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MARCH, 1959

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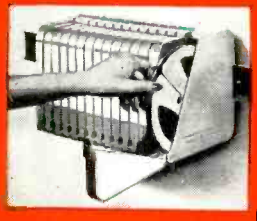

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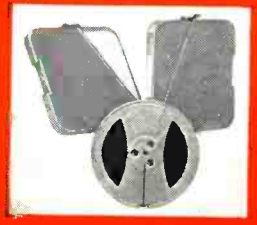

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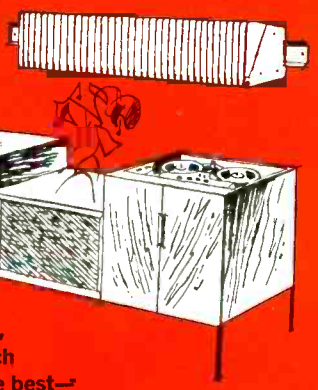

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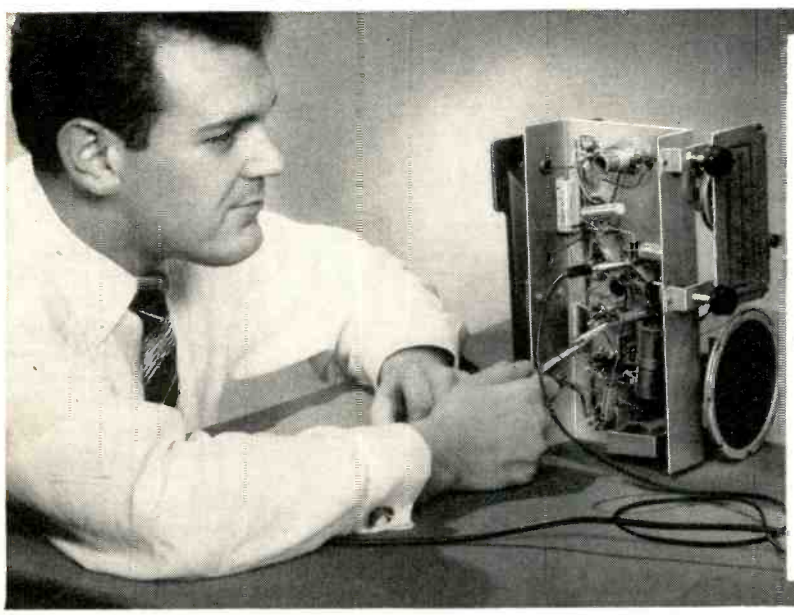

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SUBSCRIPTION SERVICE: Forms 3579 and all subscription correspondence should be addressed to Circulation Department, 434 South Wabash Avenue, Chicago 5, Illinois. Please allow at least four weeks for change of address. Include your old address as well as new—enclosing if possible an address label from a recent issue.

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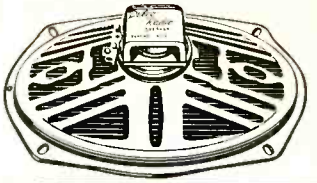

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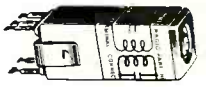

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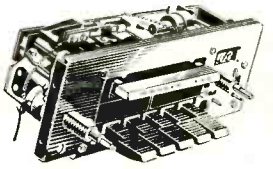

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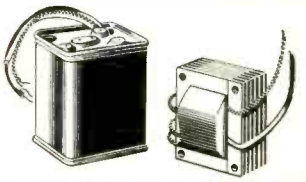

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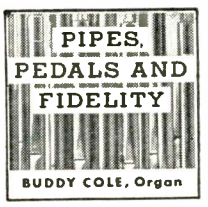
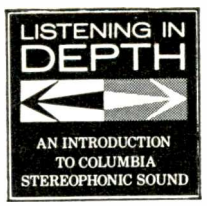


13. Organist Buddy Cole plays 11 tunes—Mine, Caravan, Carioca, etc.

14. Cugi's greatest hits—Besame Mucho, Tico-Tico, Brazil, 9 more

15. The most popular of Tchaikovsky's lovely, melodic symphonies



16. Available in stereo only. 16 popular and classical selections

Yes, now you can acquire the world's finest stereophonic AND high-fidelity monaural recordings — at truly substantial savings! And as a dramatic demonstration of the Columbia (Lp) Record Club's money-saving Bonus Plan — you may have, at once, ANY 3 of the sixteen records shown here, FREE . . . available in your choice of stereophonic sound OR monaural high fidelity!

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Your only membership obligation is to purchase four selections from the almost 200 Columbia and Epic records to be offered in the coming 12 months. Thus you receive seven records for the price of four — a saving of more than one-third on your record purchases.

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You enroll in any one of the six Club Divisions:

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Each month the Club's staff of musical experts selects outstanding recordings from every field of music. These selections are described in the Club Magazine, which you receive free each month.

You may accept or reject the selection for your Division, take any of the other records offered (stereo or monaural), or take NO record in any particular month. You may discontinue membership at any time after purchasing four records.

