator and the output tube when they find only the output tube bad. Even if you do this, measure the dc grid voltage and be sure it's correct. Also, look at the grid waveform with a scope and compare it with what the service notes show. The waveform of Fig. 3 for instance, indicates sweep distortion because there is a dip near the top of each sawtooth, which affects linearity on the right of the screen.

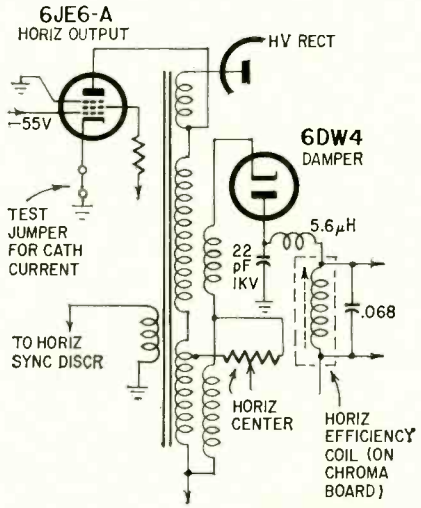


Fig. 4—Silvertone 7190 series chassis.

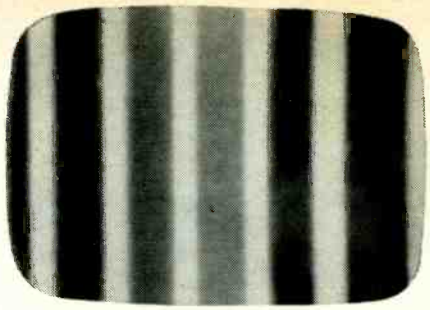


Fig. 5—Result of misadjusted or defective blue-shaping coil. Note thickening of the bars on right. They should be linear.

Efficiency-coil adjustment

If misadjusted, this coil can shorten the life of a horizontal-output tube by increasing its plate dissipation. Thus, a chassis that goes rapidly through flybacks calls for a readjustment of the efficiency coil if the horizontal oscillator system checks out all right. For proper adjustments it is necessary to read cathode current in the output tube, and many color receivers have a removable jumper or link for opening this circuit, as shown in Fig. 4.

You'll usually find the efficiency coil on the chroma board. Adjust the core slug for a dip in cathode current, as read on a milliammeter in the cathode circuit. After you've reached the lowest current point, gradually adjust the slug and raise current by approximately 10 mA (or the value specified by the manufacturer). Never permit the minimum cathode current to exceed the level specified by the set manufacturer. Then set the brightness control at minimum and adjust high voltage to 25 kV (or as specified in the service notes). Make sure your vtvm and high-voltage probe are accurately calibrated.

Blue shaping coil

Despite its name, this is *not* a convergence coil. If this coil is improperly set it will not only damage the output tube, but will cause horizontal nonlinearity. A vertical bar pattern indicates this trouble by a thickening of the right-hand bars, as shown in Fig. 5.

(continued on page 91)

Rotary Stepping Switches—They're Everywhere

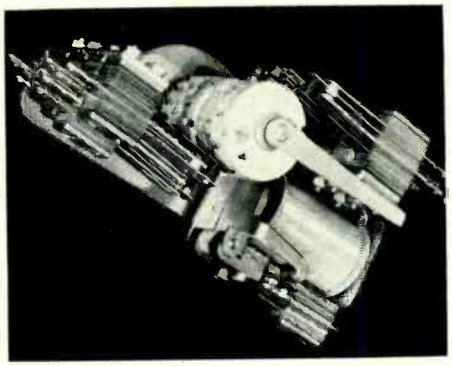
Part 1—How they work and what you should know about them

By TOM JASKI

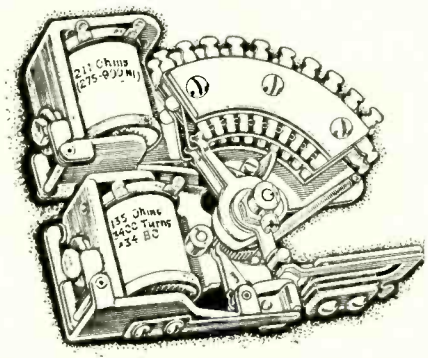
EVERY TIME YOU DIAL A TELEPHONE, YOU activate nearly a dozen electromechanical devices whose functions you probably have never figured out clearly. The voltage pulses produced by an interrupter switch, in the telephone base, travel through the phone line to the nearest central office. At this office, the call is routed by the actions of a series of rotary stepping switches.* These switches perform jobs that would take many relays, and they do these jobs faster and occupy less space than relays do.

Wired a certain way, steppers can perform the same operations over and over again. They provide complete isolation between controlling and controlled circuits. These desirable characteristics are two of the reasons telephone systems still use steppers. Other uses: remote control of radio and TV transmitters; counting items on a factory production line; selecting circuits for monitoring gas pressure, liquid volume, heat and cold, and similar measurements in factories and warehouses.

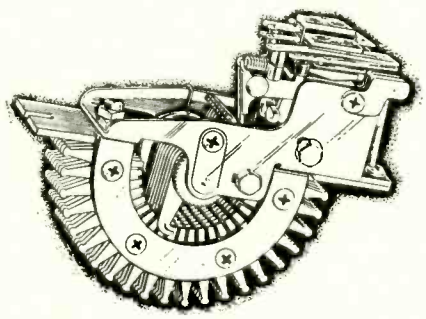
Abundantly available in surplus for some years now, rotary stepping switches were used as *line finders* in early automatic telephone exchanges. In association with Strowger switches† (two-motion, 100-point switches) they have, since 1918, carried literally billions of signals.



A cam-operated relay with 36 separate steps per cam and 3 banks of switches.



The minor switch has a motor and a release magnet, and a maximum of 10 steps.



This 22-point rotary switch has 6 contact levels and a set of interrupter springs.

Cams

Apart from the Strowger switch, there are four basic types of rotary stepping switches (or rotary stepping relays, as they are sometimes called). First, there is the pawl-driven relay, with cams which open and close contacts. The top photo shows one example. Each set of contacts is completely separate from the others. Regular relay-type contacts and springs are used in any assortment that is normally used on relays. Cams are available with up to 36 intervals. For each revolution of the shaft, the contacts can be opened or closed as much as 36 times.

In addition to *working* contacts, some rotaries use *off-normal* and *self-interrupter* contacts. *Off-normal* contacts are actually a form of reset. They are operated by a separate cam, only *once* per revolution, and only when the switch has been stepped away from a rest or "home" position.

Self-interrupter contacts are made for the heavy duty of interrupting the motor-magnet current without excessive arcing. They are operated by the armature directly, in the off position. Thus, if the current is supplied to the magnet through the interrupter, the coil will energize, open the contact, de-energize, close the contact, and so on. The rate of self-interrupted operation is limited by the mechanical inertia of the moving parts, and is often further decreased by external circuitry.

The working contacts on this stepper are limited to three stacks, and the relay is not particularly suited to such operations as selection. It is designed for sequential operation where only a few contacts are needed.

The driving mechanism for this relay, as for other stepping switches, can be either *direct* (the motor magnet operates the pawl directly) or *indirect* (the magnet charges a spring which operates the pawl when the coil de-energizes). The indirect drive is more reliable, for each stroke is exactly the same as the one before—even if the coil current varies, and provided the relay operates at all.

Single wipers

The second type of stepping switch (center illustration) has been used for some time in telephone work. It's called a *minor* switch, because it is often used with a Strowger, or *major*, switch. The one shown is directly driven. Its shaft is driven by a pawl and ratchet, which are driven in turn by the motor-magnet armature. The shaft carries fingers which wipe across 10 contacts in each layer or *bank*. A minor switch may carry as many as 6 banks of contacts.

In this type of switch, the dog that holds the ratchet is not fixed, but is at-

*A few newer central offices use crossbar or solid-state message routing. Most US telephone systems, however, still use stepping switches.

† Strowger switches are not discussed here.

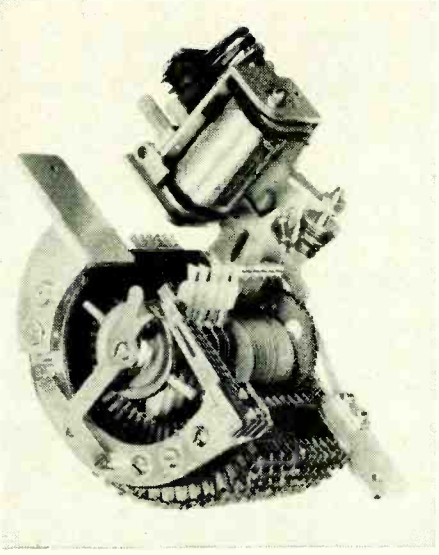
tached to another arm. This arm can be operated by a second magnet, the *release* magnet. When energized, the release magnet causes the dog to be lifted from the ratchet, and a return spring pulls the contact wipers back to "home" position. Note the off-normal contacts operated by the roller cam on the shaft. A self-interrupter, if used, would be operated by the motor-magnet armature directly.

Double wipers

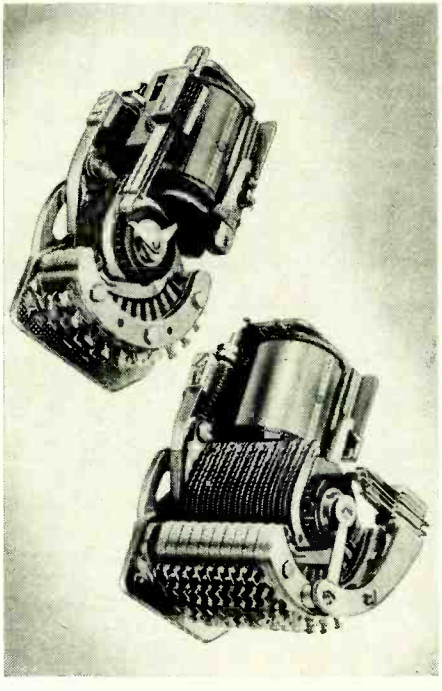
The third and older type of rotary switch (bottom picture page 39) has a double set of wipers. By continuous rotation, one wiper from a set always touches at least one contact. There's no return mechanism; to get to the starting position, the switch must be stepped *forward* to "home." As in previous examples, off-normal contacts and a self-interrupter can be used here. The switch can accommodate up to 6 banks of 22 contacts. Wipers can be so connected and adjusted that 2 banks can be scanned sequentially. Thus the switch can have 44 contacts in 3 levels.

A modern version of this kind of rotary switch is the Automatic Electric type 45 (see photo). This is an indirectly driven switch with 25 contacts per bank; a maximum of 10 banks per switch can be used. The contact banks are removable so that as few as are needed can be used. In addition, the wipers can be arranged so that instead of 10 levels of 25 contacts there are 5 levels of 50 contacts.

Photo at right shows two compact rotary stepping switches, the Automatic Electric types 40 and 80. These are also indirectly driven. The contacts are mounted in a 120° arc, and each set of wipers has three parts. Continuous scanning of 10, 20, or 30 contacts is thus possible. The type 40 has a maximum of 6 levels, and the type 80 has 10. These switches are very compact, the 40 requiring hardly more space than an ordinary telephone relay. Various types of contacts are available—shorting, nonshorting, gold-plated, etc. So are different coil voltages. Note again the off-normal contacts and also the arm on the coil armature. This arm can be used to operate interrupter contacts.



The Automatic Electric type 45 switch.



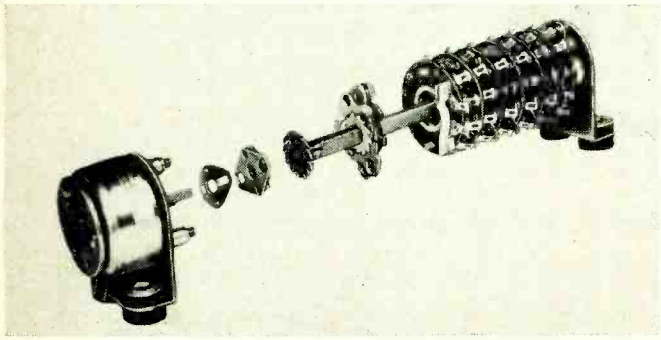
Compact steppers with 11 contacts each.

A different type of construction is used in the Ledex rotary solenoid (see photo): the contacts are mounted on conventional rotary-switch wafers. The switch operates as follows: The armature has a collar with three sloped ball races; the housing has three corresponding ball races. The armature collar rides on these balls, and a spring rotates the armature so each ball rests in the shallowest part of its race; this is with the coil not energized and with the armature as far out of the coil as possible. When the coil is energized, the armature is pulled into the coil. This causes the armature to rotate against the spring. Rotation is 30° for each step. An index mechanism prevents the shaft from returning with the armature. On the original Ledex switches, standard switch wafers were used, and these are the kind found in surplus stores. Later models (see photo below) use relay contacts for greater reliability and heavy-duty switching.

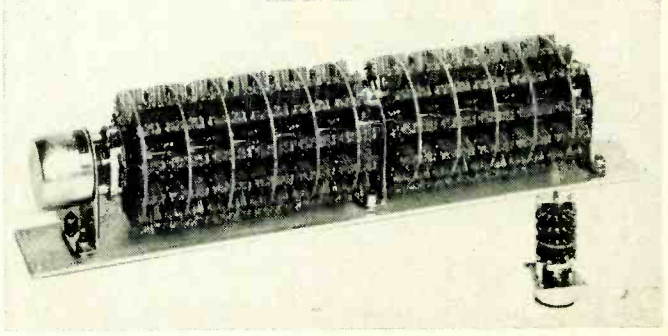
Switch diagrams and circuits

When considering control diagrams for rotary switches, it does not matter which type of switch is used (excepting the minor switch) so long as there are sufficient contacts. Otherwise, switches differ mainly in the amount of current required for operation and in the current their contacts will carry.

Fig. 1 contains both telephone and industrial symbols for the steppers, relays and associated components in the control diagrams that follow. Industrial symbols are used for simplicity, but telephone-type symbols are also shown to permit comparing these diagrams with those of manufacturers. For those



Conventional switch wafers are used in this rotary stepper.



Ledex rotary switch uses relay contacts for heavy duty.

Industrial and Telephone Symbols

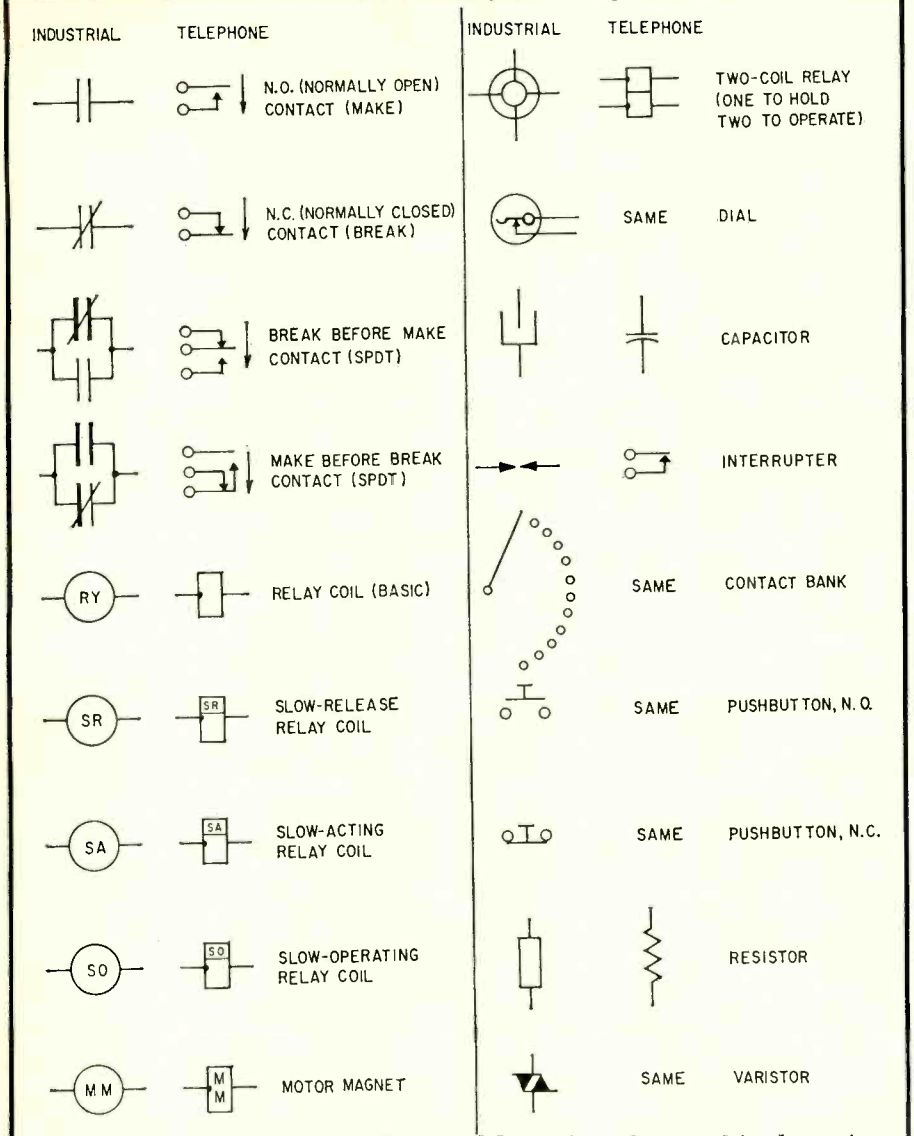


Fig. 1—Industrial schematic symbols are different from those used in electronics.

of you unfamiliar with industrial diagrams, many of these symbols will take a little getting used to. The same is true of the industrial-diagram practice of separating the essential elements of devices, such as coils and relay contacts. However, this technique results in simplified schematics which show the sequence of events. Fig. 2 is a simple example. Like most circuit diagrams, you read it from left to right.

Pulses arrive at the left of the diagram. Since the pulse line is usually long, it must not carry the heavy current necessary for operating the motor magnet of the stepping switch. The pulses trigger low-current relay coil 1CR. The coil, which is energized by each pulse, closes contacts 1CR-1 which are in series with the motor-magnet coil. The motor magnet then causes the armature to advance a step each pulse.

Contact arc suppression

Since the motor magnet may cause arcing across contacts 1CR-1, an arc-suppressing network consisting of a resistor and capacitor in series are shunted across this coil. Values are determined by coil current and voltage, and range from .005 to 0.5 μF for capacitors and from 10K to 0.5 meg for resistors. Exact values are usually found through trial and error.

In Fig. 3 the arc-suppressing network is replaced by a varistor, a semiconductor element which increases its resistance as the applied voltage increases. The result, in either case, is a slow damping of the magnetic energy in the coil. This energy, produced by the collapsing magnetic field, creates the contact arcing.

The circuit of Fig. 3 is that of a semiautomatic selector. Incoming pulses energize relay 1CR. This relay does two things: through contact 1CR-1 it energizes the motor magnet of the stepping switch, and through contact 1CR-2 it triggers slow-release relay 2CR.§ A normally closed contact (2CR-1) prevents the connection of the wiper to the battery at each step. When the proper controlled circuit has been selected, the pulses cease. After a short delay, relay 2CR closes its contacts.

Two things now happen: The se-

continued on page 64

§Relays are slowed down by placing copper slugs at the armature end of the coil (for slow release), the heel end (for slow acting) or both (for slow operating).

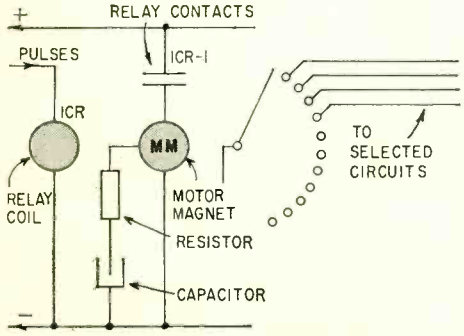


Fig. 2—Simple remote-control circuit.

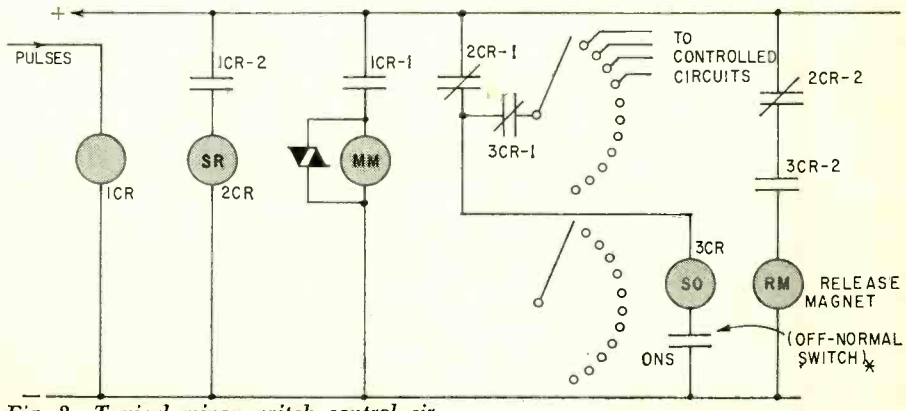
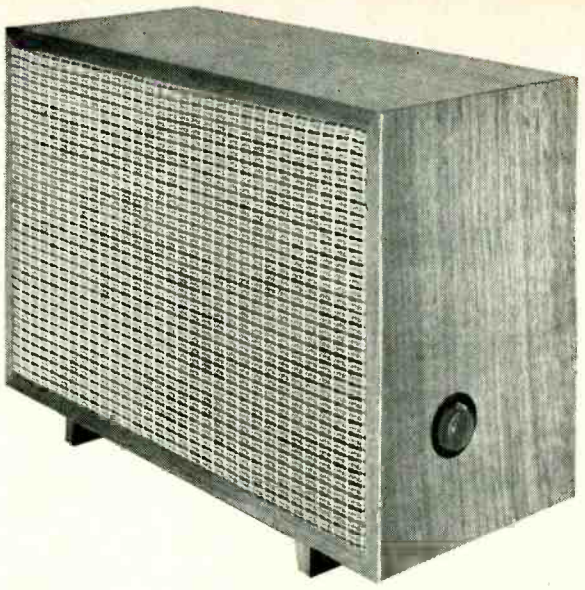


Fig. 3—Typical minor switch control circuit has semiautomatic selector feature.

WOOFING THE TWEETER



How to get more bass out of small speakers

By JIM McCORMICK

SMALL SPEAKERS ARE INCONSISTENT. They are efficient or inefficient, depending on frequency. Low-frequency response is limited and their response is often closer to a tweeter than a woofer. I decided to make one inefficient and bring up its lows for better performance. It was a 4-inch extension speaker in a tiny cabinet. The cabinet was stuffed in an effort to kill (or at least badly cripple) resonance. The efficiency of the cone, which tapered upward with frequency, was slapped back down by an electronic taper in reverse.

Plugged into a cheap radio set, the little loafer turned out to be a honey. Out came the deep natural sounds of the gut bucket, the tuba, and Senator Dirksen. And even when volume was reduced to a barely audible level, the lows were still there.

How often do you listen to the hi-fi rig? How much more time than that do *you* spend listening to small speakers horribly enclosed in table-model radio and TV sets? With nary a tone control to mitigate your misery? To give your ears a break, install a closed-circuit jack at the rear of each of these sets so you can plug in this inexpensive (but properly enclosed) extension speaker.

Before you choose the speaker, consider the volume you will require. Maximum volume in a low-cost speaker, before the onset of distortion, is determined roughly by cone size. For strictly personal listening, choose any size from an 8-ohm earphone up; for family listening, 5 to 8 inches.

Fig. 1 shows the woofing treatment. C1 and C2 are 300-μF electrolytics, back to back. Diodes D1 and D2 pump up a dc potential to keep the dielectric formed. The resulting 150 μF is used to shunt the speaker. At 50 Hz, where the cone's air coupling is poor indeed, the capacitive reactance is about 21 ohms, a not-too-severe shunt across an 8-ohm voice coil. The efficiency of the cone's coupling rises rapidly with increasing frequency, but so does the severity of the capacitive shunt: 10.5 ohms at 100 Hz, 2.1 at 500 Hz, 0.21 ohms at 5,000, etc.

Obviously, the highest frequencies are about to be chopped off completely —or nearly so—which is the reason for R. Pure resistance is tone-deaf. R is a window through which all frequencies can reach the voice coil. If the window is opened wide enough to admit voice sibilants, you may be sure it is also open to all frequencies up to and beyond the limit of audibility. In practice, R is adjusted to suit the nature of the amplifier and of the input material.

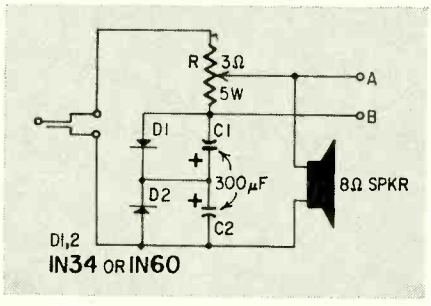


Fig. 1. Circuit rolls off the highs, but enclosure smoothens out the bass response.

Parts List

C1, C2—300-μF, 6-volt electrolytic capacitor (Sprague TE-1106, or similar)
D1, D2—Germanium diode (1N34, 1N60, or what have you?)
R—3-ohm, 5-watt potentiometer (Mallory VW3, or similar)
Misc.—One 8-ohm, fully enclosed speaker; plug and cord; closed-circuit jack; slab of 1-inch foam rubber; knob, etc.

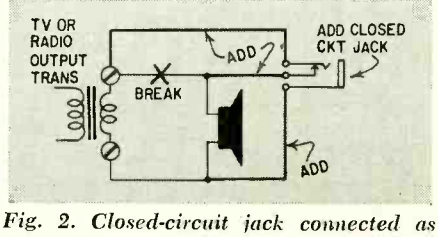


Fig. 2. Closed-circuit jack connected as shown lets you plug in another speaker.

Magnet and capacitors join forces to damp the voice coil at middle and upper frequencies, just as the secondary of the output transformer and the magnet do at the lowest frequencies. This damping helps to keep the speaker from adding color of its own to the input material. You will appreciate this characteristic in the clarity of speaking and singing voices.

The woodworker who builds his own enclosure can write his own ticket. He can, for instance, enclose two 4-ohm speakers and connect them in series for the 8-ohm total. He will get better dispersion of directional highs because of the double source. Or he could use an 8-incher and four tiny tweeters. The tweeters (used because of cone and voice-coil inertia) need handle only the highest frequencies.