The records you want are mailed and billed to you at the regular list price: Popular Monaural Selections, $3.98; Classical Monaural, $4.98; all Stereo Records, $5.98 — plus a small mailing charge.

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5. 'S Marvelous — Ray Conniff
6. Lester Lanin at the Tiffany Ball
7. Bells Are Ringing — Original Broadway Cast
8. Firebird; Romeo and Juliet
9. Black, Brown and Beige
10. Beethoven: Eroica Symphony
11. Percy Faith Plays "South Pacific"
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16. Listening in Depth (Available in stereo only)

...for the Record

ELECTRONICS WORLD

By **W. STOCKLIN**
Editor

SATELLITES, SECURITY, & SPACE

DESPITE the fact that the new Federal budget, as proposed by President Eisenhower, calls for reduced appropriations to a number of agencies and a discontinuance of certain military projects, it is heartening to note that it calls for an increase in the number of ICBM squadrons from 13 to 20 and an implementing of our current satellite and space activities.

Although many senior officers feel that total reliance on guided missiles is foolhardy and that to base our entire defense program on these push-button-controlled devices is ostrich-like, the fact remains that an ever-growing percentage of our defense dollar will have to be spent for research, development, and production of such projectiles.

The contributions of the electronics industry to this fantastic program are limitless. Not only are the laboratories and production lines of our companies working full speed ahead on triggering and control mechanisms but they are developing new and more sensitive equipment to be carried by the missiles for homing, guidance, and reporting. In addition to this particular phase, these same organizations are concerned with anti-missile defense equipment as well as protection of the anti-anti-missile type.

Nor are many of these systems the exclusive province of the military. The more sophisticated equipment will be adapted to handle the increasing number of satellites which will hurtle into space, while others will be "ganged" to provide the tremendous thrust that will be required to project instrumented and man-carrying rockets into the outer atmosphere.

Those of us in the electronic industry have reason to be proud of our "profession." We are part of a "team" dedicated to a task which staggers the human imagination. Who could have anticipated, on the basis of the primitive bi-planes of World War I, that a mere forty years later not only would jet planes be hurtling across the ocean between breakfast and dinner but that our solar system would acquire new "moons" at a casual rate.

Much as it hurts our national pride to admit that we are not presently No. 1 in the space race, credit should be given the U.S.S.R. for its impressive achievement in launching and orbiting its "Lunik" solar satellite. Undoubtedly some, if not all, of the information radioed back by the instruments before the batteries went dead will be shared with scientists throughout the world and provide another boost in the sum total of man's knowledge about his universe.

Although there are undoubted drawbacks in living at the accelerated pace demanded by these never-ending developments and many nostalgically long for "the good old days," "Age of Anxiety" or no, this is an exciting time to be alive as most people will agree upon careful consideration. With the International Geophysical Year, formally closed but informally continuing, and the unceasing probing into Outer Space, most of us will live to see interplanetary travel as casually accepted and enjoyed as the "Spend a Weekend in Europe" promotions of the airlines today.

Some scientists and military men have been willing to "stick their necks out" to the extent of predicting that 1959 will find man whirling through the atmosphere in a space vehicle—while the more conservative set 1960 as the target date.

JUST A REMINDER

By now most of our readers have been introduced to our new name and logotype, ELECTRONICS WORLD, which is scheduled to take effect with our May issue. Last month's issue and this carry, in miniature, a reproduction of the title under which you will find RADIO & TV NEWS on the newsstand two months from now.

We sincerely hope that our readers will like our new name and style and that it will soon become as familiar to all as have our predecessor titles RADIO NEWS and RADIO & TV NEWS. Our new name, like those in the past, will continue to stand for the newest and best in electronics.

Last month you also had a chance to verify the usefulness of the first of the series of Gatefolds which will appear regularly. This month the second such insert is included—this one designed especially for television service technicians and radio amateur operators. We hope you will find it and the subsequent Gatefolds we have planned for you of particular help in your work or hobby. We would appreciate hearing your reactions if you will be good enough to take time to write us. After all, this is YOUR magazine and we want it to be the type of magazine YOU find most useful! —30—

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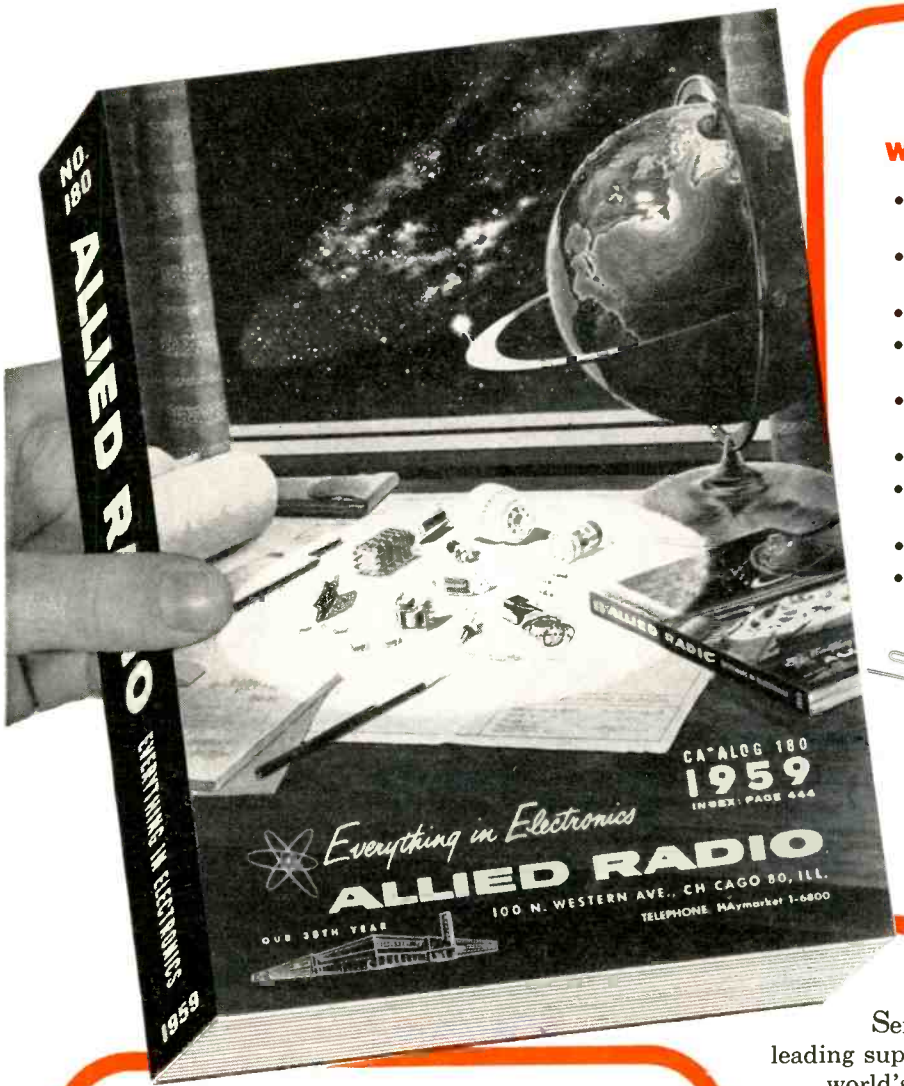

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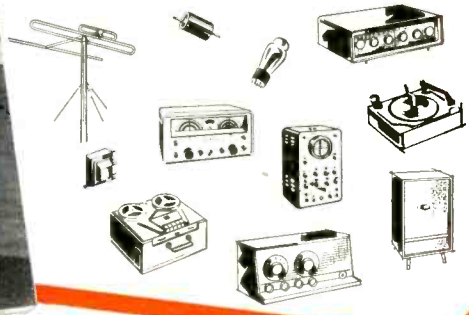

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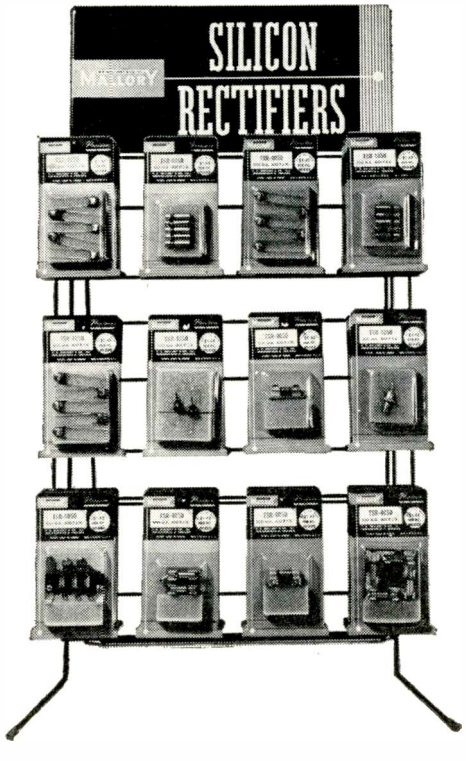

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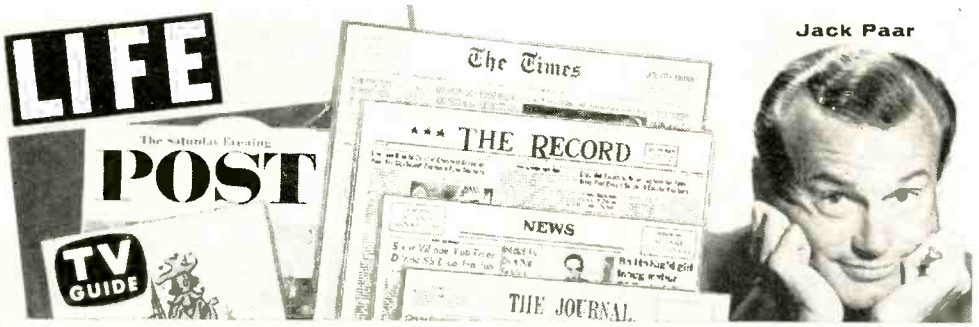