You cats who don't dig all this low-level stuff and want to enclose a large speaker—or a multiple array of small ones to get window-rattling volume—may as well forget the "woofing" business. You have enough cone area to get good bass output anyway.

If you happen to lack shop facilities, and are willing to pay for relief from ear torture, you can get help from your neighborhood service tech. He will find a way to install a closed-circuit jack in your miserable-sounding radio or TV set. (Resourceful, these men.) He will also order the extension speaker you choose. Give him this story and, when the speaker arrives, he will install the "woofing" parts and wiring.

The speaker pictured had a 20-ohm pot for a volume control. This was removed and a 3-ohm pad mounted in its place. A new knob with setscrew replaced the push-on knob. The capacitors are

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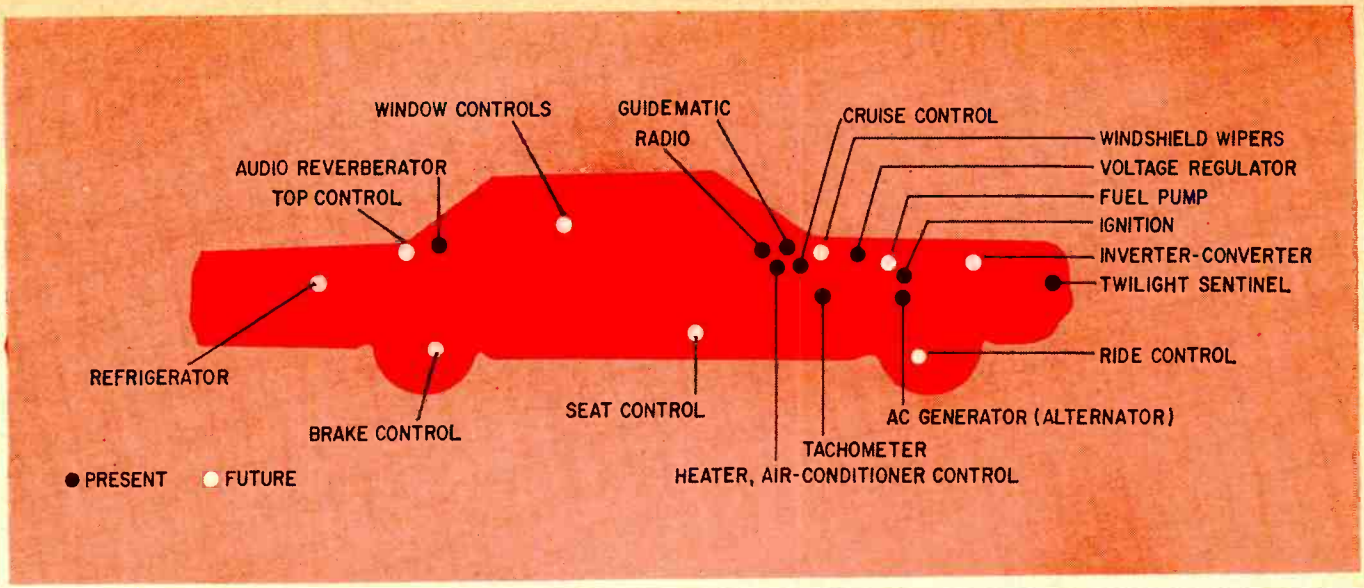


ELECTRONICS IN THE MODERN AUTO

Each year cars become more electronic. Now they're using silicon controlled rectifiers, Zener diodes and integrated circuits. From ignition to voltage regulation, more tasks are being done by semiconductors

By FRED W. HOLDER

DURING THE YEARS BETWEEN 1940 and 1960, the annual output of American auto manufacturers increased 3 million units with only minor changes in the basic automotive electrical system. Since 1960 production has risen another 3 million units. But now change is the rule rather than the exception.

The electrical system in a modern American car incorporates a broad range of electronic circuits. Most of these make extensive use of one or more semiconductor devices. Transistors, silicon controlled rectifiers (SCR's), integrated circuits (IC's) and other solid-state components give more snap to ignition systems, better-regulated alternator outputs, auto-dimming headlights and hi-fi stereo on the highway. Today's auto mechanic must be part electronic technician to repair electrical systems effectively Table I lists several additions available either as standard equipment or as factory options on new cars.

Ready availability of low-cost semiconductors spurs accelerated application of electronic circuits to automobiles. Table II gives you some idea just how many semiconductors presently are used in GM cars; for instance, the total of all types listed ranges from 119 to 129 individual solid-state components in available options.

According to one industry report, United States automakers spent nearly $20 million on semiconductors in 1963; by 1975 they will purchase about $55 million annually. The same report suggests that automobile manufacturers may replace computer manufacturers as the leading consumers of semiconductor devices. With the average price of automotive semiconductors about 25 cents, it's easy to see what widespread impact car-borne electronic circuitry will have on the continued good health of semiconductor manufacturers.

The semiconductor diode, with its small size and high current-carrying capability, has helped alternators replace generators. The transistor gave us a hotter ignition system and a better voltage regulator, to say nothing of more compact radios and stereo tape decks. Now, with lower prices for SCR's and IC's even greater things are in store.

Alternators	Transistorized Burglar Alarms
Solid-state Voltage Regulators	Warning Devices (Overspeed, Lights Out, etc.)
Transistor Ignition Systems	Speed Controls
Capacitance-discharge Ignition Systems	Automatic Climate Controls
Photoelectric Headlight Controls	Transistorized Radio Receivers and Transmitters
Lights-off Delay Circuits	Transistorized Stereo Tape Systems

TABLE I. Automotive Electronic Features

Voltage regulators

In 1963, American Motors installed the first solid-state voltage regulator in its cars. This regulator was built by Motorola. Currently, American Motors, the Pontiac Division of GM, and Kaiser Jeep are the only manufacturers furnishing solid-state regulators as standard equipment. The prime advantage of this new breed of regulators is their nonmechanical switching of the alternator's field-current

Item	Rectifiers	Low-Power Diode	Zener Diode	Thyristor	Transistors			Thermistor
					Low Power	Medium Power	High Power	
Alternator	6							
Voltage Regulator			1			1	1	1
Guidematic		1			4-6			
Twilight Sentinel		2			2			
Electrocruise		1				1		
Comfortron		1			1	1		3
C-D Ignition		8	1	1	4	1		
AM Car Radio		3			5-7		1	
AM/FM Car Radio		8	1		10-12		1	
AM/FM/Stereo Car Radio		12	2		20-24		2	
Delco Stereo Tape Player		2			8		2	

TABLE II. Quantities and Types of Semiconductors Used in GM Automobiles

GM's Guide-Matic solid-state headlight dimmer (right) replaces vacuum-tube unit.

supply. The solid-state regulator functions as an electronically controlled, solid-state switch.

A simplified version of the Motorola voltage-regulator circuit used on 1967 Rambler American cars is shown in Fig. 1. When voltage at the alternator output terminal rises higher than 14.4, Zener diode D1 conducts to supply current to the base of Q1. Transistor Q1 turns on and reverse-biases Q2, which turns off the current supplied to the alternator field winding. When alternator output falls below 14.4 volts, the Zener diode stops conduction, Q1 turns off, and Q2 allows current to flow once again through the alternator field coil. This switching action of transistor Q2 occurs many times a second. Because the switching rate is high, no variation can be detected in the alternator output.

Thermistor R4 is a temperature-compensating resistor, the resistance of which varies with temperature to control the operating point of the Zener diode. This compensation produces a higher system voltage in cold weather, when needed, and a lower system voltage in warm weather.

In 1968, an integrated circuit similar to that shown in Fig. 2 will likely be used on most Ford and Chrysler models. This IC version will be similar to an earlier transistor regulator, except that a Darlington-type output will be used instead of the more conventional cascaded circuit. The current-carrying capacity of the circuit should be high enough to meet the expected increasing electrical load in autos for the next 5 years.

In the circuit shown, R5 and C1 set the basic operating frequency, allowing the system to be pulse-width-modulated for continuous control.

Ford and Chrysler probably will use a modified TO-3 package in their regulator. The unit most likely will be mounted directly to the alternator in the form of a block measuring 1.8" x 1.8" x 0.4". This arrangement, with the block bolted flat against a machined surface on the alternator housing, will permit the housing to serve as a heat sink.

Delco-Remy, a subsidiary corporation of GM, is making a similar IC voltage regulator for heavy-duty trucks, coaches and off-road equipment. The Delco regulator is expected to appear on the 1968 models of GMC trucks. A 5-year design life is planned for these first automotive IC devices. By 1973, auto electrical systems are scheduled for conversion to 24 volts, and a new generation of regulators having greatly increased capacity will replace the first IC regulators.

Ignition systems

The next element of the auto to benefit from modern electronics technology will be the ignition system. Ford already has developed two static systems, using discrete germanium components. One of these, a contact-actuated transistor system, has been offered as an option since 1963. The other, a variable-coupling contactless system, may be offered on 1968 models. GM has had a contactless transistor system available as an option since 1964.

Roughly 150 to 200 different commercial transistor ignition systems are on the market at present. In all of them, a high current is furnished—through one or more power transistors—to the primary of the ignition coil during the time the contact points are closed. When the points open, the transistors turn off. A high voltage results from the rapidly collapsing magnetic field around the coil. A diode arrangement of one type or another is used to protect the transistors against damage from high inverse-voltage spikes.

Except for the method of triggering the transistors, contactless systems function in the same manner. In contactless systems, one of two methods generates the triggering pulse needed to turn off the power transistors: (1) interrupting or disturbing a magnetic field and (2) photoelectric methods.

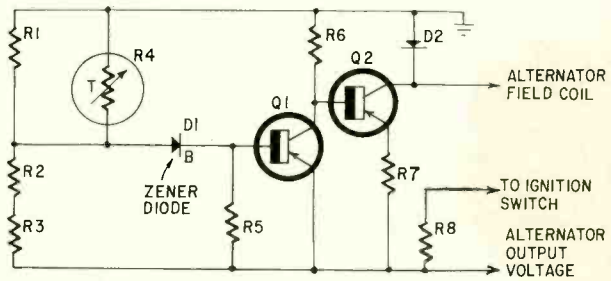


Fig. 1—Solid-state voltage regulator used by Rambler.

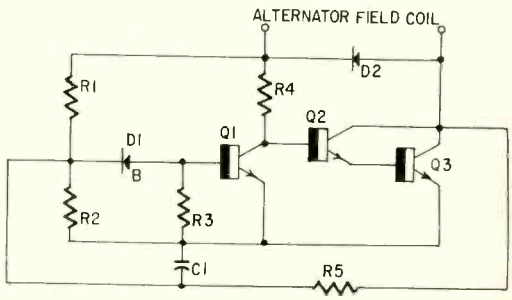


Fig. 2—IC voltage regulator for Ford and Chrysler.

Prices of these transistor ignition systems range between $30 and $100 or more. This places them beyond the point where they'd be economically feasible for standard use by the automotive industry. Consequently, transistor ignition systems have never progressed beyond option status. A breakthrough in pricing SCR's announced by a major supplier, however, will permit automakers to use these highly reliable switches. This suggests that some ignition

systems in 1968 or 1969 autos may use a form of capacitance-discharge (C-D) system similar to that available as a factory option on the 1967 Pontiac and Oldsmobile.

The Delco-Remy C-D ignition unit receives its timing impulse from a magnetic velocity pickup mounted inside the distributor. The pulse obtained has a consistent shape and duration and is well suited for triggering the voltage converter and thyristor. The power-supply circuit develops 300 volts dc to charge a storage capacitor.

During normal operation, the power-supply circuit functions as a one-shot converter circuit, pulsed "on" by the timing circuit and "off" by transformer saturation. During cranking, however, the circuit operates in the free-running mode to supply a full 300 volts dc to charge the capacitor, even when battery voltage falls as low as 4 volts.

This change in mode insures a full 30 kV at the spark-plugs over the entire operating range of speed and supply voltage. The switching circuit stores the 300-volt charge in the capacitor until a timing signal triggers the circuit, which then discharges the capacitor through the ignition coil. In this circuit, peak voltage is reached in 35 μsec rather than the 125 μsec required in the standard system; spark duration is reduced from 1200 to 200 μsec.

Headlamp Controls

Several are commercially available. For example, the Guide Lamp Division of GM manufactures two electronic controls for automobile headlamps: the Guide-Matic electronic headlamp beam control and the Twilight Sentinel automatic light switch.

The Guide-Matic, an automatic dimmer, is completely self-contained in a satin-finish sensor small enough to be held easily in one hand (see photo). All components are hermetically sealed into the sensor, which is usually mounted on the cowl in front of the windshield. A second version mounts behind the front grille of the Cadillac. The new sensor replaces the Guide's previous headlight beam control, a much larger unit.

The Twilight Sentinel, an automatic "lights-on" switch, provides automatic turn on as well as a time-delayed turn off for automobile headlights and taillights (see Fig. 3). When the light level on the photocell is reduced to 15 foot-candles (or any other preset value), photo[cell resist]ance increases to drive transistor Q1 into conducti[on], energizing sensitive relay RY1. The normally open con[tacts] RY1 close, energizing the coil of power relay RY2. [Bat]tery voltage is supplied to the headlights and tail[lights] through the armature of RY2.

The positive charge on C2 reverse-biases the base [of] Q2, holding Q2 cut off. When the ignition switch is turned off, the ignition-switch terminal is at ground potential because of the various components in the car that are connected between this point and ground. The car lights remain on because the circuit receives operation voltage through resistor R5 from the taillight circuit. Capacitor C2 then discharges through resistor R6 and rheostat R7.

The turn-off time delay is a function of the time constant of this RC circuit. When the base of Q2 approaches ground potential, Q2 conducts to supply a current flow through sensitivity control R8. The base voltage of Q1 will then increase enough to turn off Q1 and release the sensitive relay, which turns off the car's lights and removes all voltage from the system. A back-up lamp option is also available with this circuit.

Automatic environment controls

In 1964, Cadillac introduced their Comfort Control system. This was the first automatic heater and air-conditioner system mass-produced for use in an automobile. In 1967, Ford Motor Company purchased a large number of the newly developed Bendix temperature-control system, called the Autonic control.

The Cadillac system uses a combination of electronic and vacuum controls to maintain the air temperature inside at a preset level. Except during extremely hot or cold outside temperatures, both heater and air conditioner are used to hold the air temperature within the car at the desired level. A thermistor sensing network and amplifier circuit (see Fig. 4) controls an electrovacuum transducer. The transducer, in turn, controls a vacuum-operated servo motor. The servo actuates whatever components are needed to condition the air and also controls the blower motor to increase or decrease air flow as necessary.

continued on page 87

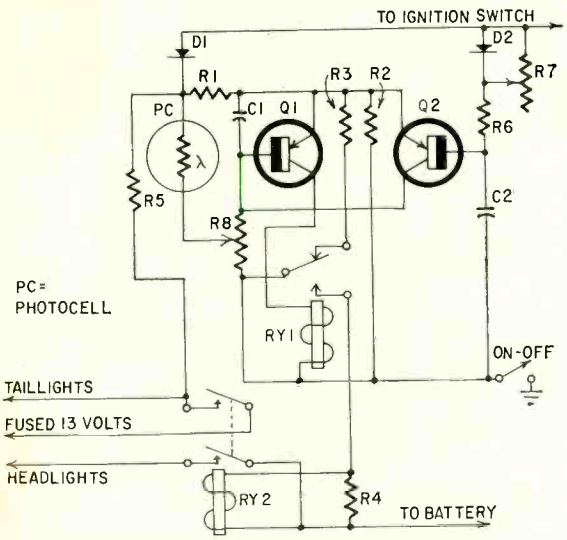


Fig. 3—Headlights are turned on automatically in near darkness by the Twilight Sentinel made by GMC Guide Lamp.

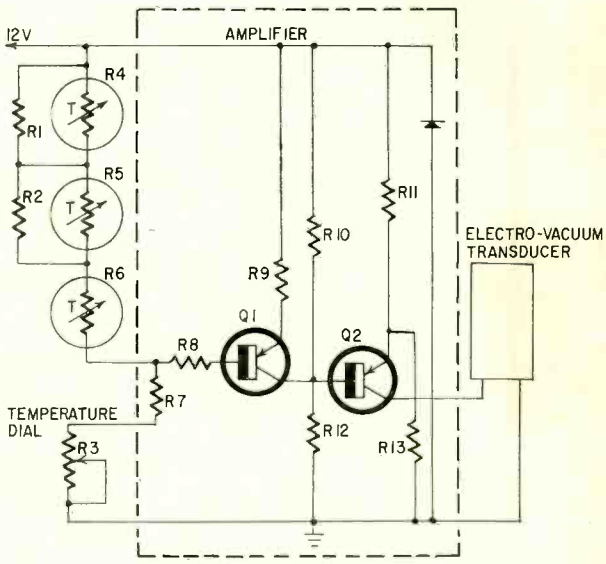
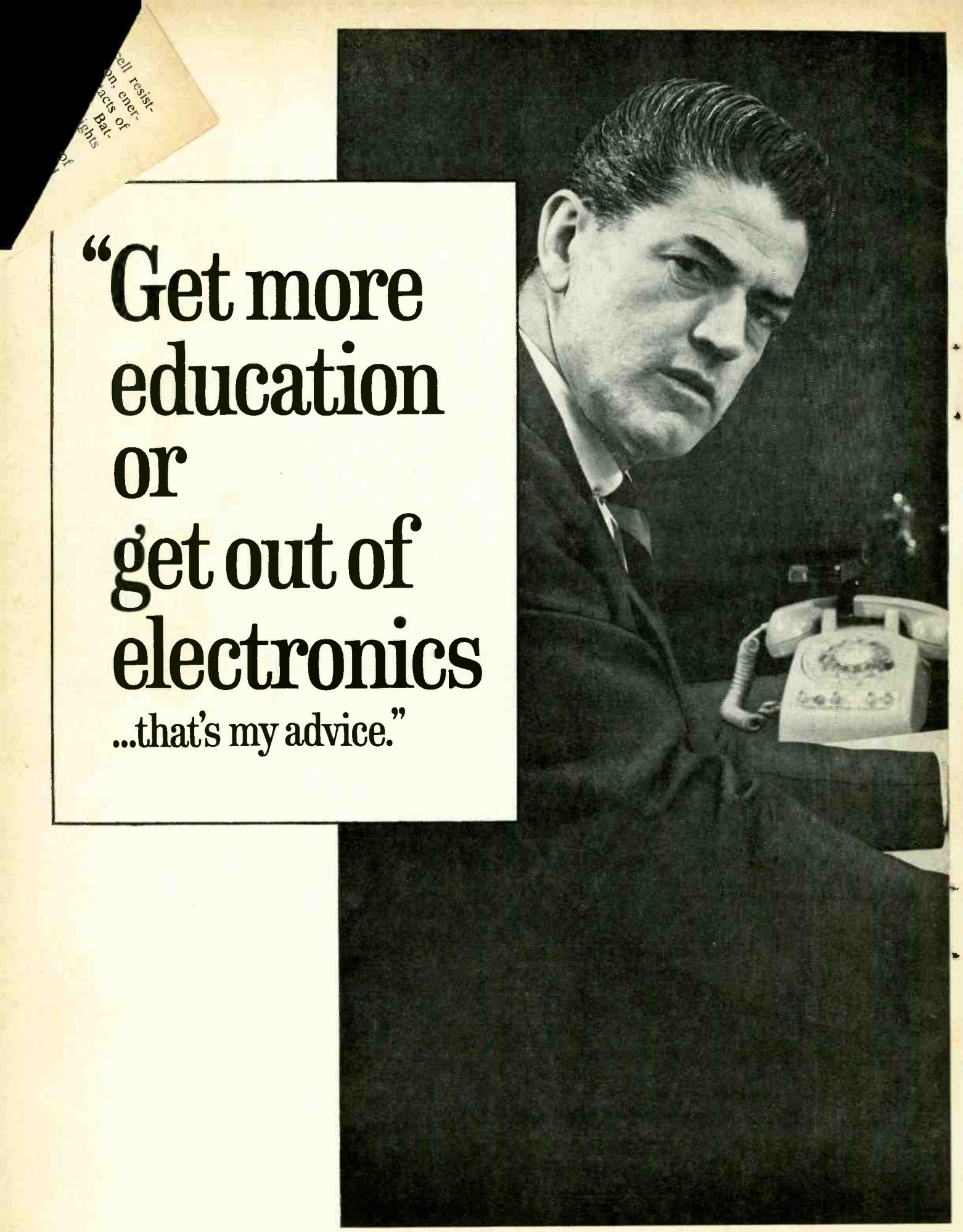
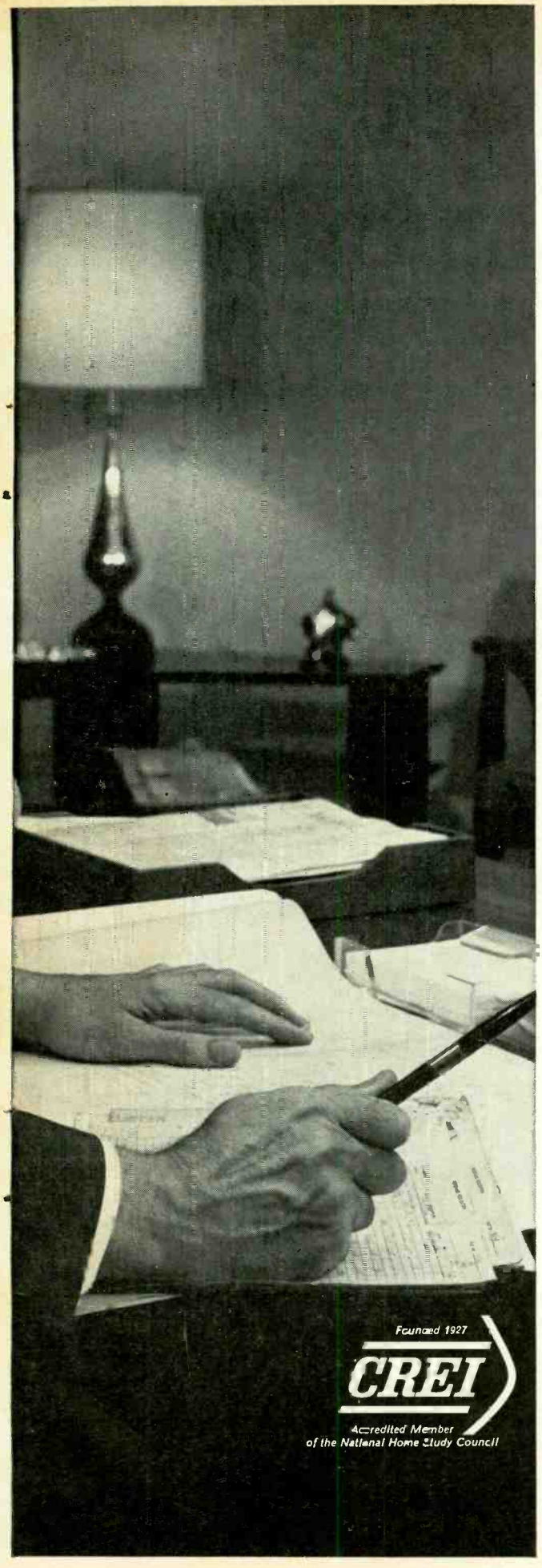


Fig. 4—Both temperature and air circulation in car are controlled by this Comfort Control circuit used by Cadillac.



"Get more education or get out of electronics ...that's my advice."



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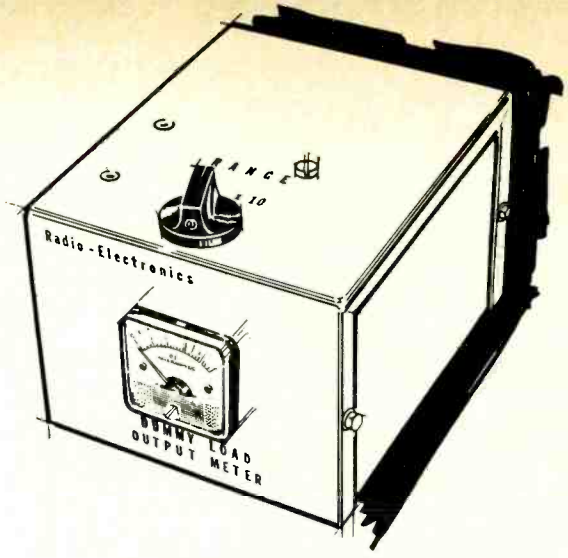
APPROVED FOR TRAINING UNDER NEW G.I. BILL

BUILD DUMMY LOAD AND RF METER



Check your transmitter without cluttering the airways

By E. F. RICE and ANDREW MUELLER*

TUNING OR TESTING a transmitter is much easier when you use a dummy load. Here is a device that serves as a dummy and a power-output meter for rigs up to 100 watts. Most CB and commercial-band two-way FM transmitters are designed to work into a 52-ohm antenna. This dummy load is a 50-ohm noninductive resistor, made up of 30 carbon resistors, each 1,500 ohms, 2 watts. They are connected in parallel and will dissipate 60 watts continuously or 100 watts intermittently.

Fig. 1 and the photo show how the resistors are mounted by soldering them in holes. Drill the holes in a pair of metal discs 2½ inches in diameter cut from No. 18 copper of the type used for flashing on roofs. Before assembling, tin the flange on the coax connector and also the area around the ⅝-inch hole in the copper disc so that the two pieces can be easily sweated together with a heavy soldering iron. After this is done the resistors can be soldered in place. Be careful not to overheat the disc or the resistors. Use heat-sink pliers on resistor leads.

The parts are mounted in a 6 x 5 x 4-inch aluminum box with the range switch on top. The power-output meter and the coax connector are opposite each other on the 5 x 4-inch ends. The photo shows parts location; wiring is not critical.

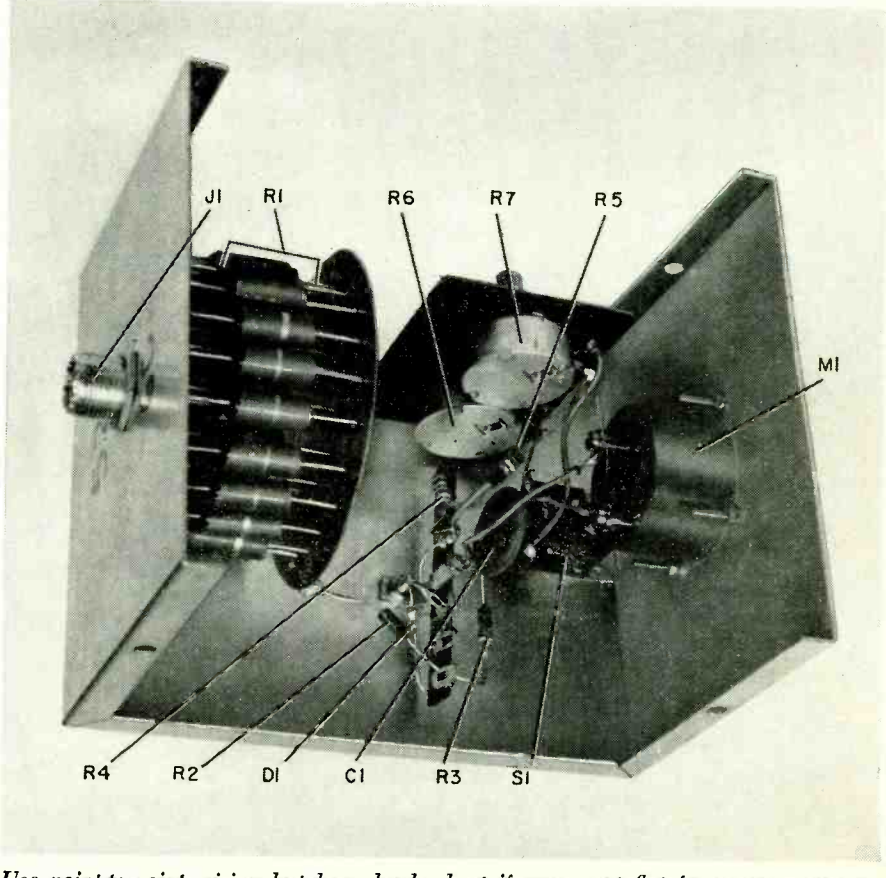
How it works

The schematic (Fig. 2) shows the 30 2-watt resistors as a single resistor, R1, across the input terminals. Voltage divider R2 and R3, across R1, lets a small part of the applied rf voltage get to D1, where it is rectified and filtered. The resulting dc is proportional to the input-signal power and is applied to the meter through the range switch and multipliers R4 and R5. R6 and R7 are calibration pots for the 10-watt and 100-watt ranges, respectively. C2 bypasses the meter for rf and gives extra filtering.

Calibration

First disassemble the meter so that you can add the additional scale shown in the photo. The original 50-μA scale is still on the meter face in the picture to help you determine the relative positions of the new marks. Notice that the new scale is not linear; power increases as the *square* of the current. The new marks can be made lightly with a pencil and the job completed with a lettering pen and India ink. Practice on scrap paper first.

The ideal way to calibrate this instrument is by comparing its readings against those of a highly accurate rf wattmeter. If you haven't access to such a device, however, here's a reasonably accurate method: You will need the use of a transmitter with a 50-ohm output, a service-type vtvm, and an rf detector probe. The probe must be the type furnished by the vtvm manufacturer for that specific instrument. Representative models are the EICO 232 or 221, Hickok 470A, RCA WV-77E or WV-98C, Simpson 312, and Triplett 850.



Use point-to-point wiring but keep leads short if you want flat frequency response.

*Chief service technician, Tel-Air Communications Co.

Couple the transmitter output to the dummy load. Don't modulate the rig. Then use the rf probe and vtvm to measure rf voltage. Since the maximum voltage rating of a probe can be anywhere from 20 to 40 volts rms (check manufacturer's specifications) you may want to measure rf across R3. Because it's part of a voltage divider, R3 will show only 1/10 the voltage across R2 and R3 (or R1).

Since the vtvm reads voltage, you will have to compute power. By Ohm's law,

$$P = \frac{E^2}{R}$$

and since $R = 50$,

$$P = \frac{E^2}{50} = .02E^2$$

Refer to the table and you'll see the voltage readings (these are rms volts, remember) you want for various wattages. On the dummy load, set the range switch to X1. Adjust the transmitter for either 22.4 volts across R1, or 2.24 volts across R3, depending on where your rf probe is. This will mean you have 10 watts in the dummy. Now adjust R6 (on the dummy) until the meter reads full scale. From now on leave R6 alone. Readjust the transmitter and follow the table, marking the meter dial (as shown in the photo) at each point.

Since the detector probe may be nonlinear below 1 volt, you may want to put the probe across R1 when you get down around 10 or 12 volts. You will then be reading the full 10 or 12 volts.

Next set the range switch to X10. Adjust the transmitter for some arbitrary wattage—say 5 or 10 watts—as measured by the vtvm and converted with the table. Then adjust R7 on the dummy until the meter reads exactly that value of watts. The rest of the points on the scale will then fall in line.

Using the output meter

The dummy load can be constructed to match other impedances. For example, if the transmitter is designed to feed a 300-ohm line, a suitable dummy can be made by paralleling 33 resistors, each 10K, 2 watts.

Table of Voltage and Power

Volts (R1)	Watts	Volts (R3)
22.4	10	2.24
21.2	9	2.12
20.0	8	2.00
18.7	7	1.87
17.3	6	1.73
15.8	5	1.58
14.2	4	1.42
12.3	3	1.23
10.0	2	1.00
7.1	1	0.71
5.0	0.5	0.50
2.2	0.1	0.22

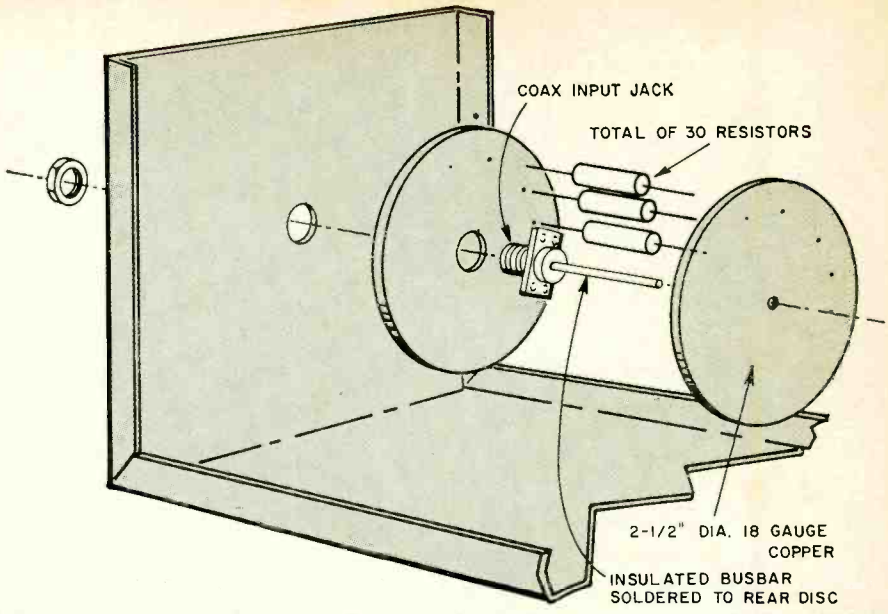


Fig. 1—Two copper discs form the terminals for the 30 resistors used in parallel as the dummy load. Be sure not to overheat them while soldering them in place.

PARTS LIST

C1—.05 μF, 600 volts, disc ceramic
C2—.005 μF, 1,000 volts, disc ceramic
R1—parallel combination of 30 resistors, each 1,500 ohms, 2 watts, 10%, carbon
R2—8,200 ohms, ½ watt, 5%, carbon
R3—910 ohms, ½ watt, 5%, carbon
R4—39K, ½ watt, 5%, carbon
R5—180K, ½ watt, 5%, carbon
R6, R7—wirewound pots, 100K, 5 watts (Centralab WN series or equivalent)
D—IN914 silicon diode
J1—coax receptacle (Amphenol 83-1R) or equivalent)
M—0–50-μA meter
S—spdt rotary switch
Chassis—6 x 5 x 4-inch aluminum box (Bud Minibox CU 3007A or equivalent)

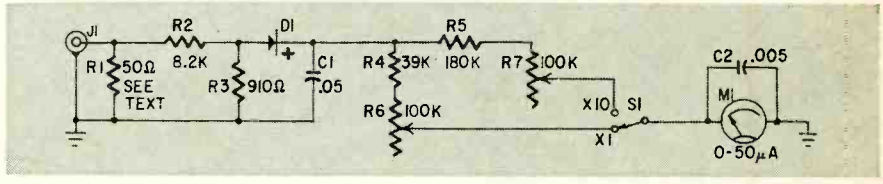


Fig. 2—The circuit contains the bare minimum to do the job efficiently.

When using the output meter remember that proper adjustment of the transmitter loading into the dummy does not assure proper operation when the rig is connected to the actual antenna. There is always some inductive or capacitive reactance at the transmitter terminals which must be tuned out by the coupling controls when the transmitter is finally tuned-up to the antenna. To make sure that an antenna and transmission line are working properly, check the standing-wave ratio before you connect the transmitter to the antenna.

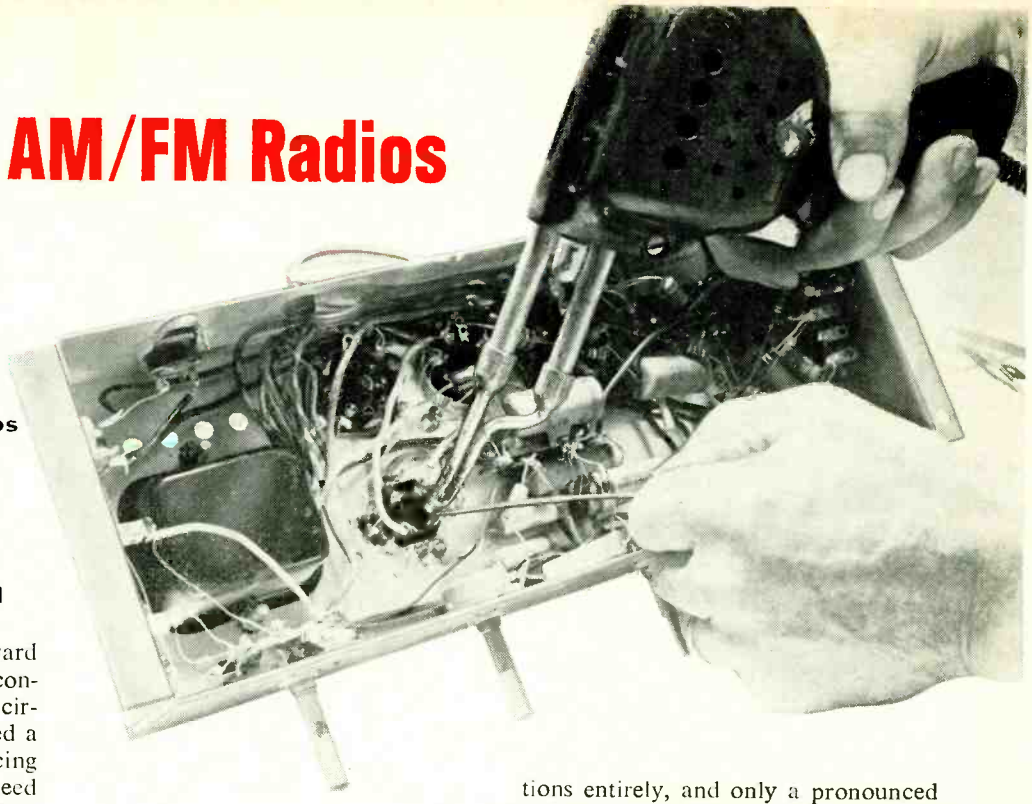
For base stations, swr should be less than 1.5:1. You'll find that 2:1 is about right for roof-top mobile antennas. Transmitter tuneups on the air must be done by a person holding a First- or Second-Class commercial radiotelephone license. This applies to any adjustment which affects power, modulation or frequency.

The output meter is useful for adjusting the transmitter as a part of routine maintenance. Also, it can be used to determine the transmitter's ability to deliver its rated carrier power. This is particularly important to CB'ers. You can also use the dummy antenna when checking frequency and deviation in FM transmitters. **R-E**

As you calibrate the meter with a known rf signal, mark the meter face by hand.

SERVICE

Table-Model AM/FM Radios



A brief rundown of troubles and solutions in AM/FM radios

By HOMER L. DAVIDSON

In spite of the general trend toward FM-stereo tuners and expensive consoles incorporating complex FM circuitry, table-model sets are still used a lot. Several straightforward servicing hints can help any technician to speed his handling of these receivers. We'll cover a few of them here.

We can start by checking the AM/FM block diagram shown in Fig. 1. A 300-ohm lead-in ties the FM antenna to the first stage. This rf amplifier may consist of a single tube or a dual triode serving as both rf and converter stages. Generally, a dual-triode tube serves as a local oscillator, rf and mixer stage of the AM section.

Mixer output is coupled to the first i.f.-amplifier section. Two or three i.f. stages are used to increase selectivity and sensitivity. A limiter often follows the last i.f. amplifier stage in the older type of FM receivers. Newer receivers employ a ratio detector that does its own limiting and detecting. In this type of circuit, an unbalanced ratio detector develops the audio signal. The audio section may contain one or two tubes or a single dual-purpose tube.

The i.f.-amplifier section is common to both AM and FM reception. Each stage uses a pair of i.f. transformers—one for AM, the other for FM. The AM transformer is really a pair of mutually coupled, parallel-resonant tuned circuits, each consisting of a coil and a capacitor.

These circuits have a high impedance to signals around 455 kHz, but a low impedance at the FM i.f. of 10.7 MHz. Hence, in the AM mode the 455-kHz i.f. signal develops a voltage drop across each side of the transformer and the signal is therefore passed on to the next stage. In the FM mode, on the other hand, the impedance of the AM circuits is so low there is no voltage drop and the 10.7-MHz signal isn't passed on by the transformer.

The opposite action occurs in the FM transformer. Thus the AM and FM i.f. transformers don't interfere with each other.

FM converter

An AM/FM tube-type radio generally uses a dual triode, one section as an FM rf amplifier and the other as the FM mixer/oscillator-type converter. Plate voltages on the converter are typically 90 to 100. Grid voltage will vary from −5 to −3. Remember, a vtvm should always be used in checking oscillator voltages.

A resistance change in the grid circuit of the oscillator will cause the tube to function weakly or not at all. A shorted grid resistor will stop oscillations entirely, and only a pronounced hissing noise will be heard. When you get a loud FM hiss but no station signal, suspect the FM-converter section.

If the value of grid resistance increases substantially, the receiver will produce a loud hiss, local FM stations will come through only weakly and, of course, selectivity will suffer. Oscillator voltage will increase to about twice the original value.

This was the story on a Zenith model Y733 FM radio that came into the shop a short time ago. The 10,000-ohm grid resistor had increased in value, resulting in poor selectivity and a loud hiss. Even a strong local FM station was weak. With the outside antenna connected, a station 40 miles away could barely be heard.

If the 50-pF capacitor (Fig. 2) opens, the receiver will not pass a signal. A loud FM hiss will be heard. Grid voltage becomes zero, but the plate voltage will not change.

This was the condition we discov-

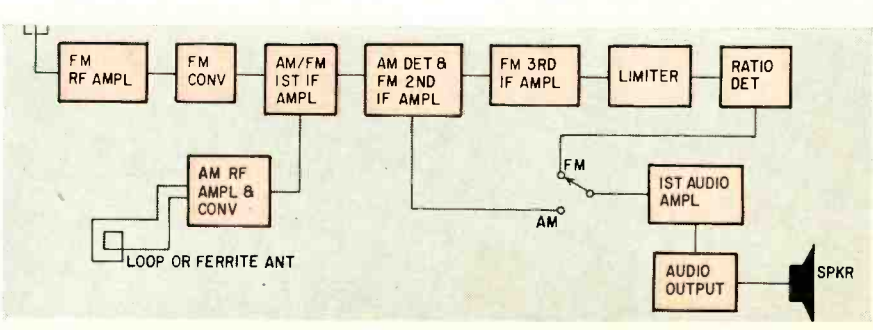
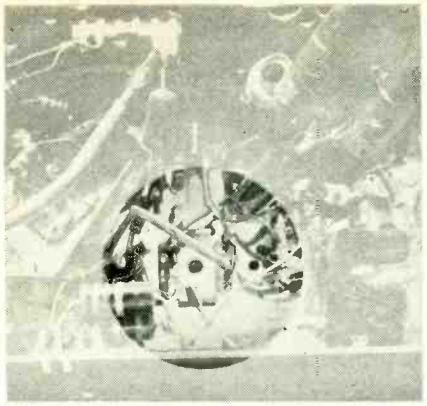
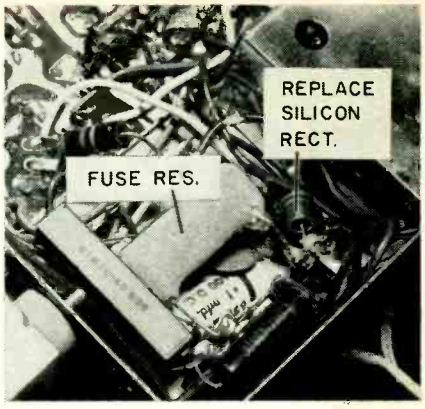


Fig. 1—Typical AM/FM set uses multifunction stages and some common sections.



When you replace an i.f. transformer, keep track of leads with masking tape.

B+ here was only 22 volts; that 0.01 μF bypass capacitor had a partial short.



Be sure to replace the fusible resistor whenever you replace a silicon rectifier.

ered in a Zenith model C730 chassis. The oscillator circuit is similar to Fig. 2. Also, if the small bypass capacitor (not shown) connected from the plate of the oscillator to ground opens, there will be nothing but a loud hiss. Replace the capacitor with a ceramic type of 5% tolerance, or a silver-mica.

It's a simple matter to test several FM converter tubes and use the most active one as a replacement. Be sure it's not microphonic and that all pins are straight and clean.

I.f. limiter and discriminator stages

There generally are three i.f. stages in the typical inexpensive FM receiver. Some receivers also have a limiter amplifier following the third i.f. stage. Many ac/dc FM receivers use half of one tube as the ratio-detector stage and the other section as the first audio-amplifier stage.

The AM signal does not come through the limiter stage or the third FM i.f. section. It is tapped off at the output of the second AM/FM i.f. amplifier, detected and switched into the grid of the first audio stage. Voltages on the ratio-detector diodes are quite low; check with a vtvm.

An increase in resistance of either diode resistor will distort the signal and reduce its strength. If the bypass capacitor on the limiter's screen grid opens, the signal is really low. Hardly any FM hiss is audible and what audio there is will be distorted. Interference from automobile ignition systems also will be severe. Plate voltage on the limiter stage is low: 30 to 60 volts dc.

An FM i.f. transformer does not seem to go bad often. In the same chassis, however, the AM i.f. transformers sometimes short. Tap the can or wiggle the transformer lugs while listening to AM. Measure grid voltage of the following stage; it should be negative. If you find a positive voltage, the transformer is shorted. Sometimes when you've got negative grid voltage, pull the tube—if the transformer is shorted, the voltage will go positive.

You can also find a bad i.f. transformer during alignment. If one of the cans tunes broadly, replace it.

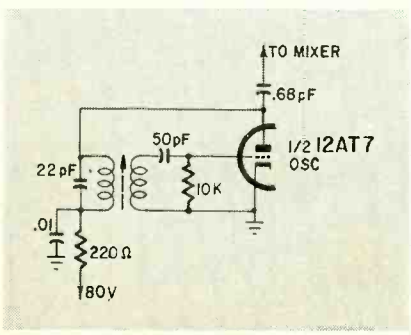
The AM detector has usually been a tube, but more and more today you'll find a solid-state diode. Sometimes the second FM i.f.-amplifier tube is biased and used as an infinite-impedance detector, as well as an FM amplifier. The rest of the receiver is generally conventional.

Alignment

All you need are a vtvm and an rf signal generator. Rotate the oscillator capacitor or permeability-tuning section to the open position. Apply a signal from the generator to the mixer grid at a frequency of 10.7 MHz. Tie the vtvm to the receiver at point A in Fig. 3. Keep generator output low—you should read around 1 volt on the vtvm. Adjust the slugs in the i.f. transformers for maximum readings.

For rf alignment leave the tuning capacitor at 108 MHz and tune the generator to the same frequency. Next adjust the oscillator trimmer capacitor, mixer and antenna or rf trimmer for maximum readings on the vtvm. Then close the tuning capacitor and set the generator to 88 MHz. Adjust the antenna, rf and oscillator coils for maximum indication. Repeat the rf alignment once.

Be sure all pilot lights are working. If one bulb seems to have a dark glass, replace it, for it won't last long and may mean a callback. Clean that dial glass. Brush the dirt and dust out of the cabinet corners. Polish that plastic cabinet; use soap and water. It is surprising how a few such details will add to the appearance of a service job. **R-E**



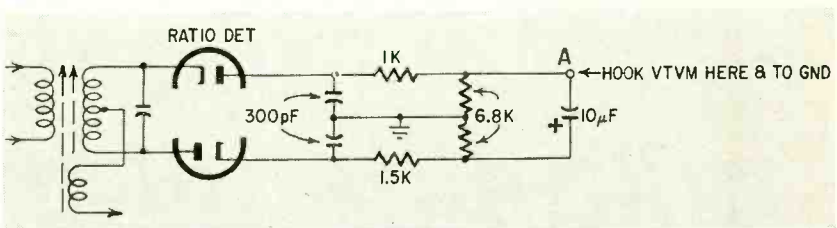
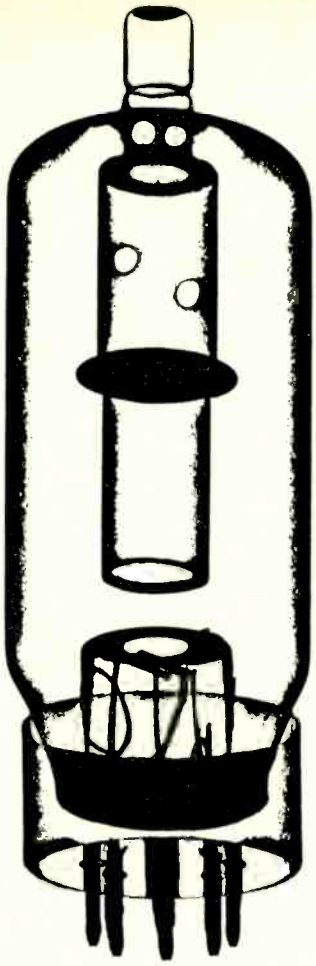


Fig. 2 (left)—In this circuit, the 50-pF grid capacitor opened, blocking oscillator signal.

Fig. 3 (above)—The FM ratio detector may be a tube or pair of solid-state diodes. For alignment, connect vtvm from the negative side of capacitor to ground.



SPECIAL FEATURE

By DAVID LACHENBRUCH

WHAT YOU SHOULD

High-voltage tubes in a color

DO X-RAY EMISSIONS from color television sets pose a potential hazard to the public or to service technicians?

This question was widely publicized in recent months—but in the public press, at least, the answer seems to have gotten lost. The entire color-TV X-ray issue was brought to public attention as the result of a design error by a major manufacturer and the subsequent field modification of about 90,000 large-screen receivers. The General Electric incident touched off intensive TV testing activities by the Department of Health, Education and Welfare, by state and regional health authorities and by television manufacturers.

It resulted in the introduction of several bills in Congress for federally enforced standards and testing of high-voltage electronic devices. Hearings were held on the subject by two House subcommittees and one Senate committee, and it appears that one such bill will be passed in the next session of Congress.

The incident also prompted a wave of official concern for the safety of viewers and service technicians from possible X-ray overexposure.

Both the G-E problem and the X-ray scare in general are surprising in view of two well-established facts: (1) From the very birth of the TV industry, manufacturers have been especially vigilant on the subject of X-rays. (2) At the voltages employed in color television receivers, X-radiation can easily be stopped with very simple shielding.

A tiny leak

The G-E trouble—one of those things that "just could not happen"—resulted from a change in chassis design for the 1967 models, which went into production in spring 1966. The shunt regulator tube was sunk into a well in the chassis. After a large number of these receivers were in the field, G-E discovered in routine retests that excessive amounts of X-radiation were leaking downward in a fingernail-size arc through the tube socket. The size of the leak was so small that it had previously escaped detection.

Since G-E's 1967 KC chassis lacked external shielding below the shunt regulator tube (although the leakage in many models was stopped by the cabinet), the company instituted a crash program to develop a family of direct-replacement tubes which incorporated an extra measure of internal shielding, for modification of these sets in the field. A widespread effort resulted in location and modification of almost all of the questionable receivers through simple tube replacement.

The vast majority of the original G-E shunt regulator tubes (designed for the KC chassis) on dealers' and distributors' shelves were also taken off the market and replaced by the new heavily shielded types. However, there are still a few around, on shelves and in tube caddies. For each one returned, to a General Electric distributor—*regardless of the make of the tube*—G-E pays a bounty of $5, plus a free exchange of a direct-replacement substitute.

Needless to say, no one should have any of the questionable tubes in his possession, and a search for any of these obsolete tube types may be both emotionally and financially rewarding:

Obsolete type	*Replacement*
6EA4	6EH4
6EF4	6EJ4
6LC6	6LH6

What about color-TV sets in general? Are there X-radiation dangers, hazards or pitfalls? Here a background review may be helpful.

The National Council on Radiation Protection and Measurements (NCRP), a government-chartered independent nonprofit organization, has recommended that X-radiation levels for TV sets not exceed 0.5 milliroentgen per hour (mR/hr) at a distance of 5 centimeters (about 2 inches) from the set's surface. This figure was not established for the protection of individuals (who can take exposures many times greater without ill effect) but for protection of the "population" at large, to help keep general background radiation levels down.

Any X-ray exposure from sets meeting this standard represents a very small percentage of the natural "background" radiation that is part of our everyday environment—in effect, it is negligible. The NCRP figure is considered, by NCRP and by radiation scientists, to be very conservative. In fact, it is one-fifth the amount of radiation permitted from TV sets by Underwriters' Laboratories until September, 1967, when UL changed its standard to conform with NCRP recommendations.

Following the G-E disclosures, American television set manufacturers, under the aegis of the Electronic Industries Association, conducted exhaustive X-radiation tests of more than 500 color TV receivers, covering chassis types representing approximately 95% of all color sets in use.

The results showed that, under normal operating conditions, not one set radiated above the 0.5-mR/hr standard. In fact, the vast majority measured considerably less—many of them below the capabilities of the measuring equip-

KNOW ABOUT X-RAY RADIATION IN TV SETS

receiver can produce soft X-rays, but you can easily protect yourself

ment used. Tests of Japanese receivers sold in the United States showed similar results.