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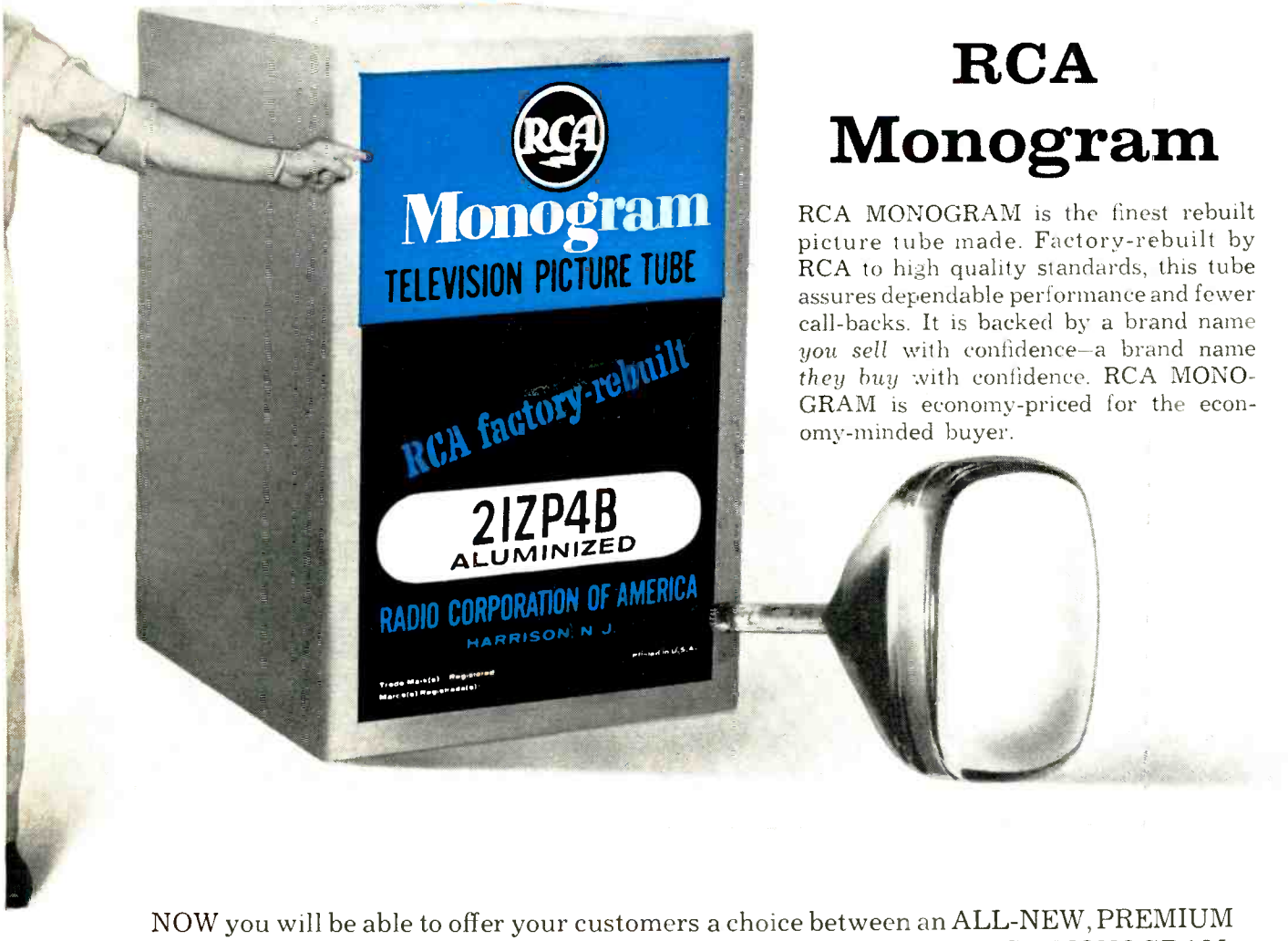

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RCA MONOGRAM is the finest rebuilt picture tube made. Factory-rebuilt by RCA to high quality standards, this tube assures dependable performance and fewer call-backs. It is backed by a brand name *you sell* with confidence—a brand name *they buy* with confidence. RCA MONOGRAM is economy-priced for the economy-minded buyer.

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FROM YOUR RCA DISTRIBUTOR TODAY

RADIO CORPORATION OF AMERICA
Electron Tube Division *Harrison, N. J.*

NEW LOOK IN TV

To the Editors:

In your December, 1958 issue, you published an article entitled "New Look in TV."

I am calling this article to the attention of all 700 members of ESFETA, Inc. in the December issue of "ESFETAN," our monthly association newsletter. This article is highly commendable, and speaking unofficially at this time, I am quite sure that all of independent service will be most happy to see an article of this sort gracing the pages of one of our leading magazines.

GEORGE CARLSON, Secretary
Empire State Federation of
Electronic Technicians Ass'ns, Inc.
Jamestown, New York

Thanks very much for your very kind comments on the article. Our goal, of course, as always, has been to help the service technician and the industry as a whole.—Editors.