X-rays are produced whenever a beam of electrons strikes some material at a relatively high velocity, as in a vacuum tube. Accelerating voltages of at least 10 or 15 kV are required before any significant quantity of X-rays is emitted. Because of the absorption of X-rays by glass tube envelopes, there is normally no significant escape of radiation from tubes unless voltages are in the range of 20 kV or higher. Thus, in a color television receiver, there are two or three potential sources of X-rays—the picture tube, the high-voltage power supply and the shunt regulator tube (if one is used).

Radiations produced at these voltages are known as "soft" X-rays—the type which does not significantly penetrate body tissue. The amount of exposure to X-rays depends on the amount of voltage, duration of exposure and distance from the source of the X-rays. The use of heavily leaded glass envelopes on picture tubes, and shielding around the other two high-voltage tubes, keeps X-rays well below the permissible figure in most normally operating color sets.

Clean bill

In all inquiries and tests to date, color receivers (except the G-E sets in question) have received a clean bill of health under "normal operating conditions." This brings up two questions of utmost significance to the technician: (1) What are "abnormal" operating conditions and how can they be avoided? (2) Even if there is no danger to viewers, how can the technician be assured that he is not receiving excessive X-ray exposure?

Fortunately, the answers to both questions involve only common-sense precautions and the following of normal servicing instructions—instructions which should be heeded anyway to avoid shock and implosion danger and repeated set failure.

Specifically as to the second question: There are no concrete data to show that the technician—even the worst, most careless technician—can receive dangerous exposure. But, by the same token, there is no proof that he can't.

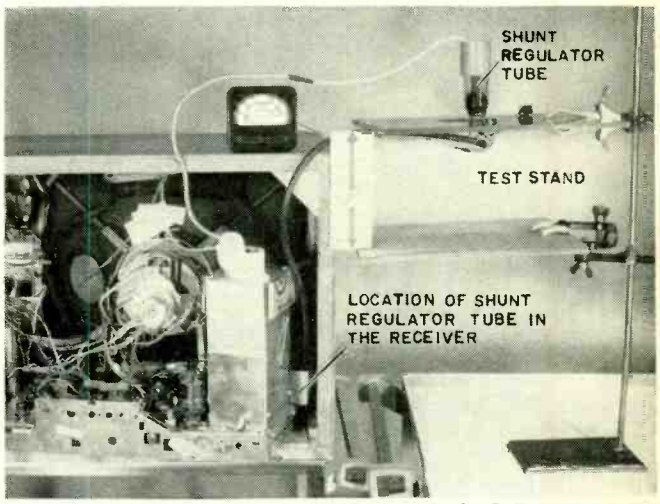
Since relatively little is still known about the cumulative effects of soft X-rays, the technician has an important responsibility to his customer (and himself) regarding those "abnormally operating" sets. These are receivers operating at above the high voltage specified by the manufacturer or without proper shielding. Many color sets with a recommended voltage of 25 or 26 kV can be operated as high as 33 kV (although they may fail prematurely).

At the level of voltages used in color sets, X-ray emission increases roughly in proportion to the square of the voltage increase. Though manufacturers' tests showed that many sets operating at too-high voltages quickly developed circuit failures (and those which continued operating emitted only moderately excessive radiation), don't tempt fate.

The rules to be followed in home or shop repair, for safety of both viewer and technician, are listed in most service manuals. Those which can keep X-ray exposure below the safe minimum deserve special emphasis:

1. Be sure that all service personnel are familiar with the subject of radiation. This can be covered by having them read this article.

2. To avoid possible exposure to radiation and shock hazard, never apply power to the receiver unless the high-voltage compartment is completely assembled with the door closed and all other original factory-installed shields are in place. These shields include any additional shielding on the outside of the high-voltage compartment, shields surrounding the high-voltage rectifier tube or the shield inside the plastic tube cap. If a shield is missing from an incoming set, replace it at once as a standard servicing procedure.



Courtesy National Center for Radiological Health

Experimental setup used to survey radiation from shunt regulator tubes. A G-E KC chassis was used as the power supply. Location of socket on chassis made radiation measurements almost impossible so an adapter and test jig were used. The tube was mounted 7 inches above a sheet of Royal Blue X-ray film.

3. High voltage must never be adjusted to exceed the factory-specified amount with the brightness and contrast adjusted to minimum (no illumination on the screen). Refer to the manufacturer's service manuals for specific instructions. If the high-voltage check indicates a malfunction or improper adjustment, correct this fault before any other service procedure—such as picture-tube setup, yoke adjustment or troubleshooting—is performed. It's important to use an accurate and reliable high-voltage meter. Meters should be calibrated at regular intervals.

4. Whenever tube replacement is necessary, replace regulator tube, picture tube and high-voltage rectifier tube only with the types specified for the specific receiver. Refer to the tube-location label attached to the inside of the receiver, or the service manual, since the tube being replaced may be an incorrect type previously installed by someone else.

5. In troubleshooting procedures, never apply a line voltage exceeding the manufacturer's specifications. Many technicians use a variable stepup transformer to let a set

(continued on page 88)

continued from page 16

Eligibility for the Amateur First Class license was proposed to be limited to an Advanced, General or Conditional Class licensee who has held such license for at least one year. The examination for the new Amateur First Class license was to comprise a 16-word-per-minute code test and a written examination of a difficulty level between the present General and Amateur Extra Class license examinations. It was also proposed that the present Advanced Class license would no longer be renewed as such and that present holders of this license would be issued the General Class license upon renewal.

The proposal for creation of a new higher class of license to be known as the Amateur First Class license was very favorably received. The purpose of this license was to provide an intermediate advanced license as a "stepping stone" to the highest license attainable, the Amateur Extra Class license. A large number of comments recommended that the Advanced Class licensees be granted "grandfather" privileges to the new higher class license. The Commission agreed with these arguments and believes that the Advanced Class licensees, who qualified by examination for the incentive privileges in effect prior to 1952 and have operating experience of at least 15 years, presumably have qualities which was the purpose of the proceeding to foster. Accordingly, the recommendation for "grandfather" rights to the new license was adopted and will apply to present holders of the Advanced Class license.

Final Proposals

The Commission concluded that, effective November 22, 1967, the present Advanced Class license shall be retained as the new higher class of license instead of creating the Amateur First Class license. Present holders of the Advanced Class license will be renewed as such with all the privileges and status belonging to the new Advanced Class license. The Advanced Class license shall be available to any eligible applicant who successfully passes the examination requirements. These will include a code test of 13 words per minute and a written examination comprising elements 3 and 4(A) as set forth in Section 97.21 of the Commission's Rules, as amended. Since the code test for this license is being reduced to 13 words per minute, code test credit as well as credit for other elements, in accordance with

Unabridged Amendment of Part 97, FCC Rules

1. Section 97.7 is amended to read as follows:

§ 97.7. Privileges of operator licenses.

(a) **Amateur Extra Class and Advanced Class.** All authorized amateur privileges including exclusive frequency operating authority in accordance with the following table, effective on the dates shown:

Frequencies	Class of license authorized	Effective Date
3500-3525 kc/s 3800-3825 kc/s 7000-7025 kc/s 14000-14025 kc/s 21000-21025 kc/s 21250-21275 kc/s	Amateur Extra only	November 22, 1968
3500-3550 kc/s 7000-7050 kc/s 14000-14050 kc/s 21000-21050 kc/s	Amateur Extra only	November 22, 1969
3825-3850 kc/s 7200-7225 kc/s 14200-14235 kc/s 21275-21300 kc/s 50-50.1 Mc/s	Amateur Extra and Advanced	November 22, 1968
3825-3900 kc/s 7200-7250 kc/s 14200-14275 kc/s 21275-21350 kc/s 50-50.25 Mc/s	Amateur Extra and Advanced	November 22, 1969

(b) **General Class and Conditional Class.** All authorized amateur privileges except those exclusive frequency operating privileges which are reserved to the Advanced Class and/or the Amateur Extra Class.

(c) **Technician Class.** All authorized amateur privileges on the frequencies 50.25-54 Mc/s and 145-147 Mc/s and in the amateur frequency bands above 220 Mc/s.

Note: Technician Class licensees may additionally operate on the frequencies 50-50.1 Mc/s until November 22, 1968, and 50.1 to 50.25 Mc/s until November 22, 1969.

(d) **Novice Class.** Those amateur privileges designated and limited as follows:

(1) The d.c. plate power input to the vacuum tube or tubes supplying power to the antenna shall not exceed 75 watts, and the transmitter shall be crystal controlled.

(2) Operation on the frequency bands 3700-3750 kc/s, 7150-7200 kc/s, 21.10 to 21.25 Mc/s, and 145-147 Mc/s is authorized for radiotelegraphy using only type A-1 emission.

Note: Novice Class licensees may additionally operate until November 22, 1968, on 145-147 Mc/s for radiotelephony using types of emission as set forth in § 97.61.

2. Section 97.9 (b) is amended to read as follows:

§ 97.9 Eligibility for new operator license.

(b) **Advanced Class.** Any citizen or national of the United States.

3. Section 97.21 is amended to read as follows:

§ 97.21 Examination elements.

Examinations for amateur operator privileges will comprise one or more of the following examination elements:

(a) Element 1(A): Beginner's code test at five (5) words per minute;

(b) Element 1(B): General code test at thirteen (13) words per minute;

(c) Element 1(C): Expert's code test at twenty (20) words per minute;

(d) Element 2: Basic law comprising rules and regulations essential to

beginners' operation, including sufficient elementary radio theory for the understanding of those rules;

(e) Element 3: General amateur practice and regulations involving radio operation and apparatus and provisions of treaties, statutes, and rules affecting amateur stations and operators;

(f) Element 4(A): Intermediate amateur practice involving intermediate level radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony and radiotelegraphy;

(g) Element 4(B): Advanced amateur practice involving advanced radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony, radiotelegraphy, and transmissions of energy for measurements and observations applied to propagation, for the radio control of remote objects and for similar experimental purposes.

4. Section 97.23 is amended to read as follows:

§ 97.23 Examination requirements.

Applicants for original licenses will be required to pass the following examination elements:

(a) Amateur Extra Class: Elements 1(C), 3, 4(A), and 4(B);

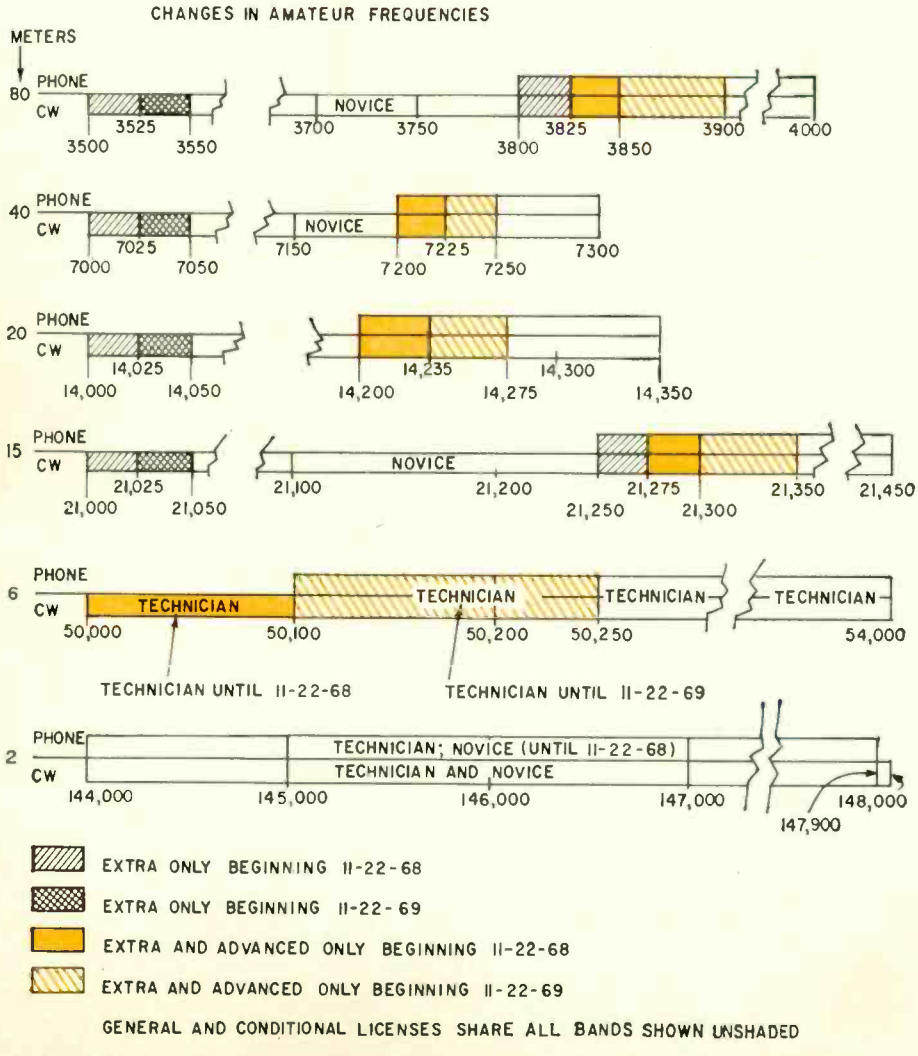
(b) Advanced Class: Elements 1(B), 3, and 4(A);

(c) General Class and Conditional Class: Elements 1(B) and 3;

(d) Technician Class: Elements 1(A) and 3;

(e) Novice Class: Elements 1(A) and 2.

text of unabridged amendment continued on page 83



Section 97.25 of FCC Rules, will be given to those applicants for the Advanced Class license who hold the General Class license.

The Commission noted the renewed interest in the Amateur Extra Class license since the inception of the proceeding (the number of holders of this license increased over 25% in little more than one year) and concluded that the continued issuance of the Amateur Extra Class license as part of the incentive licensing program was appropriate and warranted.

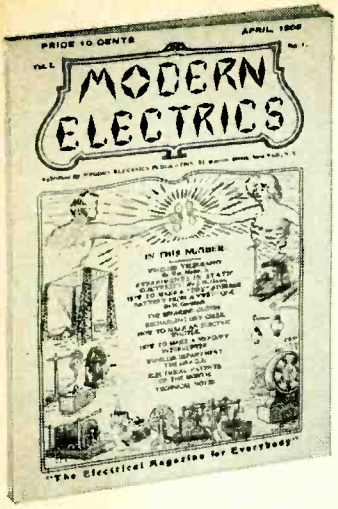
As the incentive for the upgrading of licenses, the Commission proposed the reservation of frequency segments in the 2-, 6-, 15-, 20-, 40- and 80-meter bands for the exclusive use of the higher-class licenses.

The FCC intends careful review and if it is determined that there is insufficient occupancy of any part of the reserved frequency segments then the effective date of the schedule will be postponed in whole or in part.

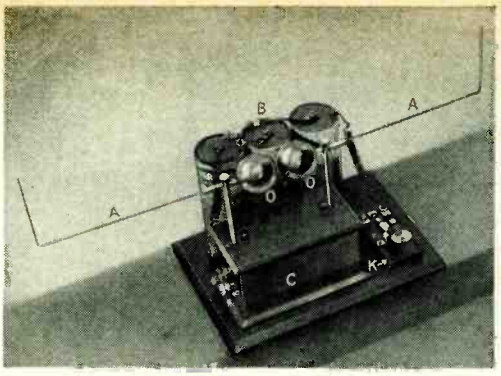
The Commission also adopted proposals that new holders of the Novice Class license shall be given a two-year nonrenewable license term in lieu of the present one year nonrenewable term, and that, effective one year after adoption of these rule changes, telephony privileges for the Novice Class licensees in the frequency segment 145-147 MHz shall be deleted.

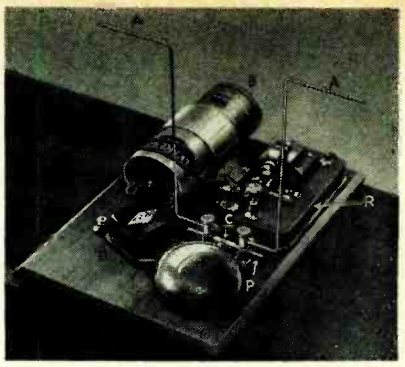
One aspect of the proposed distinctive call-sign schedule related to the assignment of call signs with a single-letter prefix and a double-letter suffix (e.g., W2AB, K1AA). These call signs are popularly referred to as "two-letter" call signs and are cherished as the mark of an "old timer." At the present time the FCC has about 8000 of these call signs available for assignment.

To reflect both longevity and/or attainment in amateur licensing, the available two-letter call signs will continue to be assigned to previous holders and will also be assigned to holders of the Amateur Extra Class license who submit proof of having held an amateur radio station license issued by the United States Government 25 years or more prior to the date of application therefor. Present holders of two-letter call signs can continue to hold them even if they do not meet this requirement. The $20.00 special call-sign request fee will apply to these requests. Applicants will not be permitted to select specific two-letter call signs. However, a former holder of a specific two-letter call sign may regain such call sign if it is available in accordance with Section 97.51(a)(1) and (2) of the Rules. Finally, new holders will be limited to one such assignment. **R-E**



The world's pioneer radio magazine, published by Gernsback as adjunct to his E.I. Co. catalog.





The Telimco radiotelegraph set—the first radio sold to the public. The transmitter is on the left and the receiver is on the right. Maximum range was about one mile.

Hugo Gernsback 1884-1967

(*continued from page 4*)

Gernsback as publisher

Though Electro Importing Co. continued (and was succeeded in the '20's by RASCO—the Radio Specialty Co.), Gernsback's main efforts in the future were to be in publishing. *Modern Electrics* was sold in 1912. After a number of combinations with other magazines, it (and the others) became today's *Popular Science*.

Gernsback immediately started a larger magazine, the *Electrical Experimenter*, which changed its name to *Science and Invention* in 1920. In 1919 he started the country's first "purely radio magazine," *Radio Amateur News*. It became *Radio News* in 1920 and is still in existence. (The name was changed to *Electronics World* in 1959, after a period as *Radio and Television News*).

In 1926 he founded, with *Amazing Stories*, not only a new magazine, but a whole new *genre*. Science fiction had appeared regularly in all the Gernsback magazines (quite a bit of it written by Gernsback himself) and a little was published in other magazines, together with weird stories and fantastic fiction. But this was the first attempt at a magazine entirely devoted to true scientific fiction. Its success stimulated dozens of others into being. All, however, look back to Gernsback as the First Cause, and he is unanimously acclaimed the Father of modern Science Fiction.

In the winter of 1928-29 his publishing company ran into financial difficulties and the publications passed into other hands. Almost immediately Gernsback started RADIO-ELECTRONICS as *Radio-Craft* (the name was changed in 1948). He also started a number of other magazines, including *Television News*, which ran about a year in the early '30's, and *Short-Wave Craft* (later *Short Wave & Television* and *Radio & Television*), which was combined with *Radio-Craft* in 1941. In 1933, he introduced *Sexology*, the most successful of a number of biomedical publications he published at different times. Together with its Spanish-language version, *Luz*, it continues as a highly successful magazine.

Altogether, Gernsback published more than 50 magazines in the technical, experimental, biomedical, aviation and other fields (even one called *Motor Camper and Tourist*—in 1924!—and another called *Technocracy*). The number of books he published cannot be estimated accurately, but runs into the hundreds.

Gernsback as writer-prophet

The young Gernsback had to write much of the material in his earlier magazines, and was a regular contributor to the last years of his life. His first book, *The Wireless Telephone*, 1908, a combination of progress report and hopeful prediction, was an attempt to speed the development of the art.

In 1911 he wrote his most important work, *Ralph 124C 41+*, a science-fiction novel in which he predicted fairly accurately the progress of science and invention for the next half century and more. His other important full-length book, *Radio for All*, was a simple theory and how-to-do-it book for beginners. It was written in 1922.

Gernsback's imagination and scientific method led him to predict an almost unbelievable number of electronic advances that—seemingly absurd when suggested—became facts during his lifetime. *Ralph 124C 41+*, serialized in *Modern Electrics* in 1911, described radar (with an illustration) so clearly that it can be used as a textbook to explain radar today. (The imaginary equipment was used to locate a space vessel, incidentally.)

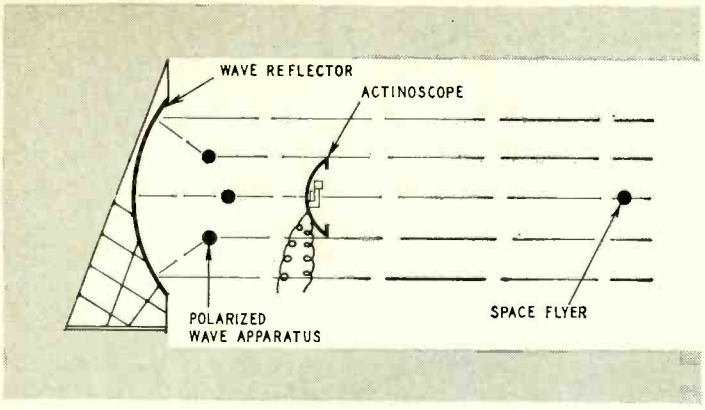
In the same book Gernsback mentioned two-way television, germicidal rays, tape recorders (with ¼-inch tape!), night baseball, artificial silk and wool, stainless steel, magnesium as a structural material, and fluorescent lighting.

Many of his predictions were made in his annual Christmas booklets, which were called *Forecast* since 1951. Some predictions have already been realized, like the Celestial TV (and airplane shelterway) of *Forecast 1952*, issued at Christmas 1951. Others, such as electronic weather control, are still in the future.

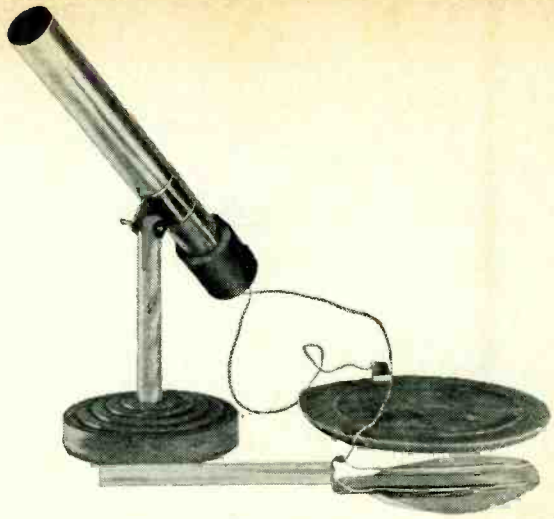
Another class of predictions—which might almost be called demands—appeared very early. The article "Television and the Telephot" appeared in *Modern Electrics* December 1909. In it, Gernsback unquestionably introduced the word "television" into the English language, insisted that wireless picture transmission must come, and suggested ways in which it could be realized.

As early as 1924 he described a radio-controlled military television plane that would transmit six pictures, covering all directions, to a viewing station on the ground. In 1928, he pioneered actual television broadcasting, transmitting tiny pictures from his broadcast station WRNY in New York City on a regular schedule. The 1.5-square-inch pictures were not considered entertainment quality even at that time, but the transmissions were picked up faithfully by 2,000-odd experimenters.

Education by television—"Tel-Education"—was one of Gernsback's favorite subjects, and he advocated it in a number of articles and at least five editorials, beginning in 1951. He circulated some of his editorials on the subject to large numbers of educators, legislators and others.



First drawing of radar equipment appeared in Modern Electrics, *December 1911, as illustration in the popular "Ralph 124C 41+".*



Electret and tester. The tester at left—one of Gernsback's latest inventions—is easy to use.

In Forecast 1955, he proposed the Tele-Doctor, a device combining a television set with instrumentation for pulse, respiration, blood pressure and other needed data, which could be controlled by a doctor in a central office. The device would be rented by the patient, presumably from the local drugstore, and plugged into the telephone line. The doctor, with his control instrument, could then get all the information that could be obtained in a home visit, in a fraction of the time. (In 1967 a New York headline read "Heart Pattern by Phone Has Saved Many Here.")

One of his last demands was for a National Facts Center—a Washington-based computer and data-processing central, closely allied with the Patent Office. It would record, correlate and store all scientific knowledge. Such a center could save billions of dollars by preventing duplicated, useless research and by keeping researchers abreast of the exact state of any art.

Gernsback's influence

Gernsback's predictions and his demands on the future undoubtedly affected inventors, researchers and legislators —his correspondence bears witness to that. But his involvement was often much closer—he never hesitated to propagandize, lobby or even point with alarm when necessary.

As early as 1909 he founded the Wireless Association of America, to advance the interests of all interested in or connected with the radio art. In 1912, when legislators sought to eliminate the radio amateur, Gernsback sprang to his defense, pointed out his value to the country and to the art, and listed in an editorial what he believed the privileges and limitations of the amateur should be. The amateur section of the Wireless Act of 1912 is practically a paraphrase of that article.

In 1919 the very existence of amateur radio was threatened. Gernsback's article—with its famous "Verboten" cartoon by Paul—blasting the notorious Alexander Act is credited with being an important if not the decisive factor in the defeat of that bill. Later, he formed the first organization of radio repairmen—the Official Radio Service Men's Association (ORSMA). Gernsback editorialized continuously on service technicians' problems.

But his direct contributions, as early equipment supplier and later as publisher, had an even greater effect. By making it possible for the experimenter to buy otherwise unobtainable equipment in small quantities and at reasonable cost he drew thousands into the field who would never have become interested in scientific pursuits. (A prominent Australian engineer on a exchange visit to Canada came to New York a few years ago to see and photograph the man who had started him on his career. But first he made a pilgrimage to 233 Fulton St., home of the Electro Importing Co.) In later years, the interest of many more thousands has been directed toward scientific and technical objectives by Gernsback magazines, with their continuous orientation toward the future and their never-ceasing flow of information presented so that the reader without an engineering education can understand and enjoy it, as easily as the more educated reader.

Gernsback as inventor

Gernsback obtained more than 80 patents during his lifetime. He made little attempt to commercialize most of them. An exception was the compression-type "condenser" (the principle of the present trimmer capacitor). It was used as the "book condenser" in the Crosley Trirdyn radio, and he licensed Crosley and a few others. A few other patents were obtained to protect some of the 60-odd devices he developed for the Electro Importing Co. His bone-conduction hearing aid, patented in 1928, was re-invented some years later and manufactured without interference from Gernsback. ("I never intended to market it," he said. "Why should I bother someone else?")

Not only did he develop many inventions but he suggested many more. Sometimes—as in signaling the planets —he went into exact details. Some of these turned out to be overcautious—it was not necessary, for instance, to erect sending and receiving stations on opposite sides of the earth to receive radio reflections from planets. In other cases, he suggested several possible approaches, without going into detail.

In other cases he promoted and pushed the work of other inventors directly. His interests in electrets, at a time when the average physicist did not even recognize the word, led him not only to print articles on the subject, but to persuade people into actually constructing them. Thus Edward Padgett first heard of electrets in the office of RADIO-ELECTRONICS and accepted the suggestion that he try to make some. He described his experiments in a series of articles in the magazine. The electret (a wax disc with a permanent positive charge on one face and a negative charge on the other) was publicized at the RADIO-ELECTRONICS booth at the next IRE show. Later, another old author, Victor Laughter, told readers how to make electrets as big as pie plates.

Gernsback the man

The feeling he invoked among those he inspired into electronic careers is difficult to describe. In many cases he produced disciples rather than readers—a prophet indeed with honor in his own group. The head of one large re-

This picture, from The Experimenter, *in 1924, was first description of military TV. Radio-controlled plane with six cameras sent pictures back to headquarters for six-panel display.*

search organization is impelled to testify, whenever the name is mentioned, that it was Hugo Gernsback who caused him to develop the interests that led him to his present position.

Gernsback, in turn, had a fantastic loyalty to old friends—and he counted his old readers in that group. When the name *Radio-Craft* was becoming obsolescent he asked his staff for a new name. It should contain the word "television" and be reasonably short. Not satisfied with the suggestions received, he sent them, together with a few of his own and a few extras to make weight, to 500 of his steadier subscribers. The result was an upset: more than 50% of the lists—with a choice of 13 names—came back with a vote for one of the weight-makers, RADIO-ELECTRONICS. Gernsback accepted the mandate of his loyal readers and used a title that did not include the magic word of the period.

His personal loyalties were equally strong. While Lee de Forest was under pressure from powerful interests, Gernsback never wavered in backing his claims to having developed a new instrumentality in the Audion (not merely "a Fleming valve with a grid in it"). He again supported him during the struggle over the discovery of regeneration, in spite of the fact that de Forest's opponent was the largest advertiser in the electronics field. (In 1924 the Supreme Court acknowledged de Forest as the inventor of the regenerative circuit.)

He was also one of the last friends of the great (but in his last years, ignored) Nikola Tesla, and it was through his intervention that Tesla obtained from Westinghouse the pension—or consulting retainer—that maintained him the last years of his life.

Gernsback and the world

For some years a recognized figure as a great radio salesman and successful publisher, his "window into the future" irritated those whose viewpoint was more limited (Doesn't he realize the difficulties in the way of. . . ?). His insistence, for instance, that pictures not only could be sent by wireless, but that the engineering fraternity should buckle down and devise means for doing so, did not ingratiate him with a group trained to concentrate on the problems in the way of accomplishing an objective.

With his financial near-collapse in 1928, his critics became more outspoken. Respectable scientists and industrialists often dismissed him as a harebrained crackpot. Only as his impractical ideas became prosaic facts did many of the solid citzenry of the electronics world begin to take notice of him again. And his economic advances in the 1940's had a profound influence on the same group. Nothing succeeds like success, and it was again a successful publisher talking.

When the scientists at Massachusetts Institute of Technology first announced the successful reflection of signals from Venus in 1958, the paper opened with the statement that it was "first proposed by Gernsback in 1927" ("Can We Radio the Planets?" *Radio News*, February, 1927).

He received recognition and awards from many other sources, and was published in most of the wide-circulation magazines. A four-page spectacular in *Life*, July 26, 1963, was illustrated by his farthest-out (into space) concepts. *Ralph 124C 41+*, which first appeared in book form in 1925, came out in a second edition in 1950; was made a paperback by Crest Books in 1958, and appeared in a Russian edition (Moscow, 1964).

Gernsback drew his power from two things: a child-like and unquenchable curiosity and a strong urge to communicate. At all times he welcomed the new—however improbable—and on occasion was criticized for printing wild ideas. For example, he did not hesitate to publish the theories of Professor Ehrenhaft, who insisted there was such a thing as magnetic current. With Ehrenhaft's death his theories disappeared (till a few months ago, at least). But Gernsback refused to learn from experience, and in 1950 printed an even wilder account of electronic spaceships that would maneuver with cathodic power. This was by another German professor named Oberth. (One can't lose all the time, and within three years that wild idea was being discussed by scientific societies, and seemed hardly wild at all after the successful orbiting of Sputnik.)

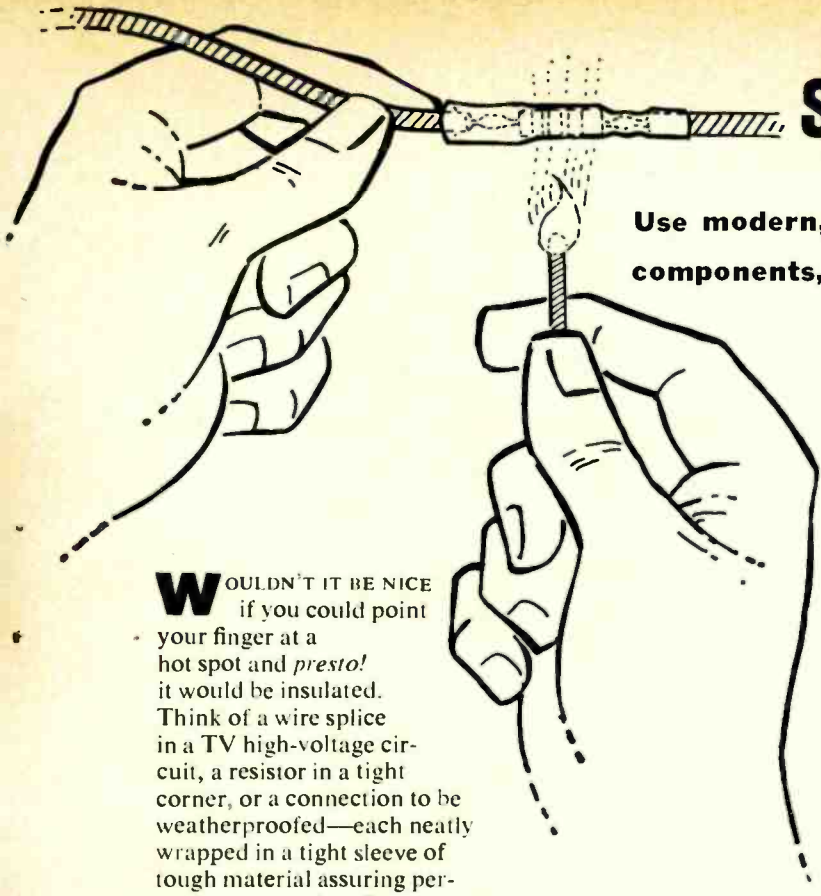
No single magazine article can hope to cover adequately the life of Hugo Gernsback. He was too many things—was called the Father of Science Fiction, the Father of Radio Amateurism, the Fairy Godfather of the IRE (He retorted, "I accept the 'godfather' but 'fairy', no!"). For many years he was the mentor of the experimenter and constructor, and later of the radio service technician. (This magazine, incidentally, introduced the term "technician" instead of "serviceman.")

Gernsback the humorist

Far from sharing the too-common view that a technical article or magazine must be deadly dull to be serious, Gernsback injected humor into his magazines from the beginning. (For a time, he even published a humor magazine, as well as a series of "Scientific Comics.")

Modern Electrics carried a page entitled "The Martian Screech" in many issues. Supposedly edited by Fips the office boy, an immigrant from Mars, it described many electronic wonders of that planet, plus Fips' own inventions. These included transmission of matter (such as ham sandwiches) and contrapolar current, a remarkable form of electricity carried on linen thread (insulated, of course, by wrapping it with bare copper wire). A coil of this contra-conductor, connected across a storage battery, would cool rapidly beyond the freezing point, instead of heating.

Years later, Fips reported his breakthroughs in the April issues of RADIO-ELECTRONICS. The *Westingmouse* was the most famous. A *vest-pocket* radio (in 1933!) it contained seven APR-1 tubes and was unbelievably small (hardly twice as large as a present-day transistor set). Reactions from a large electric company—that had received numerous orders from readers who were ready to believe the unbelieveable—were so positive that Fips emerged again only in 1944, with a Radium Radio, so powerful it needed a throttle instead of a volume control. Every year thereafter he described new and revolutionary inventions, such as a crystal amplifier, office noise neutralizer, electronic brain servicing, and 3-D TV receiver. (The first three wild ideas are now in use, incidentally, and it is rumored that researchers are working hard on 3-dimensional TV.) **R-E**



Shrink on the Insulation

Use modern, easy way to cover wire, splices, terminals, components, etc.

By JULIAN N. JABLIN, W9IWI

WOULDN'T IT BE NICE if you could point your finger at a hot spot and *presto!* it would be insulated. Think of a wire splice in a TV high-voltage circuit, a resistor in a tight corner, or a connection to be weatherproofed—each neatly wrapped in a tight sleeve of tough material assuring permanent protection. If you could do this, gone would be the nuisance of applying bulky wrappings of tape in inaccessible spots. Also, you wouldn't worry about the possibility that the insulation could eventually dry out and come apart, or lose its ability to insulate.

Such magic is not yet part of the electronics scene. What *is* available now is a new tubular insulating material that you can slip over a soldered connection or a component and shrink to a tight grip. The results are fast, neat, and professional looking.

The material which makes this possible is plastic *shrinkable* tubing. It is made in a variety of diameters and, when heated, shrinks to a portion of its original size. You may have seen such tubing in commercial and military equipment, where it has been used for several years. Now it's available in consumer quantities at electronics distributors. Once you have tried it, you will find yourself devising new ways of employing the tubing to make your work easier and better. Probably you will substitute it in most cases where you might have used tape or spaghetti.

An example is the small power supply in Fig. 1. I put everything—transformer, silicon rectifiers, filter components, VR tube—in a 4″ x 5″ x 6″ box. On the cover plate I mounted the pilot light and ac switch. Even with slack wiring, it would have been difficult to tape the connections to prevent shorts. So, I slipped short lengths of shrinkable tubing on the wires. Then, after soldering the splices, I slid the tubing down over the exposed joints and heated the tubing with my soldering gun. The insulation then shrank on. I prewired the VR tube (see Fig. 2) and, since it was mounted on short spacers above the surface of the metal box, I insulated all the lugs.

How it works

What makes the tubing shrink? In the manufacturing process, it is irradiated or otherwise treated and expands. When heat is applied, it shrinks to its original diameter and remains stable at this size. The usual shrinkage ratio is 2:1—that is, the tubing will shrink to 50% of the diameter it is when you buy it. Thus, when slipped over a wire or component which is slightly smaller than its unheated size, the tubing will grip tightly after you have heated it. There is some slight shrinkage lengthwise, but for all practical purposes you can ignore this if you cut the tubing a bit longer than the part to be insulated.

Manufacturers produce shrinkable tubing in various diameters, made of several plastics which have different characteristics. Some are highly flexible after heating, some less so; some will withstand higher ambient temperatures than others; some have a meltable inner wall for better encapsulation of components. For the most part, the technician or experimenter can use any type that is available. All will do what you want—provide a tough, high-dielectric, stable sleeve over a part that is to be protected.

Shrinkable tubing is produced by several manufacturers. *Alphlex*, made by Alpha Wire, is packaged in a boxed assortment of sizes, types and colors, as well as in packages of 4′ or 6″ lengths in individual diameters. Other makers are Belden Manufacturing Co. and Birnbach Radio Co. Any electronics parts distributor or mail-order house listing these manufacturers' products can supply shrinkable tubing.

Heat and color code

To heat the tubing, I have used my soldering gun, a match, and my wife's oven, depending on the job. The insulating sleeves on the pliers in Fig. 3 were processed in an oven at 350°F for a few minutes. Because of the large difference in diameter from the middle to the end of the

continued on page 84

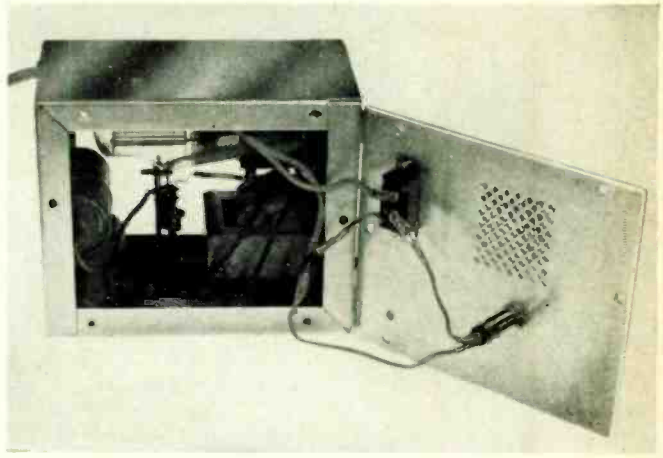


Fig. 1—(Top) Shrinkable tubing insulates splices in this compact power supply.

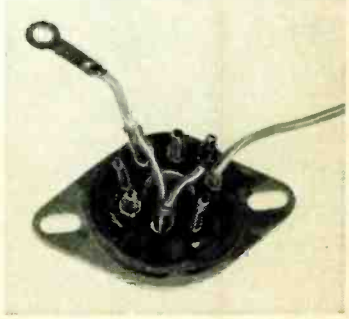
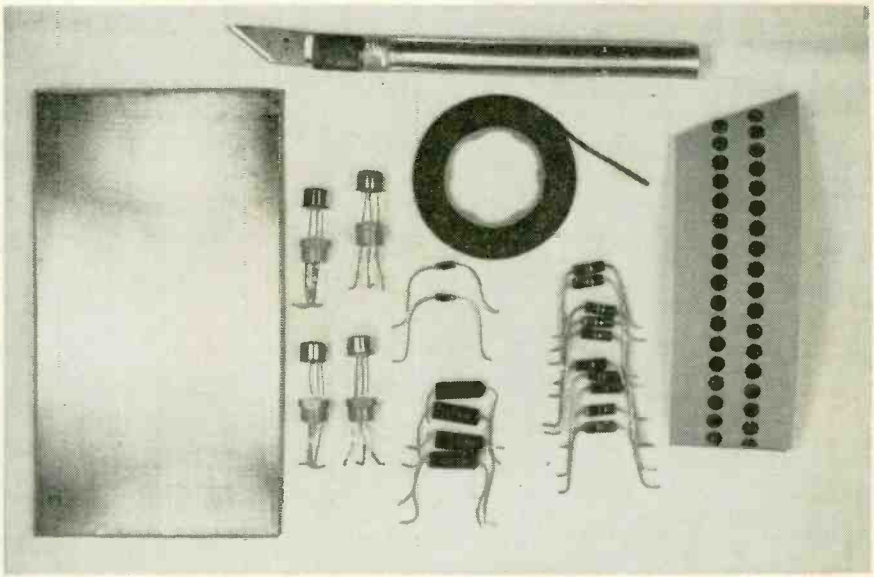


Fig. 2—(Right) VR tube socket in power supply is prewired before mounting. All lugs are covered with heat shrinkable tubing.

HOW TO MAKE PRINTED

Plan Layout Etch and Test

By R. T. MONTAN'E



Before. Materials and components used to construct the amplifier are shown here. Resist-tape (center) and dots (right) mask the metal from the etchant in the acid bath.

Planning the layout of a printed-circuit board so it resembles the actual schematic diagram is the key to this simple circuit-evaluation technique. Interconnecting wiring is laid out by placing etch-resist materials on the copper side of a blank board. The prepared board is then etched. All components are soldered directly to the copper circuit that survives the etching process, and the breadboard is ready to be tested. The complete job, from layout to testing for a typical solid-state amplifier, takes about 2 hours.

All materials required to process the PC board can be obtained from almost any large electronic parts distributor. Complete kits of materials are available, or each item shown on the material list can be purchased separately. A kit usually has enough material to process two boards.

Select a board of adequate size, either by estimation or by laying out all necessary components in a rough approximation of the finished circuit. The four-stage amplifier, used here to illustrate the process, is constructed on a 3½ x 5-inch board.

After you've cut the board to the proper size, clean the copper-plated side with steel wool. It has to be absolutely free from dirt and oxidation, so avoid finger marks.

Following usual procedures for schematic layout, place the components on the board—input to the left, output to the right. Form the B+ and ground buses using resist tape. Next, separate each transistor-socket lead and locate resist dots to provide connections for base, emitter and collector.

You can make things easier for yourself by not drilling holes in the board. Bend component leads at right angles and you'll be able to solder them directly to the copper lines.

Of course, it makes no difference in layout whether you drill holes or not. Follow the plans given here, laying out the circuit paths.

You can make your layout task easier if the schematic is drawn with as few crossed lines as possible. When a crossing must be made, a component (resistor or capacitor) usually can be used as the bridge.

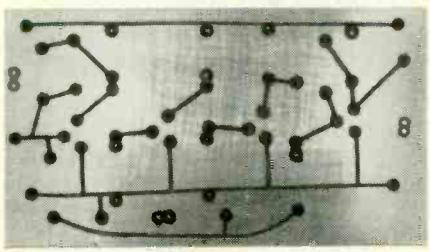
Coupling and bypass capacitors should be mounted edgewise on the board to economize space. Collector resistors are mounted close to the collector supply line—the line is plus in this case for npn transistors.

At this point in preparing the board, your layout should be thoroughly checked for mistakes. The next step is to etch away the excess copper; once it's gone, mistakes are difficult.

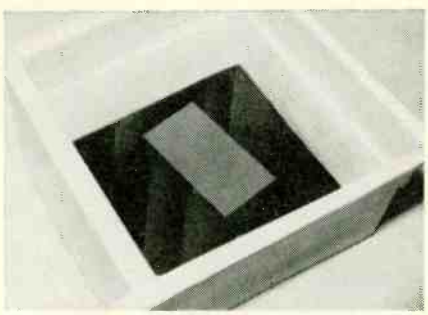
A plastic pan, large enough to accommodate a 12 x 12-inch board, is required to contain the etching liquid (ferric chloride). The etchant is poured into the pan carefully; it leaves permanent stains on clothing. The liquid should be about ¼ inch deep.

All bubbles are removed from the

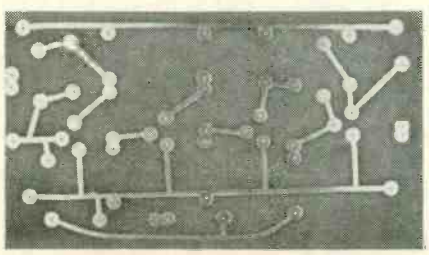
Mask, Etch and Clean



First, apply resist tape to the board.

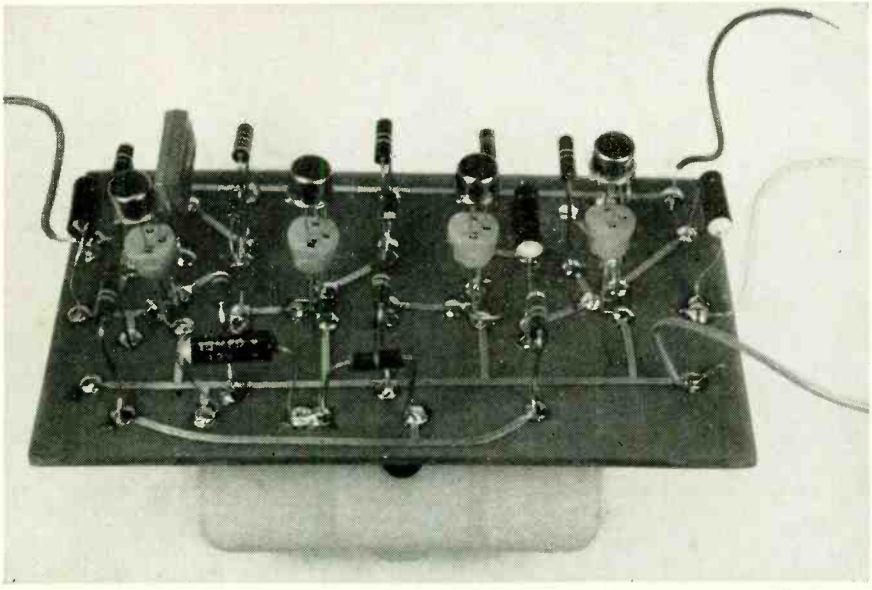


Then, put board in etchant, copper down.



Finally, remove resist and wash.

CIRCUIT BOARDS



After. To avoid drilling you can connect the components on the wiring side of the board.

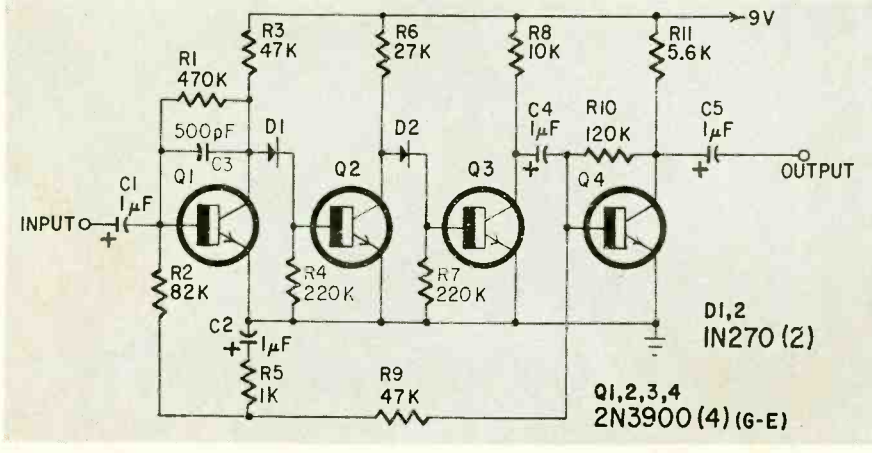
surface of the bath before the printed board, copper side down, is placed in the etchant. Remove the board after 1 minute and check to see if air bubbles have formed. Rub a little etching fluid over any area where bubbles appear, then place the board back into the pan for an additional 20 minutes. Check occasionally to be sure the board is floating. Be careful not to overetch the board, or the copper underneath the resist tape may dissolve.

When all exposed copper has been dissolved, remove the board from the etchant. Rinse it thoroughly in cold, running water. At the same time, remove the resist tape and the resist dots. Clean the copper circuit paths and the board itself with household steel wool. To remove all traces of the etchant, rinse the board in running water for 10 minutes. Finally, dry the board for 30 minutes. Remove any unwanted copper burrs or snags with a sharp tool or knife.

From this point on, all you have to do is mount the components to the board. **R-E**

Materials List

Tape resist circles, 3/16" (Brady TC-187-062 or similar)
Tape resist strips, 1/16" (Brady CSR-062 or similar)
Copper-clad XXXP board
Liquid resist (Kepro R-2 or similar)
Etching solution
Misc. Plastic pan to contain etching bath
Knife, solder, wire
Note: Materials are made in a variety of sizes, quantities and prices, are available at many distributors.



Notice the similarity of the layout of the schematic with the layout of the PC board.

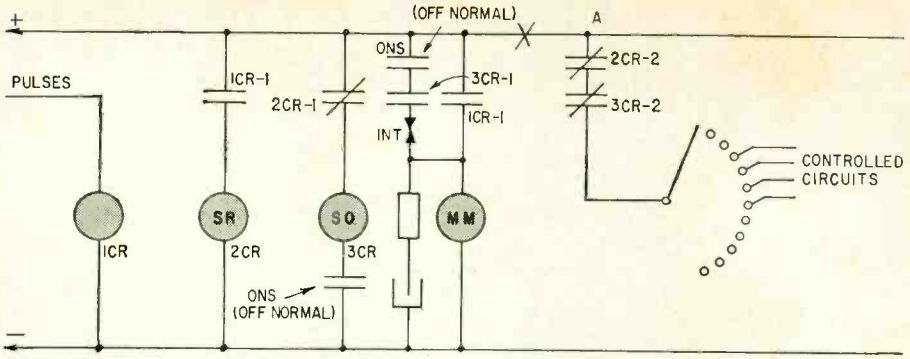


Fig. 4—This circuit makes switch step forward to "home" at end of its sequence.

ROTARY STEPPING SWITCHES

continued from page 41

lected contact is connected to a battery (the B + line), starting a controlling pulse, and slow-operate relay 3CR is energized. After another delay this relay stops the controlling pulse by opening normally closed contact 3CR-1 in the wiper circuit. Second, 3CR closes contact 3CR-2 which energizes the release magnet on the stepping switch.

Note the use of off-normal contacts (ONS). Relay 3CR cannot energize until the switch is away from "home." Notice too that neither relay 3CR nor the release magnet can energize until 2CR has released. Since 3CR is slow operating (meaning also slow release), and the wiper is connected through normally closed contact 3CR-1, the switch wiper remains disconnected until after the switch has returned home. What has happened? Incoming pulses have selected a circuit, a control pulse has been delivered, and the switch has been returned home. Duration of the control pulse depends on 3CR. The pulse lasts as long as it takes this relay to open contact 3CR-1 in the wiper circuit.

Fig. 4, a similar circuit, outlines the circuit for a rotary switch without a release magnet. In this case 3CR also closes a circuit to the interrupter, allowing the switch to step forward to "home" by itself, which will happen in about ⅓ second. 3CR must remain closed that long. The off-normal con-

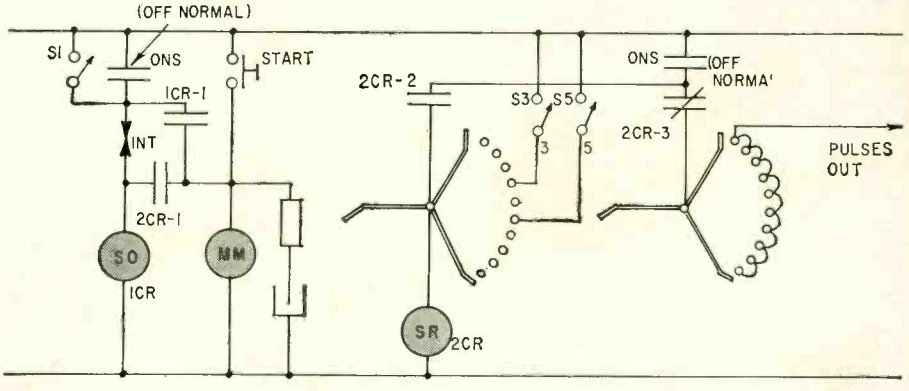


Fig. 5—When S3 closes, 3 pulses are transmitted and switch then steps "home."