* * *

"WHAT IS IT?" REPLIES

To the Editors:

Regarding the "whatzit" in your January, 1959 "Letters" column, I believe it is a hoax. The writer has wireless books back as far as 1907 and wireless magazines from 1910. There is nothing in them that faintly resembles the "whatzit." The writer was a ham in 1909, went to sea as a wireless operator from 1911 to 1921, and he has seen nothing that resembles this thing. As for the *RCA*, I do not think that it even means *Radio Corp. of America.*

Perhaps I am 100 per-cent wrong, but that is one man's opinion.

H. Y. B.
Manhattan Beach, California

To the Editors:

The "whatsis" made by *RCA* looks very much like an antique power supply for an equally antique gas-filled x-ray tube. It must date about 1900. The cable reels are the key.

GEORGE H. HUFF, Engineer
Terado Company
St. Paul, Minnesota

To the Editors:

I am including complete instructions for the unit photographed in your "Letters from our Readers" column. My machine was used by a dentist for x-rays until just a few years ago. It will deliver about a 6-inch spark between the terminals. I had the x-ray tube too, but it got broken.

I would guess that the equipment was built around 1910 or 1915 by *Victor.* It stands in a case and measures about 5 feet to the top of the ball.

BILL DWINELLE
Radio and Television Service
Denver, Colorado

To the Editors:

It is a piece of medical apparatus, and probably the Tesla coil portion of a larger instrument adapted to an old-time gas x-ray tube that could be used with it.

S. THERON JOHNSTON, M. D.
Appleton, Wisconsin

We certainly appreciate all the answers that we got on the piece of equipment shown in our January "Letters from our Readers" column. Special thanks to Reader Dwinelle for sending us a copy of the instruction book for the "Victor No. 7 High Frequency Outfit." This shows the complete drawing with all the important parts labeled. The unit was designed to be used with a special ultraviolet lamp, and would also produce x-rays for medical purposes.

Thanks also to Dr. T. H. Lipscomb, roentgenologist, who pointed out that the unit was manufactured by the Victor X-ray Corp., *which later became the* General Electric X-ray Corp.—*Editors.*

* * *

"CONSUMER REPORTS" ON SPEAKERS

To the Editors:

In assigning ratings to various loudspeakers in their article in the December, 1958 issue of "Consumer Reports," *Consumers Union* has shown a willingness to give consumer guidance based on judgments in a field in which such judgments have been scrupulously avoided in the past by all reputable laboratories. The question needs to be asked whether *CU* has capabilities beyond those that are to be found anywhere else and whether their capabilities are sufficient for the assignment of valid figures of merit to loudspeakers and loudspeaker systems.

In this connection, the following can be said of at least one portion of their report. Many of the statements concerning our *JansZen* electrostatic are contrary to the general consensus regarding the performance capabilities of push-pull electrostatics and contrary to the findings of independent test laboratories. Also, their relative rating of our product is contrary to the conclusions that have been reached on the basis of extensive tests on unselected samples of the two rated electrostatics. These tests were made at *Janszen Laboratory, Inc.,* Cambridge, Mass., and the results will be published soon, to-

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	License	Weeks
Donald E. Mason, 2659 Centinella, Santa Monica, Calif.	1st	12
Everett T. Bozard, 411 N. Wash. St., Alexandria, Va.	1st	12
Henry M. Best, 1003 Vermont St., Fremont, N. C.	1st	11
Harold V. Jones, P.O. Box 705, Alamogordo, N. M.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Donald L. Leeburg, Box 1075, Anchorage, Alaska	1st	12
J. Milton Condit, 1312 N. 78th Street, Seattle, Wash.	1st	8
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Richard Baden, 4226 - 37th St., N.W., Washington, D.C.	1st	12
James F. Stewart, 2618½ Prospect Ave., La Crescenta, Calif.	1st	12
Norman R. Cook, 130 Olive Street, Neodeska, Kans.	1st	12

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gether with information on procedures and equipment that were used.

It seems highly significant that *CU* did not publish adequate information on the test methods and equipment employed in their tests. It should not, however, be surprising, since loudspeaker testing requires more exacting and time-consuming measurements than any other high-fidelity component, if the tests are to serve as any indication of the ability of the loudspeaker to perform its proper function in a high-fidelity system.

FRANCIS D. WETHERILL, Pres.
Neshaminy Electronic Corp.
Neshaminy, Pennsylvania

An article containing the results referred to above appears in this month's issue under the title "Testing Electrostatic Loudspeakers."—Editors.

* * *

THE VARISTOR

To the Editors:

In your November issue there was a brief article entitled "The 'Istor' Story." In the story the term "varistor" was explained as "a network of four carefully selected and matched diodes." I have always been under the impression that a varistor was a form of variable resistor, and that there are three types; rectifier, symmetrical, and thermistor.