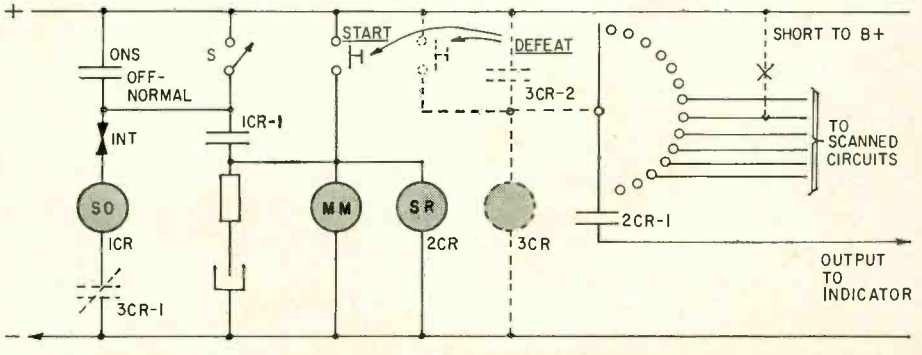


Fig. 6—When activated, this circuit will scan all the switch contacts, then stop.

Circle 31 on reader's service card ➔

tacts will stop the switch. In using rotary switches in the self-stepping mode, it's best never to rely on a relay to stop a switch. The interrupter contacts are much faster than any relay, unless they are *slowed down* by a relay.

Such is the case in the circuit of Fig. 5 (although even so, the off-normal springs are relied upon to stop the switch). This is a pulse-sending circuit. Switches S3 and S5 are two of a set of nine. (The others aren't shown for simplicity's sake. Note also that usually no more than one or two switchbanks are shown, even though the switch may have several more.)

With S1 open, and S5 closed, the following actions occur: Push the START button. The rotary switch takes one step and gets off normal. This condition closes a path to interrupter I, which energizes slow-operating relay 1CR. After a pause, 1CR energizes the motor magnet for yet another step, and so on. Each time the rotary switch steps, a pulse is sent out over the second bank of contacts. When the switch gets to step 5, five pulses have been sent out. Now relay 2CR is energized through the first switch level. This cuts off the pulse line for outgoing pulses. It also connects the motor magnet directly to the interrupter, and the switch steps rapidly forward to home. Since 2CR is a slow-release relay, all these actions can happen while 2CR is closed. In home position the off-normal springs cut off the magnet and the switch stops.

If switch S1 is closed and S2 through S10 are left open, the sender will continue to send out pulses so long as S1 is left closed. The pulse rate depends on 1CR, and can be chosen as slow as 2 operations per second. Normally it will allow 10 pulses per second.

Automatic scanning

The same principle of slow stepping is used in the circuit of Fig. 6, a device that will scan all switch contacts, for example, to detect a voltage or a ground. A relay can be included in the output circuit to stop this switch when such an event occurs. This option is shown in dotted lines. Otherwise the circuit will scan once and stop, or, with switch S closed, will scan continuously.

In all rotary stepping-switch circuits it is imperative that careful attention be given to timing. In designing a stepping-switch relay circuit, a table showing the sequence of events can be very helpful. This will be covered in the next installment, along with information on how to make such a table, and how to select 1 out of 100 points using only 2 rotary switches and a few relays.

To be continued

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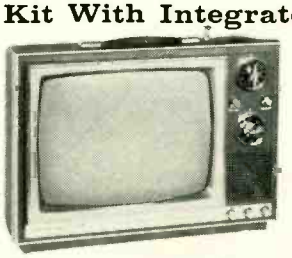

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Kit AR-17, (less cab.) 12 lbs.... no money dn., $8 mo. **$72.95**

Kit AR-27
$49.95
(less cabinet)
$5 mo.

NEW! Low Cost Solid-State FM Mono Receiver

Features cool, solid-state circuit . . . 7 watts music, 5 watts RMS power . . . 18 to 60,000 Hz response @ ±1 db . . . inputs for phono and auxiliary . . . outputs for 4 thru 16 ohm speakers . . . flywheel tuning . . . front panel controls . . . preassembled & aligned FM front-end . . . and 9¾" D. x 2⅞" H. x 11¾" W. bookshelf size. 9 lbs. Optional Heath factory assembled cabinets (walnut veneer $7.95, beige metal $3.50).

Kit AR-27, (less cab.) 9 lbs.... no money dn., $5 mo.... **$49.95**

Kit AR-15
$329.95
(less cabinet)
$28 mo.

Assembled ARW-15
$499.50
(less cabinet)
$43 mo.

World's Most Advanced Stereo Receiver . . . Choose Kit Or Factory Assembled

Acclaimed by owners & audio experts for its advanced features like integrated circuits and crystal filters in the IF amplifier section; ultra-sensitive FET FM tuner; 150 watts dynamic music power; complete AM, FM and FM stereo listening; positive circuit protection; all-silicon transistors; "black magic" panel lighting; stereo only switch; adjustable phase control for best stereo and many more. 34 lbs. Optional wrap-around walnut cabinet $19.95.

Kit AR-15 (less cab.), 34 lbs.... $33 dn., $28 mo..... **$329.95**

Assembled ARW-15, (less cab.), 34 lbs.... $50 dn., $43 mo..... **$499.50**

NEW! Heathkit Stereo Headphone Control Box

Kit AC-17
$7.95

Now enjoy the convenience of switching from speaker to private headphone listening without leaving the comfort of your favorite chair. Connects to any headphone regardless of power, and has standard jacks to accommodate two sets of any impedance, 3 or 4 connector, stereo or mono headset. Tandem volume and balance controls. About the size of a pack of cigarettes. Includes 20' cable.

Kit AC-17, 3 lbs..... **$7.95**

NEW! Exclusive Heath Hi-Fi Furniture . . . Fully Assembled And Finished

Contemporary Walnut Stereo/Hi-Fi Cabinet Ensemble Complements Modern Furnishings

Masterfully crafted of fine veneers and solids with walnut finish. Statuary Bronze handles. Equipment cabinet features adjustable shelves to accommodate all makes of hi-fi components, record storage or tape recorder compartment, turntable compartment. Speaker cabinet features special Tubular-Duct Reflex design for matching 8" or 12" speakers, plus slot for a horn tweeter.

Complete Ensemble
$244.00

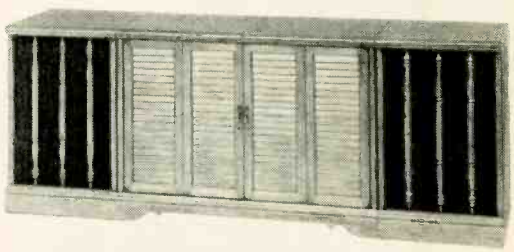
Model AE-37, equipment cabinet...
no money dn., $12 mo..... **$125.00**
Model AEA-37-1, speaker cabinet...
no money dn., $6 mo..... each **$59.50**

Early American Stereo/Hi-Fi Cabinet Ensemble

Early American richness with modern component layout. Constructed of specially-selected solids and veneers finished in popular Salem-Maple. Statuary Bronze handles. Equipment cabinet has adjustable shelves to accommodate any make hi-fi component, record storage or tape recorder compartment, turntable compartment. Speaker cabinet can be matched to any 8" or 12" speaker . . . has slot for horn tweeter.

Complete Ensemble
$264.00

Model AE-47, equipment cabinet...
no money dn., $13 mo..... **$135.00**
Model AEA-47-1, speaker cabinet...
no money dn., $7 mo..... each **$64.50**



Mediterranean Pecan Stereo/Hi-Fi Cabinet Ensemble

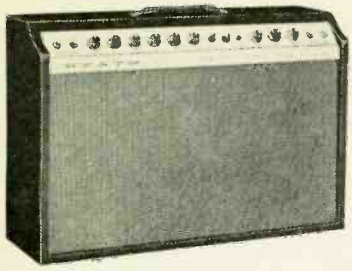
Beautifully constructed of fine furniture solids and veneers with Pecan finish. Statuary Bronze handles. Equipment cabinet has adjustable shelves to house any make hi-fi component, record storage or tape recorder compartment, turntable compartment. Speaker cabinet can be matched to any 8" or 12" speaker . . . has slot for horn tweeter.

Complete Ensemble
$299.00

Model AE-57, equipment cabinet...
no money dn., $14 mo..... **$150.00**
Model AEA-57-1, speaker cabinet...
no money dn., $8 mo..... each **$74.50**

Enjoy Widest Kit Selection, Easy Credit,

"Starmaker" Dual-Channel Solid-State Guitar Amplifier



Features 25 watts EIA, 60 watts peak power; two channels, each with two inputs; handles lead guitar, singer's mike; tremolo & reverb; two 12″ speakers; line bypass reversing switch for hum reduction; foot switches; black vinyl-covered wood cabinet with aluminum front panel & chrome knobs. 52 lbs.

Kit TA-16 **$134.95** $13 mo.

Assembled TAW-16 **$199.95** $19 mo.

NEW! Single-Channel Solid-State Guitar Amplifier

Compare To Amps Costing $175 & More! Boasts 20 watts EIA, 40 watts peak power; tremolo & reverb; two inputs for lead guitars, singer's mike; 12″ speaker; line bypass reversing switch to reduce hum; foot switches; transformer power supply; black vinyl-covered wood cabinet with aluminum front panel & chrome knobs. 35 lbs.

Kit TA-27 **$89.95** $9 mo.

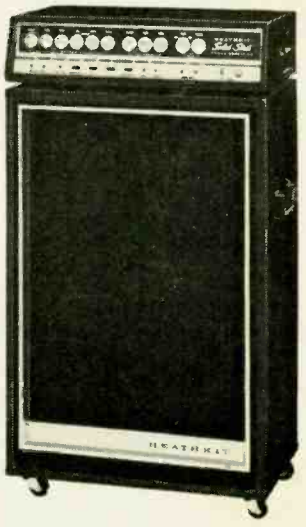
Assembled TAW-27 **$134.95** $13 mo.

NEW! Deluxe Solid-State Combo Amplifier & Speaker System . . . Choose Kit Or Factory Assembled

Kit TA-17 Amplifier
$175.00
$17 mo.
(Wired TAW-17, $275)

Kit TA-17-1 Speaker System
$120.00
$11 mo.
(Wired TAW-17-1, $150)

Kit TAS-17-2
Special Combination Offer!
2 Speaker Systems & Amplifier
Save $20
$395.00
$40 dn.
$34 mo.
(Wired TAW-17-2, $545)



All the "big sound" features every combo wants . . . tremolo, built-in "fuzz", brightness, reverb, separate bass and treble boost and more. Delivers a shattering 120 watts EIA music power (240 watts peak power) through two TA-17-1 speakers . . . or 90 watts through one TA-17-1 speaker. Features 3 independent input channels, each with two inputs. Handles lead or bass guitars, combo organ, accordion, singer's mike, or even a record changer. All front panel controls keep you in full command of all the action.

Speaker system features two 12″ woofers, special horn driver and matching black vinyl-covered wood cabinet with casters & handles for easy mobility.

NEW! Heathkit Jr.® Guitar Amplifier

Kit JK-37 **$29.95** $5 mo.

Ideal For Youngsters! Build in an evening. All solid-state. 9 watts music power. 8″ speaker. Single channel, two inputs. Variable tremolo. Volume & tone controls. Red vinyl-covered wood cabinet with striped grille cloth and carrying handle. 12 lbs.

NEW! Heathkit Jr.® Portable Phonograph

Kit JK-17 **$19.95**

All solid-state. Plays all 4 speeds, all record sizes. Crystal cartridge with sapphire stylus for all types of records; 4″ speaker; built-in 45 rpm adaptor; prebuilt turntable & hardboard cabinet. 117 v. AC, 60 Hz operation. 11 lbs.

Heathkit Jr.® Electronic Workshop "19"

Kit JK-27 **$13.95**

Ideal gift for any youngster who wants to learn electronics. Contains principles of operation & instructions for building 19 electronic projects . . . PA system, transistor radio, burglar alarm, etc. Spring-type connectors. Safe, flashlight battery operation. 4 lbs.

NEW! Professional 10-Band Shortwave Listener's Receiver

Kit SB-310 **$249.00** $23 mo.

(SB-600 8 Ohm, 6″ x 9″ Speaker, $18.95)

Covers 6 shortwave bands (49, 41, 31, 25, 19 & 16 meters) . . . 80, 40 & 20 meter ham bands . . . 11 meter CB. Includes 5 kHz crystal filter for AM, SSB and CW listening. Features selectivity that slices stations down to last kHz . . . no more guessing station identities; 11-tube circuit; crystal-controlled front-end for same rate tuning on all bands; prebuilt & aligned LMO; tuning dial to knob ratio 4 to 1; and many more deluxe SWL features. 2-tone green metal cabinet included. Optional crystal filters for optimum CW & SSB available. 20 lbs.

Deluxe 23-Channel CB Transceiver

Now FCC Type Accepted! All solid-state circuit. Full 5-watts. All crystal-controlled transmit & receive channels. Built-in speaker; "S" meter; squelch control; and other deluxe features. 12 v. neg. gnd. operation. AC power supply & crystal pack optional. 8 lbs.

Assembled GWW-14A **$124.95** $12 mo.

NEW! Amateur Novice CW Transceiver

Kit HW-16 **$99.50** $10 mo.

Get on-the-air at lowest cost. CW operation on first 250 kHz of 80, 40 & 15 meter bands. 75 watt CW input, up to 90 watts for general class. "Break-in" CW operation. Crystal control transmit with VFO receiver tuning. Metal cabinet, easy to build. 25 lbs.

Circle 33 on reader's service card

Direct-To-You Delivery From Heath

Save Up To $500 On This Heathkit® / Thomas "Paramount" Transistor Theatre Organ

Kit TO-67
$995.00
(including bench)
Write for credit details

All Genuine Thomas Factory-Fabricated Parts. Features 15 manual, 4 pedal voices; instant-play Color-Glo; all solid-state circuit; 200 watts peak power; two separate speaker systems . . . 2-speed rotating Leslie plus main system with two 12" speakers; two 44-note keyboards; professional horseshoe console with stop tablets; 28 notes of chimes; 13-note bass pedals; selective repeat & attack percussion; reverb; stereo headset outlet; assembled walnut finish hardwood cabinet and bench; and more. 265 lbs. 7", 33-1/3 rpm demonstration record 50c.

America's Lowest Cost Solid-State Organ

Save Up to $205! Features instant-play Color-Glo; 10 organ voices; 13-note bass pedals; repeat percussion; two 37-note keyboards; 75 watt peak power; vibrato; matching preassembled walnut cabinet & bench; 5-year warranty on plug-in tone generators. 172 lbs. 7", 33-1/3 rpm demonstration record 50c.

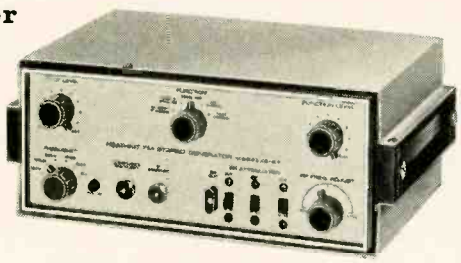
Kit GD-325B
$394.90
$40 dn., $34 mo.

NEW! Heathkit® /Thomas Organ Accessories

Exclusive Band Box Percussion
Automatically or manually adds 10 percussion voices to any Heathkit/Thomas organ. Build & install in 12 hours.
Kit TOA-67-1, no money dn., $14 mo. **$145.00**

Exclusive Playmate Rhythm Maker
Adds 15 fascinating rhythms to any Heathkit/Thomas Organ. Requires Band Box percussion (above) for operation.
Kit TOA-67-5, no money dn., $18 mo. **$189.90**

NEW! FM Stereo Generator



Kit IG-37
$79.95
$8 mo.

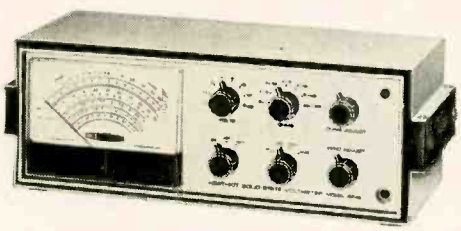
For RF, IF and FM stereo alignment. Switch selection of 400 Hz, 1000 Hz, 5000 Hz, 19 kHz and 65 kHz or 67 kHz SCA signals. Crystal controlled 19 kHz pilot signal adjustable from 0 to 10%. 100 MHz sweep signal (adjustable ±2 MHz). Phase test capability. 12 lbs.

NEW! Variable Regulated High Voltage Power Supply

Kit IP-17
$59.95
$6 mo.
Assembled IPW-17
$89.95
$9 mo.

Features 6 v. and 12 v. AC filament voltages; also furnishes B+ from 0 to 400 volts DC, bias from 0 to —100 volts DC; separate panel meters monitor B+ output voltage & current; voltmeter switched to read C— volts; output terminals isolated for safety; high voltage and bias may be switched "off" with filaments still "on" for maximum testing efficiency and safety. 17 lbs.

NEW! Deluxe Solid-State Volt-Ohm-Meter



Kit IM-16
$44.95
$5 mo.
Assembled IMW-16
$64.95
$7 mo.

Battery plus built-in AC power. 8 DC and 8 AC volt ranges, 0.5 v. to 1500 v. full scale; 7 ohmmeter ranges x1 (10 ohms center scale), x10, x100, x1k, x10k, x100k and x1 megohm; 11 megohm input resistance on DC & AC ranges; 6" 100 uA meter; single test probe. 10 lbs.

Solid-State High Impedance Volt-Ohm Milliammeter

Kit IM-25
$80.00
$8 mo.
Assembled IMW-25
$115.00
$11 mo.

Features 9 AC & 9 DC volt ranges from 150 mv to 1500 v. full scale; 7 resistance ranges, 10 ohms center scale with multipliers x1, x10, x100, x1k, x10k, x100k, x1 meg; 11 current ranges from 15 uA to 1.5 A; 11 megohm input resistance on DC, 10 megohm on AC; 6" 200 uA meter; Built-in battery or 120/240 v. AC, 50-60 Hz. 10 lbs.

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Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

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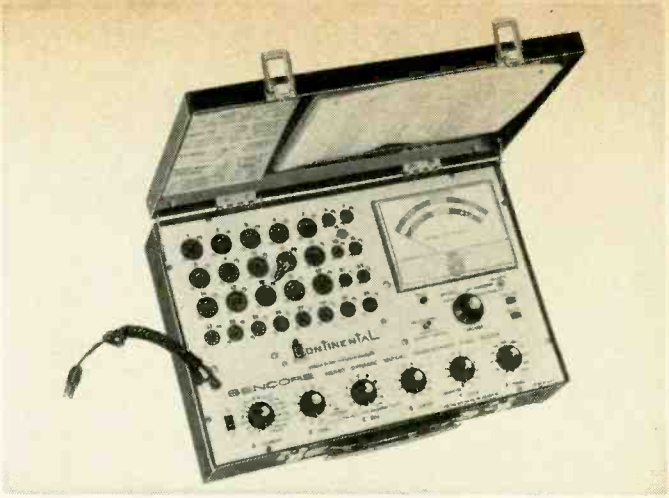


EQUIPMENT REPORT

Sencore MU-140 Tube Tester

Circle 35 on reader's service card

MORE THAN 3000 TUBE TYPES, including industrial and receiving, can be checked on the MU-140 Continental mutual-conductance tube tester. Compactrons, nuvistors and the new 10-pin decal types as well as the more conventional tubes can be checked for emission, mutual conductance, shorts, leakage and grid emission.

If you should find a tube that isn't listed, look up a similar type and use the settings indicated.

Should a new tube type require a new test position, the MU-140 has spare openings for four additional tube sockets. These openings are on the panel and are covered with a plate. Sencore will supply detailed hookup instructions for wiring in new sockets when they are needed.

The cathode-emission test is fast; only three controls have to be set—heater voltage, control-grid and load selector. A novel circuit is used here. Older emission testers tied all the elements except the cathode together and then metered the cathode current. The MU-140 measures control-grid current—most current flows from cathode to grid.

Tests for shorts are made with a low voltage, to prevent damage to closely spaced elements, such as in nuvistors and frame-grid tube types. Each element in the tube is checked against all the others for shorts. A special position for heater-cathode shorts is used.

For mutual-conductance tests, a special ABC (Automatic Bias Control) circuit automatically sets up bias and plate current and eliminates the need for adjustable controls. Only the main load is variable.

Mutual-conductance measurements require an ac signal. The test signal is a 5000-Hz square wave generated by a transistor multivibrator circuit. Its output voltage is regulated by the setting of the F SIGNAL control.

The meter circuit is protected by a diode and is calibrated to read "100" on the scale when the tube lives up to its rated G_m. The customary "BAD-?-GOOD" scale is used, as well as a numerical scale marked from zero to 120.

Grid emission or leakage is monitored by the meter. The dividing line between "GOOD" and "?" on the meter indicates approximately 200 megohms of grid leakage. The line between "BAD" and "?" is about 100 megohms. This is a sensitive test; grid current as small as 0.5 μA shows.

This grid test can catch the 6AL5 with "grid" emission. Yes, I know—this is contamination of the mount in the tube, but it'll shake you up the first time you run across it! Any diode which shows "grid" emission will affect the operation of sensitive detector circuits.

All in all, the MU-140 is a well-built instrument. —*Wm. Darragh*

Price: $179.50

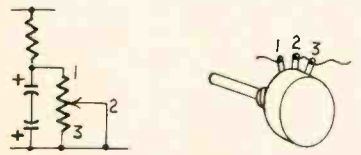
R-E

Stereo Headphone Control

continued fom page 36

than No. 22 for the leads that will carry the full speaker current (heavy lines drawn on the schematic).

The photos show all the details for wiring the control center. The solder-lug strip mounting is soldered to the back of the balance control.



The Stereo Headphone Control Center works as described. It is important to try to obtain log-taper (audio taper) controls for R6, otherwise the change from flat response to full boost occurs all in the first few degrees of rotation from the counter-clockwise stop.

Be sure to wire the control exactly as shown. If you don't, the taper is in effect reversed and the rate of change will be even more extreme than with a linear-taper control.

If the electrolytic capacitors have uninsulated metal cases, as the ones in this model did, insulate them with tape to prevent their touching the panel. The panel must be electrically common to the common side of the circuit unless you want to provide insulating bushings for the phone jacks.

Modifications

Of course you can provide only one jack if you wish, or three or more. Volume will diminish as you parallel more sets of phones. If you like, you can provide a separate volume control for each headset. You can, in fact, duplicate the portion of the circuit after the switching (to the right of the dashed line X–X on the schematic) so that each headset has full, separate control facilities.

If you like your headphone music extremely loud, you may have to forgo the bass-boost circuit (R5, R6 and R7 and C1, C2, C3 and C4). To provide 6 dB of bass boost, the circuit must introduce 6 dB of loss everywhere else in the spectrum, except at the low frequencies. In a passive equalizer, there is no way around this fact of life. So if you need loudness, disconnect or omit the bass boost circuit.

Connecting the thing

Fig. 2 shows how the control center is to be connected to an amplifier. Note that the common terminal on the control center goes to the amplifier *chassis*, not to either of the speaker terminals often labeled "common" or "C". The reason is that in many amplifiers the so-called "common" terminals are *not* common to each other or to the chassis, and cannot be connected together without disrupting some circuit function.

This connection is for headphone operation only. The normal connection to the speakers is in no way affected by the addition of the box if you follow the scheme given here. The speakers can be turned off or on by the selector switch in the control center, but this is done by interrupting the *high* (4-, 8- or 16-ohm) side of the wiring, not by disturbing the connection to the amplifier's low side.

Flat, five-conductor antenna-rotator cable is handy for making the connections between control center and amplifier because it can be slipped under a rug or run alongside of baseboard molding.

The wire should be No. 22 or heavier. Avoid running more than about 50 feet to prevent a sizable portion of your expensive amplifier power to be dissipated in the wiring. **R-E**

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SYLVANIA (Subsidiary of General Telephone & Electronics) (Pg. 27)	Circle 27
TAB BOOKS (Pg. 94)	Circle 126
TURNER MICROPHONE COMPANY, THE (Pg. 80)	Circle 108
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WARREN ELECTRONIC COMPONENTS (Pg. 100)	Circle 144
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NEW AUDIO EQUIPMENT

More information on new audio equipment is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 74 and circle the numbers of the new products on which you would like information. Detach and mail the postage-paid card.

COMPACT TAPE CASSETTES. The *C-120* 120-min. playing time. Packaged either individually in plastic, shatterproof containers, in card-stock mailing

cartons, or bulk-packed in poly bags. Full-range response at slow cassette playback speeds. Cassette dropout specifications available.—**Certron Corp.**

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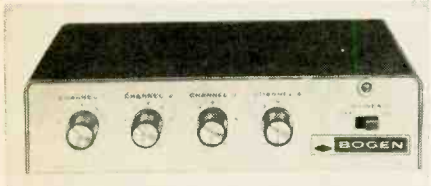
STEREO RECEIVER, *No. 99-0185WX.* Solid-state, single chassis preamplifier and amplifier, 62.5 watts/channel, response 22-20,000 Hz ± 1 dB @ 1 watt, power response 25-35,000 Hz, sensi-

tivity 80 mV. Direct-coupled output matches 4, 8, or 16 ohms. Front and rear panel tape outputs, tuner inputs, low- and high-frequency filters. Enclosed in simulated walnut grained metal case.—**Lafayette Radio Electronics**

Circle 47 on reader's service card

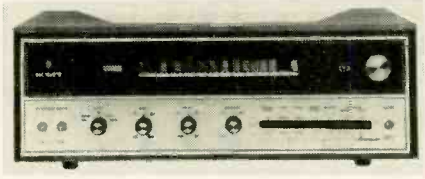
MIXER-AMPLIFIER, *MX6A-T.* Ac powered, all-silicon, solid-state, can be used to add four more microphones or other signals to an existing system. Up to 3 MX6A-T units can be paralleled to provide 12 individual inputs, with the 3 mix-



ers mounted "piggy-back". Inputs handle either high- or low-impedance microphones or electric guitars with individual volume controls. Two of the four channels will accept tuner or crystal cartridge signals. Output can drive any packaged amplifier through its auxiliary input. It will also do this with 5-volt or more sensitivity. Operates hundreds of feet from the amplifier without rewiring. Uses standard phone jacks for high-impedance microphones and guitars; screw terminals for low-impedance microphones; phono jacks for output to auxiliary input of public address amplifier or tape recorder. $74.85—**Bogen Communications, Div., Lear Siegler, Inc.**

Circle 48 on reader's service card

STEREO RECEIVERS, *FM 344C, AM/FM 384,* both solid-state stereo with integrated circuit i.f. strip and FET front end, 1.9 μV sensitivity, 90 dB cross modulation rejection, 2.2 dB capture ratio, 46 dB adjacent-channel selectivity, and 36



dB stereo separation. Both feature automatic stereo switching, interstation muting, tape monitoring facilities, dual speaker switches, noise filter, and push-button switches. 344C is $399.95 and 384 is $439.95.—**H. H. Scott, Inc.**

Circle 49 on reader's service card

STEREO RECEIVER, *CR-3000.* Transistorized, six bands with 30 watts IHF output. Frequency bands: 185–400 kHz, 550–1600 kHz, 2–4 MHz, 5.9–10.2 MHz, 11.4–18.2 MHz and 88–108 MHz (for FM/FM stereo. Features electrical bandspread and adjustable bfo. Accessory

jacks include phono inputs, tape deck inputs, and connections for auxiliary stereo equipment. 35 transistors, 22 diodes and 4 thermistors. Housed in vinyl-covered steel cabinet with chrome and black trim. Complete system—CR-3000 receiver and RSP-1 loudspeakers, $389.85. CR-3000 alone, $269.95.—**Hallicrafters Co.**

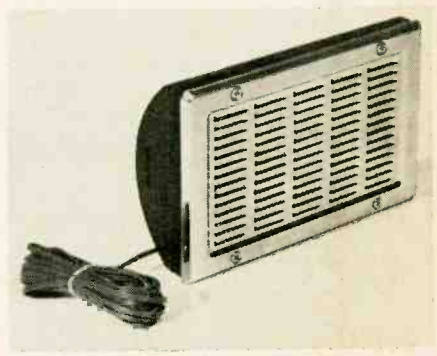
Circle 50 on reader's service card

STEREO RECEIVER, *Model 18,* delivers 40 watts continuous rms watts per channel with less than 0.2% distortion. Four-ohm acoustic suspension to 16-ohm electrostatic type speakers can be used. Oscilloscope tuning indicator, non-amplifier front end eliminates overloading, "Gyro-Touch" tuning knob is actually a

large, heavy flywheel turned so that its edge protrudes through the panel. $595.00. Accessory walnut cabinet, *Model B18-0,* $39.50—**Marantz Co., Inc.**

Circle 51 on reader's service card

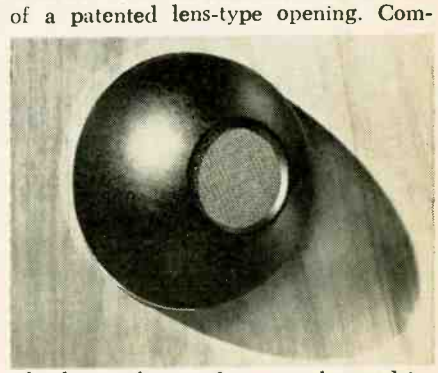
AUXILIARY SPEAKER, *Model AX46B3-1.* Ideal for use in cars, cabs, trucks, locker rooms, or in-plant paging stations. Solidly built with polished chrome grill designed to protect against



sharp instruments. Voice coil is ¾" for handling up to 6 watts. Speaker rating, 8 ohms. Includes twin leads and mounting bracket.—**Oxford Transducer Co.**

Circle 52 on reader's service card

SPEAKER, *PVS-800.* Cleaner, less distorted sound is achieved with the use of a patented lens-type opening. Com-



pletely weatherproof . . . can be used indoors or outdoors.—**Oaktron Industries, Inc.** **R-E**

Circle 53 on reader's service card

NEW TEST EQUIPMENT

More information on new test equipment is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 74 and circle the numbers of the new products on which you would like information. Detach and mail the postage-paid card.

HEAVY-DUTY SOLID-STATE POWER SUPPLIES, *PSR-500 Series.* Feature silicon rectifiers, SCR regulation, 500-watt outputs, line or load regulation less than 1% (no load to full load), ripple less than 1% at maximum rated current,

10-turn voltage control. Primary fuse and output circuit breaker prevent overloads. 3 models available: 2–32 Vdc, 0–15 amps; 2–55 Vdc, 0–10 amps; and 2–125 Vdc, 0–5 amps. 1 year warranty. $375 to $395 price range.—**Electro Products Laboratories, Inc.**

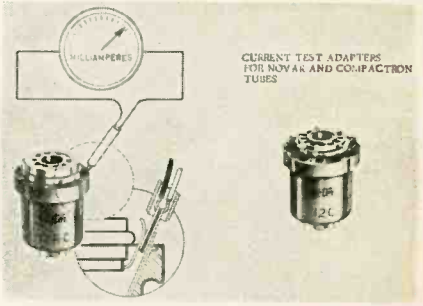
Circle 54 on reader's service card

GOOD/BAD TRANSISTOR ANALYZER, *model TT-250.* Checks transistors in or out of circuit. No numerical readings to decipher, but Good/Bad readings. Leads don't have to be unsoldered to test. Measures out-of-circuit Beta or

gain on 2 scales: 0–250 and 0–500. Also measures leakage. All testing is non-destructive to transistors. Pnp or npn are determined without set-up book. Features 6" meter in a steel case. $87.50—**Lectrotech, Inc.**

Circle 55 on reader's service card

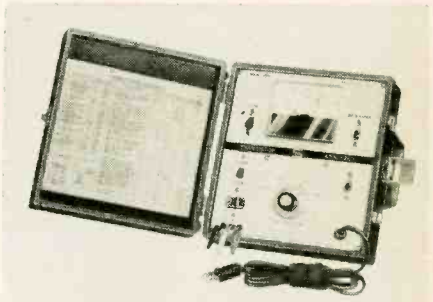
CURRENT TEST ADAPTERS, Model *T9RC* and *T12C* measure any pin position of Novar and Compactron tubes. Probes are gripped by the *Test Tabs.* Current is read at the meter to which the leads are connected. $3.65 and $3.85 ea.



P-2 Probes .79 ea.—**Vector Electronic Co., Inc.**

Circle 56 on reader's service card

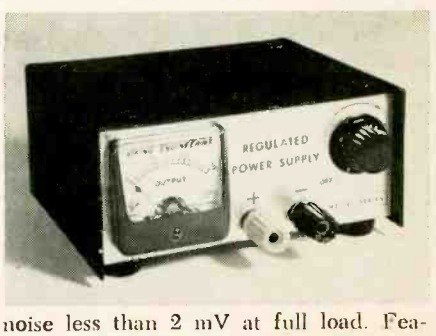
PORTABLE TRANSISTOR ANALYZER, *model 260.* Analyzes power and signal transistors without set-up or removing transistor from circuit. Electrically inserts transistor into oscillator circuit for go-no-go check. Enables fast identifica-



tion of npn and pnp transistors and lead connections. Out-of-circuit dc analysis; Beta test for direct meter reading of dc gain; I_{ceo} and I_{cbo} tests read collector-to-emitter and collector-to-base leakage. $69.50—**Seco Electronics Corp.**

Circle 57 on reader's service card

REGULATED POWER SUPPLY, *model PZ-131.* Variable outputs from 0.5 to 25 volts at currents to 200 mA, load regulation more than 100 mV, line regulation of +30 mV and ac ripple and



noise less than 2 mV at full load. Features isolated "floating" output and protection against short circuit. $34.95—**Viking Engineering of Minneapolis** R-E

Circle 58 on reader's service card

NEW FINCO®

COLOR SPECTRUM T.M. ANTENNAS are "signal customized" for better color reception...

"the ANTENNA that captures the RAINBOW"

FINCO has develcped the Color Spectrum Series of antennas — "Signal Customized" — to exactly fit the requirements of any given area.

There is a model scientfically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION ▼	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF ▼	VHF SIGNAL STRONG ▼	VHF SIGNAL MODERATE ▼	VHF SIGNAL WEAK ▼	VHF SIGNAL VERY WEAK ▼
NO UHF →		CS-V3 $10.95	CS-V5 $17.50 CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 CS-V18 $56.50
UHF SIGNAL STRONG →	CS-U1 $9.95	CS-A1 $18.95	CS-B1 $29.95	CS-C1 $43.95	CS-C1 $43.95
UHF SIGNAL WEAK →	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK →	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

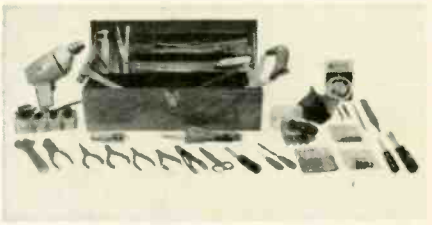
THE FINNEY COMPANY

34 West Interstate Street • Dept. RE • Bedford, Ohio 44146

Circle 107 on reader's service card

NEW PRODUCTS

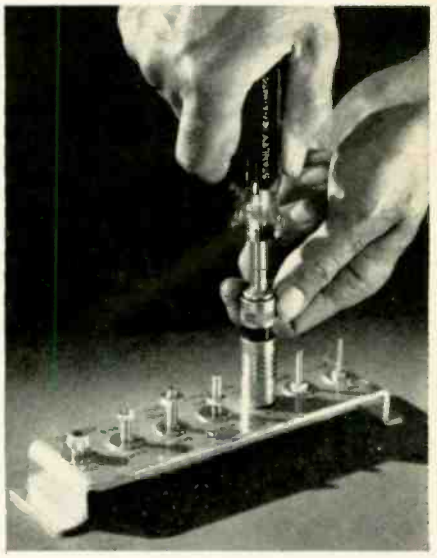
TOOL KIT, *JTK-5.* 75-piece kit for electronic technicians. Includes hacksaw, electric drill, socket punches, screwdrivers, nutdrivers, wrenches, pliers, cutters and soldering iron. Comes with 6" x 6" x 19" steel toolbox with tray. Catalog available.—**Jensen Tools**



Circle 59 on reader's service card

23-CHANNEL CB TRANSCEIVER. *The Courier 23* features 23 crystal-controlled channels, dual conversion, transistor power supply, illuminated S/rf meter and channel selector. PA system, auxiliary speaker jack, single-knob tuning, modulation indicator. $169—**Courier Communications, Inc.**

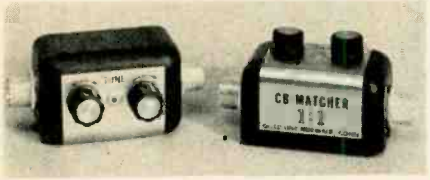
Circle 60 on reader's service card



NUTDRIVER, *Hex-a-Matic.* Six-fingered collet chuck adjusts automatically to 15 standard sizes of nuts and screws. —**The Stanley Works**

Circle 61 on reader's service card

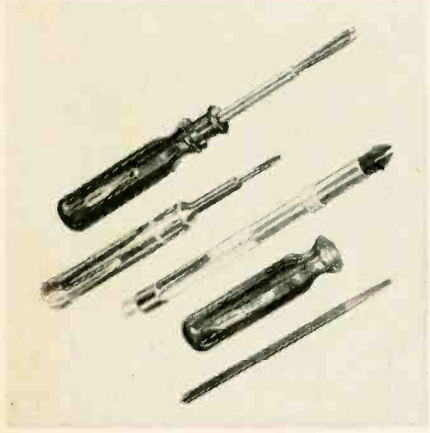
ANTENNA-MATCHING NETWORK, *the CB MATCHER.* This antenna matching network achieves a VSWR of



1.1:1, which eliminates power losses of up to 30%. The *Matcher* measures 1¾" x 2¼" x 3¾" and is finished in black and gold.—**Gold Line Connector, Inc.**

Circle 62 on reader's service card

MINI TOOLS, The *K-23,* ⅛" x 3" *Screw Launcher* holds, starts, and drives small screws. Double-bladed bit grips screw by sliding gripping sleeve forward. The *TK-500 Circuit Tester Screw Driver* tests 100- to 500-volt circuits. Handle lights up if circuit is live. The *DU-1* is a



reversible screw driver with ⅛" sq. blade for regular screws on one end, and No. 1 Phillips bit on other. No. *K-14,* 5" *Phillips Screw Launcher* starts and removes all cross-slot screws. Each of these four "mini" tools have pocket clips.—**VACO Products Co.**

Circle 63 on reader's service card

CITIZENS BAND RADIOTELEPHONE, *Pace 2300.* Solid-state 23-channel transceiver has silicon output transistor with four watts output, double-conversion superheterodyne receiver featuring Pace noise limiting circuitry, 22 silicon

transistors. Walnut grain cabinet, public-address jack, front-panel control, two external-speaker jacks, sensitivity control are standard equipment. Lifetime guaranteed circuit board. Parts have a year replacement warranty. $219.95—**Pace Communications Corp.** R-E

Circle 64 on reader's service card

SUPERCONDUCTIVE MAGNET. Industry's first commercial 125 kilogauss superconductive magnet delivered to Rutgers University by RCA. Smaller than a 1-gallon can, it contains more than 4 miles of "zero resistance" windings.

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking with a Reader's Service number. Turn to the Reader's Service Card facing page 74 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

RELAYS AND SWITCHES. 26-page booklet covers relays, switches, push-button control stations and reversing drum controls. Presents complete electrical and mechanical specifications and features. A replacement pocket-size guide for potential type motor-start relays with over 1400 listings is also included.—**Relay and Control Corp.**

Circle 65 on reader's service card

SEMICONDUCTOR PLASTIC RECTIFIERS. 12-page booklet gives important electrical and mechanical characteristics of new low-priced, plastic-encapsulated rectifiers. Contains characteristic curves and dimensional diagrams for 9 rectifier types, rated from 1.5 to 40 amps, for both lead- and stud-mounted devices. An interchangeability chart relates the rectifiers, both mechanically and electrically, to established industry types. Price lists included. **Westinghouse Semiconductor Div.**

Circle 66 on reader's service card

ANTENNA ROTOR SYSTEM. 4-page brochure describes AR-10B antenna rotor system, including an adapter for large antenna arrays, and a TA-6 thrust bearing for installation of antenna arrays more than 5 ft. above the rotor unit. Correct chimney, eave or wall, roof-guyed, and tripod mounted antenna rotor systems are illustrated.—**Cornell-Dubilier Electronics**

Circle 67 on reader's service card

1968 ELECTRONICS CATALOG, *No. 680*, 512 pages. Lists latest electronics components and new IC's. Includes stereo hi-fi, Citizens band 2-way radio, tape recorders, ham gear, test equipment, radios, TV sets and accessories, cameras, optics, marine equipment, auto accessories, tools, books, etc.—**Lafayette Radio Electronics**

Circle 68 on reader's service card

ELECTRONIC COMPONENTS. 72-page, fall 1967 catalog lists components of all major manufacturers and features such items as: accelerometers, counters, meters, motors, precision potentiometers, servo motors, test equipment and timers. Complete sections are devoted to relays, pressure transducers and gyros. Contains photos, drawings, and diagrams.—**American Relays, Electronics Div.**

Circle 69 on reader's service card

DC VOLTAGE REGULATOR MODULES. Application note provides detailed descriptive information about technical specs, parameters and series/shunt circuit applications. Engineering Data Sheets are provided for each type of unit.—**Bendix Semiconductor Div.**

Circle 70 on reader's service card

INSTANT LETTERING. 1967 catalog describes over 2,000 dry-transfer alphabet sheets and marking sets for electronics, architectural drawings, equipment, art work and general office use. Includes an organic chemical symbol set, a logic diagram set, 14 new preprinted title sets, *Letratone* shading tints and heat resistant letters for drafting.—**The Datak Corp.** R-E

Circle 71 on reader's service card

Unabridged Amendment of Part 97, FCC Rules

(continued from page 57)

5. Section 97.25 (c) is amended to read as follows:

§ 97.25 Examination credit.

(c) An applicant for the Amateur Extra Class operator license will be given credit for examination elements 1(C), 4(A), and 4(B), if he so requests and submits evidence of having held a valid amateur radio station or operator license issued by any agency of the United States Government during or prior to April 1917, and qualifies for or currently holds a valid amateur operator license of the General or Advanced Class.

6. Section 97.29 (a) is amended to read as follows:

§ 97.29 Manner of conducting examinations.

(a) The examination for Amateur Extra, Advanced, and General Classes of amateur operator licenses will be conducted by an authorized Commission employee or representative at locations and at times specified by the Commission.

7. Section 97.31 (b) is amended to read as follows:

§ 97.31 Grading of examinations.

(b) Seventy-four percent (74%) is the passing grade for written examinations. For the purpose of grading, each element required in qualifying for a particular license will be considered as a separate examination. All written examinations will be graded only by Commission personnel.

8. Section 97.33 is amended to read as follows:

§ 97.33 Eligibility for re-examination.

An applicant who fails examination for an amateur operator license may not take another examination for the same or a higher class amateur operator license within 30 days, except that this limitation shall not apply to an examination for an Advanced or General Class license following an examination conducted by a volunteer examiner for a Novice, Technician, or Conditional Class license.

9. Section 97.51 (a) (5) is amended to read as follows:

§ 97.51 Assignment of call signs.

(a) * * *

(5) One unassigned two-letter call sign (a call sign having two letters following the numeral) may be assigned to a previous holder of a two-letter call sign the prefix of which consisted of not more than a single letter. Additionally, a two-letter call sign may be assigned to an Amateur Extra Class licensee who first held an amateur radio station license issued by the United States Government 25 years or more prior to the receipt date of an application for such assignment. Applicants for two-letter call signs are not permitted to select a specific assignment except in accordance with subparagraphs (1) and (2) of this paragraph.

10. Section 97.59 (a) and (b) are amended to read as follows:

§ 97.59 License term.

(a) Amateur operator licenses are normally valid for a period of 5 years from the date of issuance of a new or renewed license, except the Novice Class which is normally valid for a period of 2 years from the date of issuance.

(b) The license for an amateur station is normally valid for a period of 5 years from the date of issuance of a new or renewed license except that an amateur station license issued to the holder of a Novice Class amateur operator license is normally valid for a period of 2 years from the date of issuance.

Shrink on the Insulation

(continued from page 61)

handles, I used two sizes of tubing, telescoping them.

Plastic tubing on tools serves the dual purpose of insulation and identification. That's why I used two colored bands (red and gray) on the pliers, and a gray band on the shaft of the screwdriver in Fig. 3. When several technicians are working in a shop there is never any question of whose tools are where—the bright bands tag them instantly. You may want to choose your own color code and use it on all your tools. The colored bands are applied after the base insulation is shrunk on, in the same manner.

You can use a soldering gun or iron to shrink tubing over a soldered joint. That is how I insulated the resistor, space lug and soldered joint of Fig. 4. After slipping the tubing into place over the joint, touch it in several spots with the hot iron to start the shrinking, then rub the iron all over the surface of the plastic. The tubing will shrink only where the heat is applied directly, so use your iron on all parts of the sleeve. Work slowly; the plastic will not burn, scorch or melt from the heat of the iron, and not enough heat will be transmitted to weaken the soldered joint or seriously affect the value of a resistor.

I am not sure, however, that I would want to try this with a diode or transistor, although manufacturers' literature does show semiconductors encapsulated with the material. In general, heat can be controlled more precisely with the hot-air guns used in production runs.

Clean your iron of solder before a shrink job; solder will stick to plastic. If any solder *does* get on the tubing, pick it off to avoid short-circuit possibilities.

More applications

Another quick and easy job with shrinkable tubing is terminal insulation of unusued wires, as in the second wire from the top, Fig. 4. Most of us are now replacing rectifier tubes with solid-state silicons. This leaves us with the rectifier filament leads dangling from the transformer. Common sense tells us that we may need 5 volts ac some day, so we do not cut these leads off short; we insulate them and tuck them away. The best way to insulate them is to cut off the bare ends of such leads and shrink a bit of tubing over them, leaving about ¼" of plastic tube extended. I do this with a match, holding the shrinkable tub-

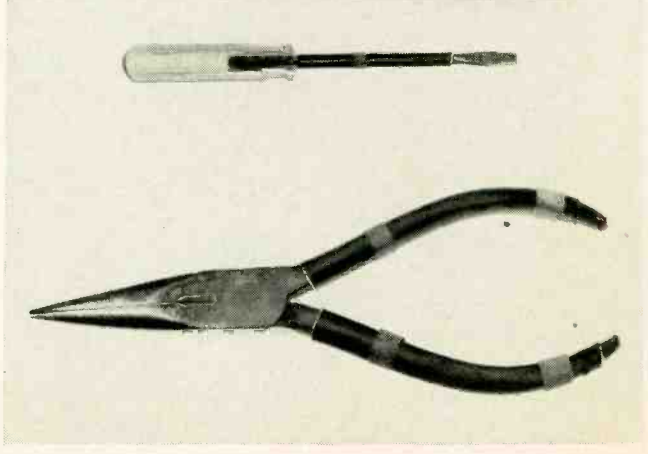


Fig. 3—Insulation on tool handles can be shrunk on in an oven at 350°F for five minutes. Use bands for identification.

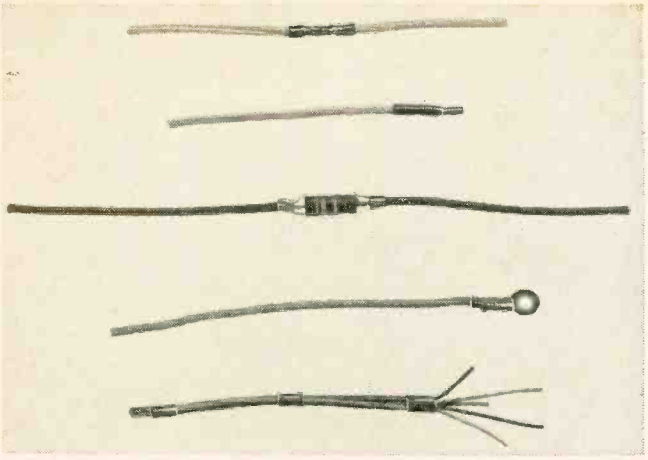


Fig. 4—Top to bottom: insulated splice; lead termination; encapsulated resistor; insulated solder lug; cabled wires.

ing in the heat but not in the flame over the match. In this way, the tubing does not burn, but shrinks evenly. While tubing that is shrunk will not flare up, it will burn slowly in direct flame.

If you have a pair of transformer or other leads, you can insulate both ends at once with one piece of tubing as described above; just make sure that no bare ends are left when you trim the wires. You can get shrinkable terminations with sealed ends made specifically for this purpose. I feel, however, that this is an unnecessary refinement unless you plan to dip the ends in a glass of water—or leave the wires out of doors.

Shrinkable tubing helps solve another major problem —weatherproofing coax-cable connectors. Dampness gets into the cable where it enters the connector and into the connector shell itself. This can be prevented by using large-diameter shrinkable tubing over the whole connector, and extending it back along the cable for an inch or so. The cable and connector must be absolutely dry before the tubing is shrunk on.

A common chassis problem is high-voltage arcing between closely spaced solder lugs on tube bases or cable connectors. These components can be difficult to handle, especially the newer tube sockets with ten connections. You can slip sleeving over each lead before it is soldered, and later shrink it into place. The tubing won't come off and will withstand the roughest handling. This is a good trick to prevent future troubles—like corona discharge in TV high-voltage supplies and chassis-arcing horizontal sweep circuits. If future servicing is required, you can cut off the insulation with a knife.

In another application, I shrank tubing on an exposed screw end in a scope circuit where there was a possibility of high-voltage wires rubbing and shorting out. The plastic gripped tightly on the screw threads and will not come off until I am ready to remove the screw.

Still more applications

An interesting noninsulation possibility is the cabling of several leads, as in the bottom illustration of Fig. 4. Here, very short bits of tubing are shrunk at intervals over groups of wires, giving underchassis work a highly professional look. This kind of shrinking is best done with the soldering iron.

Do you have a whip antenna with no protective ball on the end? Shrink on a half-inch or so of brightly colored

Shrink on the Insulation

(continued from page 85)

tubing and you'll prevent scratches.

I have used tubing in a manner that the manufacturer probably never thought of—to make an emergency flexible coupling between two shafts. I joined a variable-capacitor shaft and a panel-bearing shaft. The angular displacement between the shafts was not great, but a solid coupling could not be used. I forced a length of ½" I.D. tubing over the ends of the shafts and shrank it. I was careful not to heat the material not actually on the shafts, since I have noticed that heating reduces the flexibility of the material. The coupling is still in place; the capacitor is not adjusted frequently—it is the drive control on an amateur transmitter.

The methods of heating described above—soldering gun, match, oven—are of course expedients. The manufacturers recommend more sophisticated equipment, generally hot-air guns with controlled temperatures and a variety of tips to meet special requirements. For the small user, however, the makeshifts suggested are entirely adequate.

You will find that, inch for inch, shrinkable tubing is considerably more expensive than tape or spaghetti. Nevertheless, so little is used for each application that the overall cost is not excessive, and the ease with which the tubing is handled bears no relation to its cost.

If you have run-of-the-mill insulation problems or oddball experimental needs, you will find that shrinkable plastic tubing is a great help. It is certainly the modern way to insure good electrical and mechanical protection in your electronics work. **R-E**

TECHNOTES

OLYMPIC CTC-19, -20, -21 COLOR CHASSIS

COMPLAINT: Severe misconvergence of the blue field. (The blue convergence is out of tolerance by ¼ to ½ inch.)

REMEDY: Check R802, a 100-ohm, 1-watt resistor located next to selenium rectifier CR801 on the convergence board. It may have changed value due to over-heating caused by excessive current flow before horizontal convergence coil T801 is properly adjusted. Normally, the ferrite slug in T801 should be about ¼ to 5/16 inch from the top of the coil form.)

If resistor R802 is discolored or burnt, replace it with two 100-ohm, 1-watt resistors in series so that the new value of R802 is 200 ohms, 2 watts.—*Olympic Service Bulletin*

LINE ADJUSTMENT TRANSFORMER

A 12.6-volt filament transformer with its secondary connected in series with a TV or appliance line cord (as in Fig. 1) can be used to raise or lower the applied line voltage by 12. With a vtvm (set on 150 volts ac) across the output

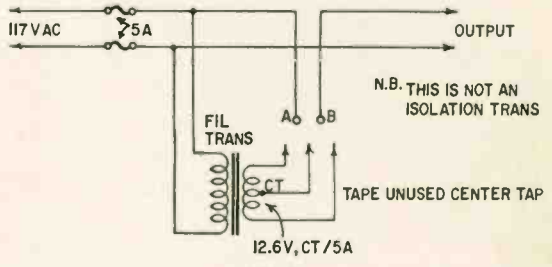


Fig. 1

leads, connect the 12-volt secondary leads to A and B. Connected one way, the input voltage will be boosted by 12; reversing the connections subtracts 12 from the line voltage.