FRANK C. TIRIMACCO
Alameda, California

According to Author Graf who wrote the original article, the official ASA and IRE definition of a varistor is "A two-electrode semiconductor device having a voltage-dependent nonlinear resistance." This is a more general description of such a device than the one given in the article. The description given there is of a 1N71 varistor manufactured by Sylvania. *Other manufacturers' varistors have different characteristics. For example,* General Electric *manufactures a "Thyrite" varistor, which is used to protect, stabilize, and control various circuits.—Editors.*

* * *

ELECTRO-MELODEON

To the Editors:

I have had some comments from readers who have been experiencing an undesirable echo effect with the Electro-Melodeon I described in the September, 1958 issue.

I would suggest that anyone having any problems with an undesired echo reread the second column on page 62 of the issue. This material will help to point out the reason for the echo. When one of the push-buttons is partially depressed, the *C* and *D* switch springs make contact and V_{24} produces a tone. Even though the *A* and *B* springs are not yet touching, a minute amount of energy from V_{24} will reach the grid of V_3. Some of this signal gets to V_3 by way of C_{11} and the internal capacity existing between the two halves of V_2. The rest of it is picked up on the rather long lead running from the variable arm of R_{17} to pin 1 of V_3, and on the

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wire from the top of R_{17} to C_{11}. Little can be done to eliminate the stray coupling between the two halves of V_2. However, grounded metallic shield braid threaded over the wires running to R_{17} will reduce the echo effect to insignificance.

In practice, the echo effect is unnoticeable when the instrument is properly played. I've been using the prototype described in the article, with no shielding, for over a year-and-a-half without difficulty. I'm sure that with a little practice anyone can achieve the same results. Use a snappy fingering technique. Don't depress or release the keys slowly, and don't allow your fingers to rest on unused keys.

HARTLAND B. SMITH
Birmingham, Michigan

We are glad to pass along this useful information from Author Smith who designed this unit.—Editors.

* * *

CITIZENS BAND RADIO

To the Editors:

Can you tell me whether or not considerable use is being made of the Citizens Radio Band, which I believe uses a frequency of about 460 mc.? Are there any articles in back issues of RADIO & TV NEWS which discuss this band and the equipment required?

G. W. BLOEMENDAL
Oak Park, Illinois

To the Editors:

Here is a report of some DX I have worked on the new 27 mc. Citizens Band.

On December 25th, I worked 11WØ-822 at Lakewood, California, a distance of about 1700 miles from St. Charles, Illinois, using a power input of less than 5 watts to a vertical, 300-ohm folded dipole antenna. We are exchanging verifications.

M. ARTHUR LAVERTY
St. Charles, Illinois

For an excellent article on the status of the 460 mc. Citizens Band, we refer you to the article "Citizens Radio Faces the Future" in our November, 1958 issue. For information on the new 27 mc. Class D Citizens Service, we refer you to the article "Build This Citizens Band Transceiver" (page 49) in this issue.—Editors.

* * *

"TINY TIM" THERMISTOR

To the Editors:

In the parts list for the " 'Tiny Tim' Portable P.A. Amplifier" (December, 1958 issue), you list R_{16} as a 130-ohm thermistor, *Veco* type 21W1. In my catalogues, this number is rated as a 100-ohm thermistor. Now which is correct, the model number you give or the resistance value shown?

WALTER PROKUSKI
Peru, Illinois

The correct thermistor is actually a 21W1 with a resistance value of 100 ohms.—Editors. —30—

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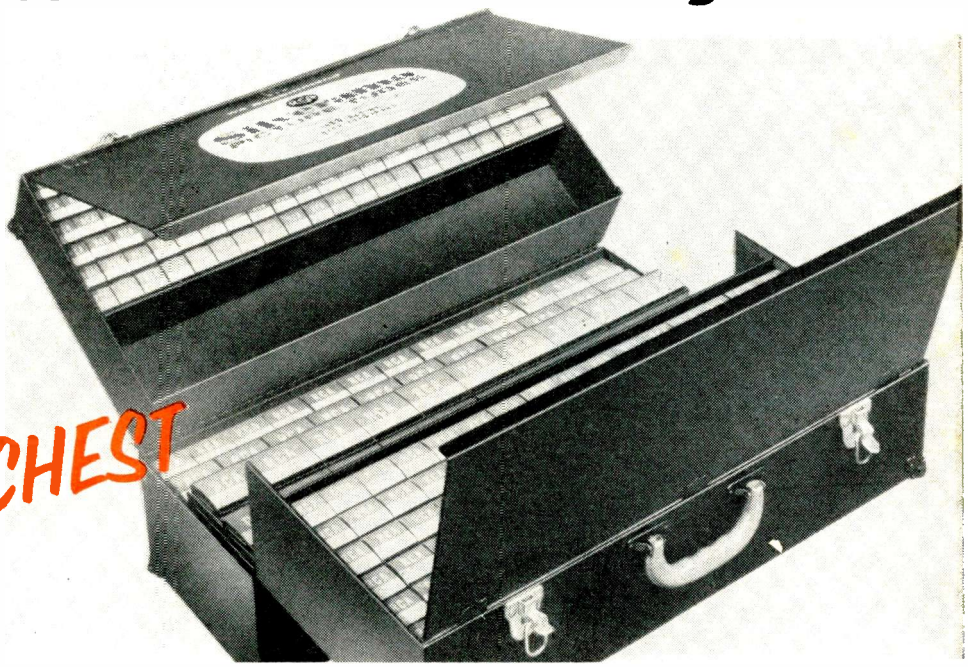

RCA's "TREASURE CHEST"—the handy way to have more than 260 RCA receiving tubes with you at all times, and all in one easy-to-carry, durable *steel* carrying case! This All-Metal RCA Treasure Chest can carry a wide selection of tube types and sizes, with all type numbers in full view when the case is opened. It has a handsome finish, is well braced and strongly hinged. Measurements—21¾" x 16" x 8⅜".

ALL-NEW RCA SERVICE INFO KIT

RCA SERVICE PARTS INFO KIT! Valuable servicing data in one easy-to-use package for work right on the job! Contains: (1) the New Service Parts Directory for RCA Victor 1955, 1956 and 1957 TV Receivers—features service information on more than 250 color and black-and-white TV receiver models, circuit diagrams, parts lists, top-and-bottom chassis views and comprehensive index; (2) New RCA Victor Radio and Record Service Parts Directory—features major replacement parts for TV and radio receivers, phonograph cartridge guide and comprehensive index.

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March 23-28

RADIO CORPORATION OF AMERICA
Electron Tube Division ***Harrison, N. J.***

Within the Industry

ROBERT E. LEWIS has been elected president of *Sylvania Electric Products Inc.*

Previously he was a senior vice-president of the company.

Mr. Lewis was president of *Argus Cameras, Inc.*, an independent company, prior to its combination with *Sylvania* in 1957. Before this, he was a consulting management engineer with *Sanderson & Porter*. Earlier, he had been treasurer and a director of *American Steel & Wire Co.*, a *U. S. Steel* subsidiary; president of *Cleveland Wire Spring Co.*; and controller and assistant to the president of *Batten, Barton, Durstine and Osborn*, New York advertising agency.

* * *

THE REPRESENTATIVES has changed its name to the Electronic Representatives Association after an overwhelming deluge of "yes" votes from members.

In announcing the official tally of 265 to 16 it was added that the organization would now be known as ERA. This clearly identifies the group as electronic representatives.

* * *

ED FLAXMAN has been appointed vice-president in charge of sales for *Service Instruments Corporation* of Addison, Illinois.

He was previously sales manager of *Waldom Electronics* and is well known throughout the electronic industry.

Mr. Flaxman's new responsibilities will include complete charge of nineteen "Sencore" representative organizations and the development of a new sales organization for the company's special products division.

* * *

AMPHENOL ELECTRONICS CORPORATION and **THE GEORGE W. BORG CORPORATION** have received approval from their stockholders for the consolidation of the two companies into **AMPHENOL-BORG ELECTRONICS CORPORATION** . . . Controlling interest in **THE BOBBS-MERRILL COMPANY** has been acquired by **HOWARD W. SAMS & CO., INC.** According to the firm, the former company will retain its present identity and will continue with its educational, legal, and trade book departments . . . **AMERICAN TELEVISION & RADIO COMPANY** has announced the purchase of **ECKSTEIN RADIO AND TELEVISION COMPANY** and is taking over the manufacturing of this line immediately . . . **ARKAY RADIO KITS, INC.** has moved to new quarters at 88-06 Van Wyck Expressway, Richmond Hill, Queens, N. Y.

* * *

HOWARD T. HARWOOD has been named chairman of the advertising section of the Electronic Parts and Equipment Manufacturers Association. The group has a membership of about 120 manufacturers throughout the Middle West.

Mr. Harwood is advertising manager of *Shure Brothers, Inc.*, Evanston, Ill.

* * *

JOHN D. MICHAEL has been named to the executive sales staff of the distributor division of *Quam Nichols Company*.

Mr. Michael comes to the speaker and electronic components manufacturing company with seven years' experience in the installation of sound systems in industrial, school, and institutional applications.

In his new post he will assist the manager of the company's distributor division.

* * *

ELECTRONICS INDUSTRIES ASSOCIATION's board of directors has established a National Stereophonic Radio Committee with authorization to develop a set of standards for stereophonic radio broadcasting for recommendation to the FCC.

The responsibility of this committee would be to develop a set of standards which, in the opinion of the industry, as represented by the Association, represents the most economical method of serving the public. The standards must permit full compatibility to the extent economically feasible; that is, all reasonable systems of multiplexing plus regular FM transmissions.

Operations will be directed by an administrative committee headed by Dr. W. R. G. Baker and with David B. Smith of *Philco Corporation* as vice-chairman. The operating committee will be headed by Graydon Lloyd of *General Electric Company*.