(Fig. 2 shows how a switch and ac receptacle can be added to make the unit easier to use.—*Editor*) Mount the transformer (and switch and receptacle, if desired) in a

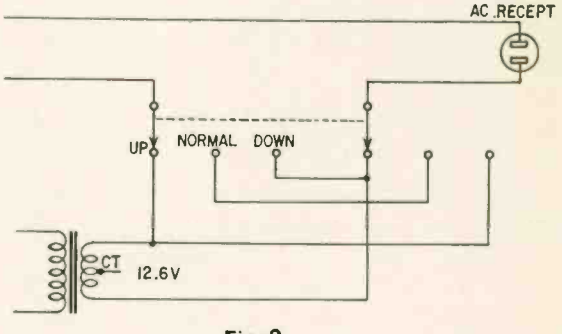


Fig. 2

small metal box with a number of small holes drilled in it for ventilation. Use strain-reliefs and grommets where wires enter the box.

A 5-ampere transformer will handle the average color set (around 350 watts). For higher wattage requirements, add 30% to the desired rating and divide by 120 to find the minimum transformer current rating.—*Admiral Service News Letter* **R-E**

ELECTRONICS IN THE MODERN AUTO

continued from page 45

The three thermistor sensors, R4, R5 and R6 in Fig. 4, are disc-type semiconductor devices composed of a blend of metal oxides with a very large negative temperature coefficient. Shunting resistors R1 and R2 are necessary to obtain the correct resistance decrease for a given temperature increase. The three sensors, in series, form one leg of a voltage divider circuit. Small changes in resistance of the sensors cause proportional changes in the voltage input to the amplifier. The temperature dial rheostat (R3), located in the other leg of the voltage divider, sets the operating point of the circuit.

In the Bendix system, various electronic, electrical and mechanical units work together in much the same way as the human brain's muscle mechanism; that is, by sensing and reacting. For example, if a 70° temperature is dialed when the inside temperature is 75° and the outside is 65°, the system will take in outside air until the required cooling is achieved. If, on the other hand, the outside temperature is 75°, the air conditioner will take over the task. And, if the interior temperature is 65°, the process is reversed; the heater will come on.

Speed controls

Engine-speed controls are more appropriately called electrovacuum systems. They are mentioned here, however, because we can expect electronics to be used more extensively in these systems within the next few years. At this time, three systems are in use: (1) the Perfect Circle Speedostat used on Chevrolet, Chevelle, Chrysler, Dodge, Plymouth, Lincoln, Mercury, Oldsmobile, and Rambler; (2) the AC Electro-Cruise used on Buick and Pontiac, and (3) the Marquette System used on Ford and Thunderbird Bendix Radio Division also is working on an automatic speed control. We can expect this unit to use more electronic components.

These systems all operate in the same general manner: the car is brought to the desired speed; the control system is enabled; the system then maintains the car's speed by automatically controlling the accelerator, and, finally, the system is disabled when the brake pedal is depressed. There are variations of this basic pattern such as "resume speed" capabilities and "retard speed" capabilities. They all serve to give the driver a break from the monotonous task of maintaining the car's speed on long stretches of open road.

Miscellaneous

Several less vital items have been borrowed from the electronics field and incorporated into the electrical systems of late-model autos. For example:

1) Printed circuits are often used to wire the dashboard instrument cluster.

2) Fusible links are installed at critical points to protect the car's wiring harness.

3) Multiwire plugs reduce the chance of wiring error and simplify component replacement.

4) And, in many models, the old push-pull switches are being replaced by toggle type and thumbwheel switches and controls.

In the next few years, semiconductors and integrated circuits are sure to find automotive application in the following areas: windshield-wiper speed controls; liquid-level detectors (gas, oil, etc.); odometers; spare-tire pressure indicators, collision warning detectors and brake anti-skid sensors. **R-E**

X-Ray Radiation

(continued from page 55)

"cook" until the suspected component fails. Never resort to this practice in servicing a color set.

6. In the customer's home, check the power-line voltage at the wall outlet to make sure it doesn't exceed the input voltage rating of the receiver. If the power-line voltage is excessive, ask the power company to adjust the line voltage to the proper level. Or else set the transformer tap as specified by the manufacturer so that the receiver is operating within the specified ratings.

Additional research

Some further rules have been propounded by the Pinellas County Health Department (Tampa–St. Petersburg area) in Florida. There, extensive tests have been conducted by a health physicist, George McCall. They have resulted in a 3-hour radiation-safety course which will be given to technicians in that county.

McCall's test results (unverified in other independent tests) indicate that there may be dangers to service technicians from the neck of the picture tube during certain adjustments. According to McCall, when the yoke is retracted, high-speed electrons are deflected to the wall of the picture-tube neck, causing emission of a ¼-inch-wide beam of radiation around the circumference of the neck.

To avoid the possibility of this type of exposure, the Pinellas County Health Department is recommending these additional rules:

1. From a local medical supply house, buy a small quantity of leaded plastic sheeting, of the type used for dental X-ray aprons. The lightest-weight material (¼ millimeter) is okay. This should be draped over the set or tube during servicing. (It provides protection from implosion, too.)

2. For protection of the eyes against both implosion and X-rays, wear a pair of good safety glasses during servicing.

McCall explains that these precautions are particularly important if the voltage is above the manufacturer's specified level—a condition which never should be allowed to exist.

The "X-ray menace" recently was put into perspective by Dr. Lauriston Taylor, president of the NCRP. Testifying before a Congressional committee, he said:

"Television equipment generally is made so as to reduce radiation to an unimportant level, certainly for the general public and usually for the service man. Steps to insure this include heavying-up of the glass, adding high-atomic-number materials to the glass, placing metal barriers at strategic points in the set, enclosing the set in a box, and so on. It takes very little material to attenuate any X-rays produced in television equipment and it can be considered a blunder when something goes wrong and this is not accomplished.

"It would be my guess that even working with the defective television sets, such as those that have been publicized recently, there would be probably small risk to the service man at a bench, primarily because of the small likelihood of any appreciable portion of his body remaining in close proximity to the source of radiation. This again is not to say it is good, but to point out that it might not be as bad as some recent news stories have indicated. . . . The protective steps are so readily simple that a rudimentary manual could give the user most, if not all, of the information that he would need." **R-E**

SERVICING HINTS ON NEW COLOR TV SETS

(continued from page 38)

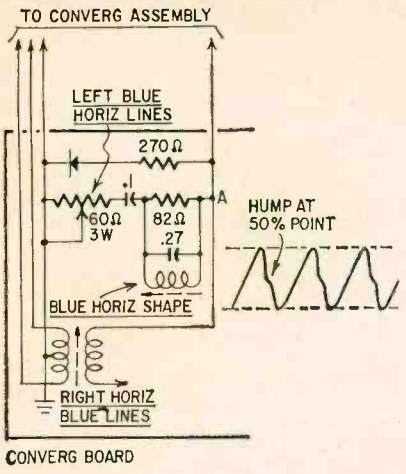


Fig. 6—To set blue-shaping coil, put scope from point A to chassis. Then adjust the slug for hump at mid point in trace.

In some later color receivers the blue shaping coil isn't adjustable. The idea is to prevent tampering and overloading the horizontal-output system. This type of coil is set at the factory and should not require changing except when the horizontal-output transformer is replaced.

A typical blue shaping circuit is shown in Fig. 6; this is a portion of the Silvertone 7190 series. To adjust the coil, connect an oscilloscope between point A in Fig. 6 and ground; you should see a trace like that at the right in the figure. Then adjust the coil slug for a bend at the 50% point on the waveform slope. For the receiver shown, the waveform is approximately 45 volts peak to peak.

You should take a few other precautions to prevent overload of the horizontal system:

Never turn the set on with the plate cap disconnected from the horizontal-output tube.

Never turn the set on with the yoke unplugged.

Never turn the set on with the damper tube removed from its socket.

Never replace the horizontal oscillator tube immediately after the set has been in operation. Give the output tube a chance to cool off. With a hot output tube there will be immediate conduction and the necessary bias will be delayed until the oscillator tube heats up. In the meantime the output tube will be overloaded and its life shortened.

Purity and convergence

If you follow the manufacturer's setup procedures on the new color receivers, you will get near-perfect black-and-white and color pictures. You don't have to tolerate color shading in b-w pictures because of circuit limitations. With rare-earth phosphors being used in nearly all new color CRT's, you get brilliant whites and perfect blacks.

In today's sets, the initial setup adjustments (if properly made) will remain fairly stable for many months. During routine servicing calls, however, part of your procedure should be to check b-w reception, to make sure no objectionable shading exists on the screen. If it does, check the degaussing system as outlined earlier and degauss the entire screen area. If color shading *still* exists, recheck purity and dc convergence. Only slight touchups should be required.

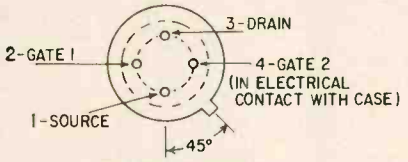
Make sure you also check the agc system, the color-killer settings, and focus, for misadjustment of any of these can detract from peak performance. The horizontal lines obtained for good focusing are not as sharply defined as in b-w receivers. Still, careful adjustment of the focus control or voltages will make the lines clearly evident and will help make the picture crisp and sharp.

Today's color receivers are better than ever, and will produce better pictures. But they'll do this only if you set up and service them properly. **R-E**

NEW SEMICONDUCTORS

NEW TETRODE N-CHANNEL FET'S

The TIXS80 and TIXS81 are two new N-channel epitaxial planar silicon FET's designed for vhf amplifier, mixer, autodyne converter and agc applications. They feature low C_{rss} (small-signal common-source reverse transfer capacitance)—0.8 pF, transconductance of



TIXS80 & TIXS81

5000 μmhos minimum, and a square-law transfer characteristic that minimizes crossmodulation. Case has a TO-72 outline which is a TO-18 with a fourth lead added. Absolute maximum ratings at 25°C free-air temperature are:

Drain–gate-1 voltage	30 volts
Drain–gate-2 voltage	30 volts
Reverse gate-1–source voltage	−30 volts
Reverse gate-2–source voltage	−30 volts
Continuous forward gate-1 current	10 mA
Continuous forward gate-2 current	10 mA
Diss. at or below 25°C air temp.	300 mW
Diss. at or below 25°C case temp.	750 mW

Detailed electrical specifications on these two transistors are contained in *Bulletin No. DL-S 679961*, available from Texas Instruments, Inc., Semiconductor Components Div., PO Box 5012, Dallas, Tex. 75222.

NEW SILICON TRANSISTOR

The 2N3638 is a low-power pnp diffused silicon planar transistor designed primarily for medium-speed saturated switching applications. Maximum voltage and current ratings are:

V_{CBO}	−25 volts
V_{CEO}	−25 volts

AND MICROCIRCUITS

V_{CES} —25 volts
I_C 500 mA

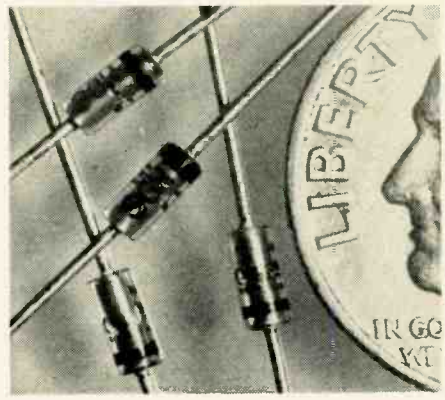
The CS2369, an npn diffused silicon planar transistor similar to the 2N2369, is designed for low-power, large-signal audio applications. Maximum voltage and current ratings are:

V_{CBO} 40 volts
V_{CEO} 15 volts
V_{EBO} 4.5 volts
I_C 500 mA

Complete electrical, large- and small-signal characteristics are available from the manufacturer, Continental Device Corp., 12515 Chadron Avenue, Hawthorne, Calif. 90250.

THE "WOW" DIODE

A new silicon planar epitaxial subminiature diode has been developed for high-speed switching and core-driver applications. The diode, called W-O-W, for "without whiskers," features high conductance, high mechanical strength and long-term stability. Electrical characteristics are maintained under high-temperature reverse-bias conditions. The hermetically sealed package is a



dual-stud, fused glass-to-metal design. Further information is available from Hughes Semiconductor Devices, 500 Superior Ave., Newport Beach, Calif. **R-E**

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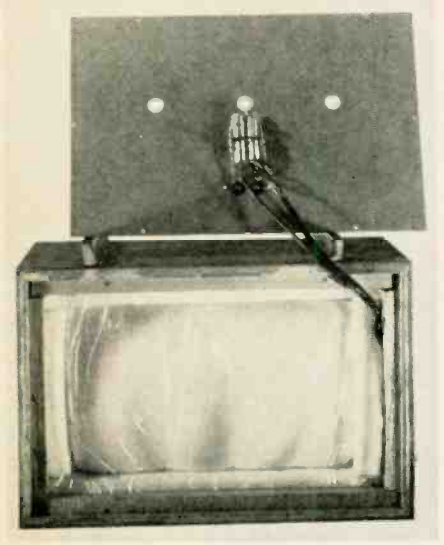
WOOFING THE TWEETER

continued from page 42

mounted on the paperboard rear cover by passing a length of hookup wire around them and through two holes in the cover.

To stuff the cabinet, a slab of 1-inch foam rubber (made for pillows) was cut into proper-size pieces with scissors. Each piece was wrapped in plastic food-wrap before being put into place. (Sound waves travel with relative ease through foam rubber, but when a pressure wave impinges upon the air-tight plastic, it must either move the plastic or be reflected. The plastic moves because its inertia and that of the rubber behind it is low. The rubber is compressed. Inasmuch as the rubber reacts at a different rate, work is done, and the wave's energy is partially absorbed.)



Plastic food wrap covers foam rubber to enhance compression and decompression of the enclosure. Speaker is behind padding.

Pieces to fit the top, bottom, and sides of the cabinet were wrapped and pushed into place. Two pieces were cut to lie flat against the front panel on either side of the speaker. A half-circle cut from the end of each piece made them fit the contour of the speaker. The next slab was cut full-length, and needed only a rectangular hole in the middle to let it slip over the magnet frame. The one after that was identical, and the next one needed no hole at all. A final slab (not shown in the photo) had a hole cut to accept the capacitors, and was used to compress the lot. (CAUTION: *Don't* use this type of stuffing in the same cabinet with a tube-type radio, TV, or amplifier. It is allergic to heat. And it could catch fire!) **R-E**

ELECTRIC EELS OPEN ZOO

Westinghouse electronic equipment was "plugged" into a tank of electric eels to officially open the new Pittsburgh Aqua-Zoo. An electric eel is a living battery—positive at the head and negative at the tail. When it detects food or an approaching enemy, it switches to full power and unleashes its death-dealing high voltage.

NOTEWORTHY CIRCUITS

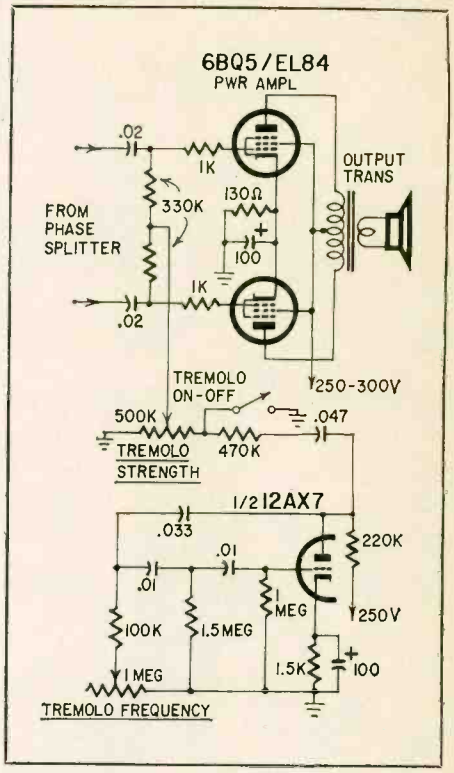
TREMOLO CIRCUIT FOR GUITAR AMPLIFIER

We receive a steady trickle of letters requesting information on adding a vibrato or tremolo circuit to an ordinary tube-type PA or hi-fi amplifier so it can be used with an electric guitar. *Vibrato* is a regular variation in *frequency* and circuits for producing it are not readily adapted to ordinary amplifiers.

Tremolo, a regular variation in *amplitude* or *volume*, is relatively easy to add to most amplifiers as indicated by this circuit from *Funkschau* (Munich, Germany).

The tremolo signal is generated by half of a 12AX7—or any simiar triode—connected as a phase-shift oscillator. The usual ground connection for the output grids is lifted and the junction of the resistors is connected to the arm of the TREMOLO STRENGTH control. The tremolo signal is injected into both output grids in phase to modulate the push-pull audio signal.

The TREMOLO STRENGTH control sets the modulation depth. The TREMOLO FREQUENCY control adjusts the tremolo signal over a range of approximately 2–30 Hz.



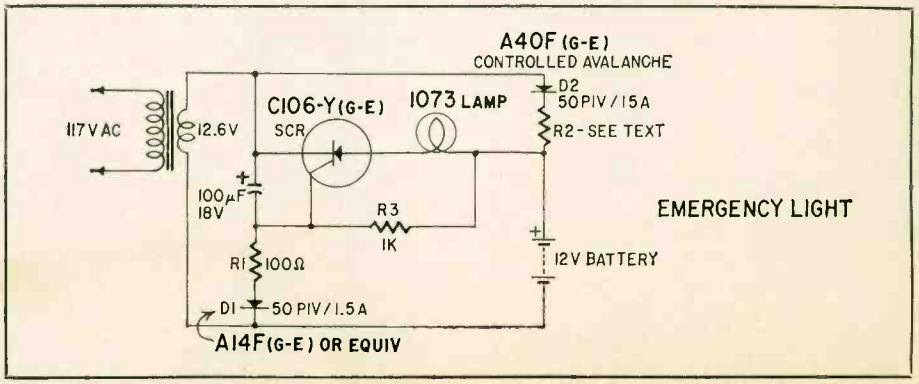
EMERGENCY LIGHT SYSTEM

Reliable emergency lighting is a must for many public buildings and a valuable asset in homes. During power failures it can prevent panic, injuries and possible loss of life. The diagram, from a G-E data sheet on the C106 SCR, shows a simple automatic emergency lighting system.

The lamp is a type 1073 normally used in automobile back-up lights. It is powered by a 12-volt storage battery. When ac power is on, the 100-μF capacitor is charged through D1 and R1. This places a negative voltage on the SCR gate and keeps it from conducting and lighting the lamp. The battery is kept charged by rectifier D2.

When the ac power is interrupted, the capacitor discharges and the SCR is turned on by the positive gate voltage developed by current flow through R1, D1 and R3. Battery current flows through the lamp, the SCR and the transformer secondary. When ac power is restored, the capacitor recharges and turns off the SCR and lamp.

Current-limiting resistor R2 should be selected to limit the battery charging current to the required level. The battery rating should be adequate to power the 2-amp lamp at full brilliance for an adequate period of time. **R-E**



TRY THIS ONE

RADIO KNOB POINTERS

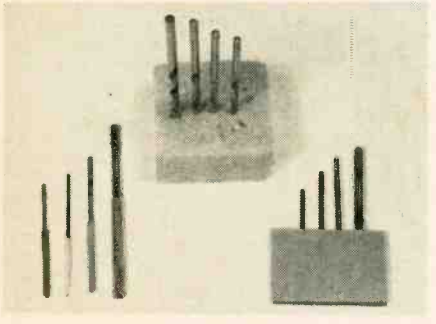
When making pointers for radio knobs and panels it's a tough job to do neat work by cutting grooves and filling the grooves with white crayon or paint. An easier way is to cut your pointers from Scotch plastic tape and then stick

the pointers onto the knobs or panels, as shown in the photo.

Cut your pointers any size and shape, and stick them wherever you want them. It's surprising how long they last. To remove them just pull them off and your knobs and panels are left scratchless. Plastic tape comes in various colors, so use light colors on dark knobs and panels, and vice versa. —*Art Trauffer*

PROTECT DRILL BITS

If you don't own a drill index, be sure to store your small drills somehow so they don't become chipped and dull by banging around inside a drawer or tool caddy. There are many ways to do this. Spaghetti may be slipped over each



drill. For small drills, the corrugations inside a sheet of cardboard may be used. A block of Styrofoam plastic also works well. Just push the drills into it. This method works for any small tool with a sharp edge.—*Don Lancaster* **R-E**

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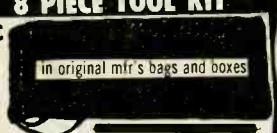

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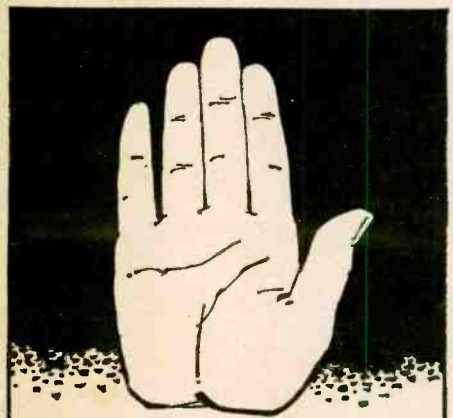

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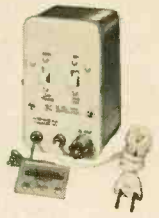

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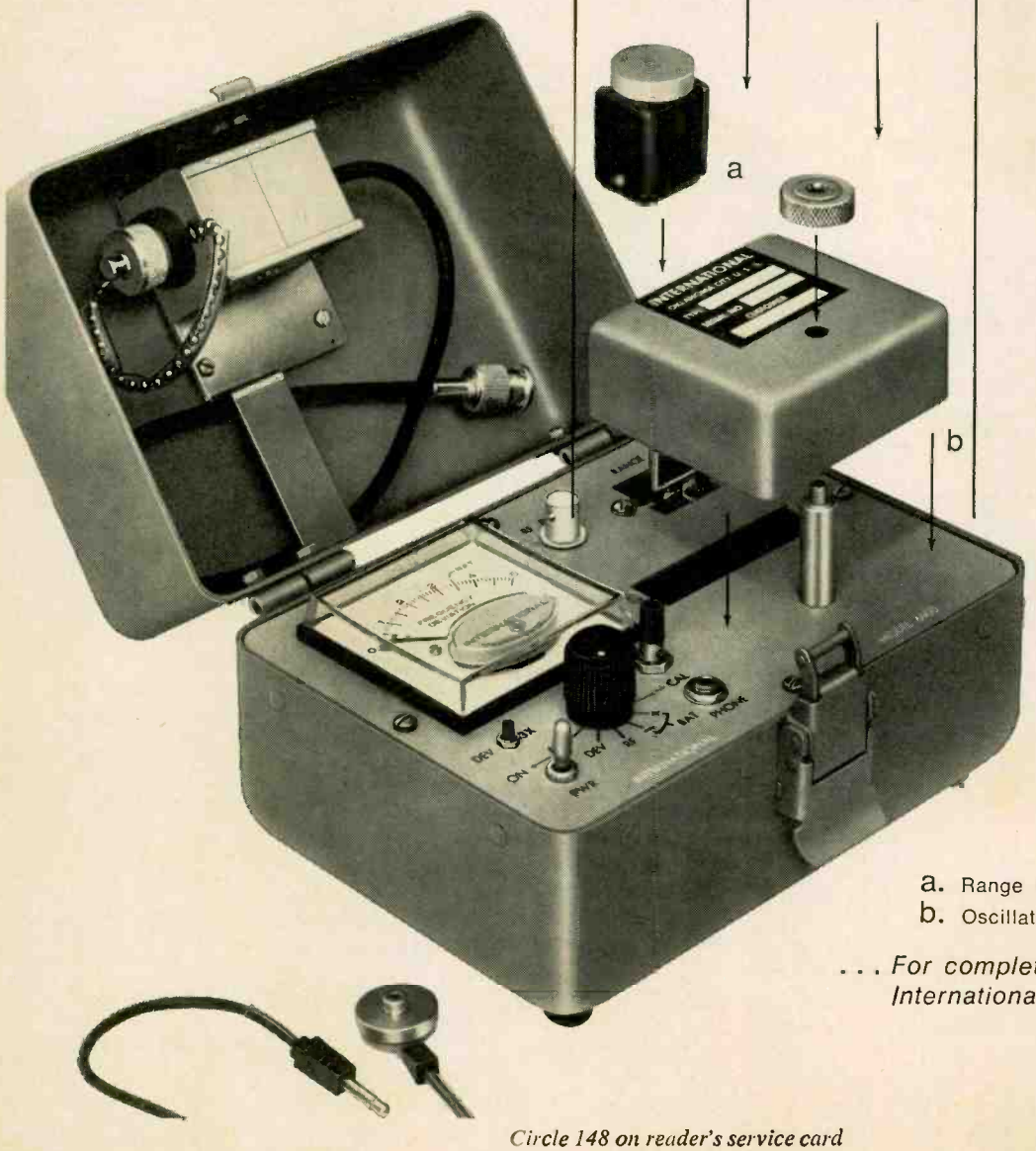

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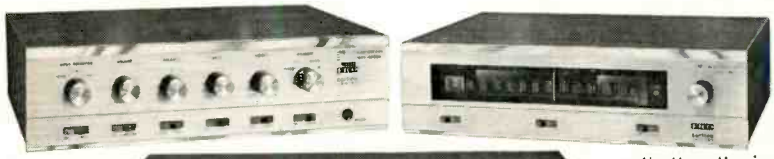

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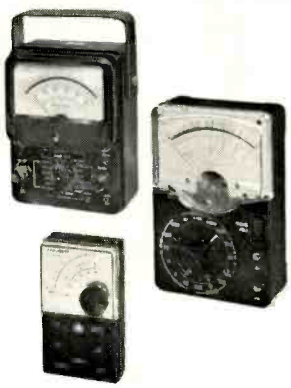

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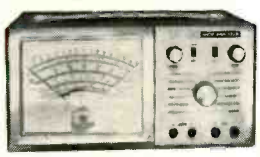

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