* * *

WILLIAM H. ATTSCHULER has been appointed to the newly created position of factory manager of *Pentron Corporation* . . . *Switchcraft, Inc.* has named **THOMAS L. DOWELL** as distributor sales manager . . . *Raytheon Manufacturing Company* has named **JOHN H. BEEDLE** as head of its new equipment and systems division and **J. PENN RUTHERFORD** as manager of the new industrial apparatus division . . . **GEORGE W. De-**

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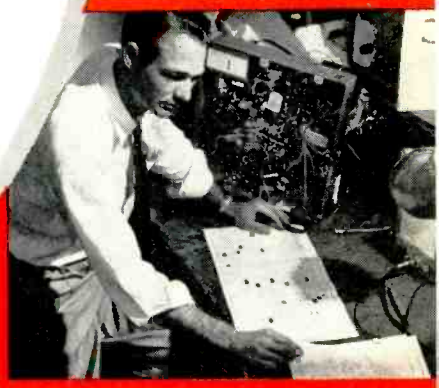
—Julius L. Burke,
Dallas, Texas



Mr. Burke at his bench consulting a time-saving, tell-all Standard Notation Schematic—an exclusive PHOTOFACT feature.

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—Leland Moyer, *Fort Plain, N. Y.*

"I couldn't do any business without PHOTOFACT. I just wish I could have afforded all of them before."
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"It would be very difficult to service some sets without Sams PHOTOFACT; they make the tough ones easy to service."
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"PHOTOFACT means faster and better service."
—Ray W. Nichols, *Seymour, Ind.*

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—Herbert L. Till, *Iuka, Miss.*

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—Henry Ingham, *Tetum, Texas*

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SOUSA has been named vice-president in charge of marketing for the semiconductor division of *Hoffman Electronics Corp.* . . . **DR. JAMES B. FISK** has been elected president of *Bell Telephone Laboratories* . . . **STAN NEUFELD** has joined *Brand Products, Inc.* as vice-president in charge of sales . . . **J. GERALD MAYER** has been named president of *Radio Receptor Co., Inc.*, subsidiary of *General Instrument Corp.* . . . **JACK KARNS** has resigned as vice-president of *Recoton Corporation.* At the same time, **ALFRED WISH,** formerly secretary of the firm, has been elected vice-president . . . *Raytheon Manufacturing Company* has appointed **RICHARD E. SEIFERT** as sales planning manager for the semiconductor division and **NATHANIEL H. SPERBER** as publicity manager for the firm . . . **HARVEY W. HARPER,** founder and chairman of the board of directors of *Tung-Sol Electric Inc.* died at the age of 80 . . . **DR. CHARLES G. SMITH,** one of the three founders of *Raytheon Manufacturing Company,* has retired from that company at the age of 70.

* * *

MOGENS E. CHRISTIANSEN has been appointed general sales manager of the *Mallory Battery Company* of Cleveland, a division of *P. R. Mallory & Co. Inc.*

Mr. Christiansen has been employed in battery manufacturing, engineering, and sales for nineteen years. He came to this country from Denmark in 1940 and joined *General Dry Batteries, Inc.* where he served in production, quality control, engineering, and sales capacities.

Prior to his new appointment he was assistant general sales manager of the firm.

* * *

INSTITUTE OF HIGH FIDELITY MANUFACTURERS has re-elected Joseph N. Benjamin as president. Mr. Benjamin is president of the *Bogen-Presto Division* of the *Siegler Corporation.*

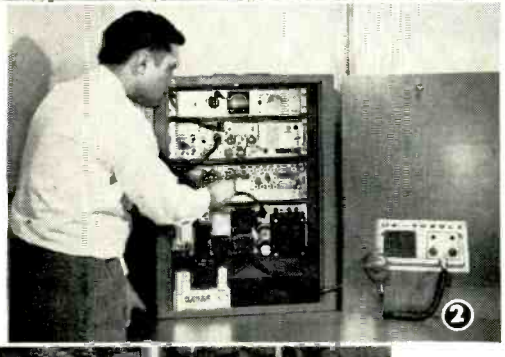
Philip Gundy, president of *Ampex Audio Inc.*, was elected as Institute vice-president; Saul Marantz, president of *Marantz Company,* was named secretary; and Milton D. Thalberg, president of *Audiogersh Corporation,* was re-elected treasurer.

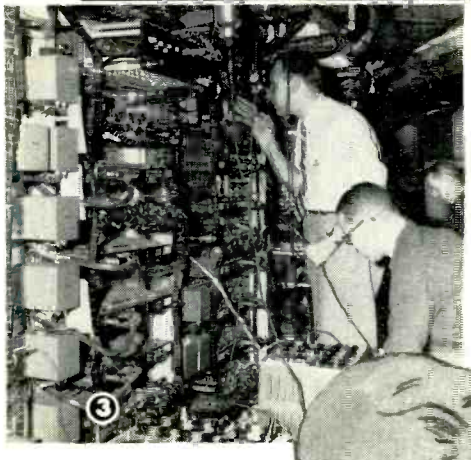
Mr. Benjamin and Mr. Thalberg were renamed to the board of directors for two year terms along with the following: L. J. Epstein, formerly director of sales and merchandising, *University Loudspeakers Inc.;* William S. Grommes, the president of *Grommes Division of Precision Electronics Corporation;* and Walter O. Stanton, president of *Pickering and Company.*

The Institute, formed with 23 firms in 1955 to set industry standards and educate the public about component high-fidelity, now numbers more than 120 manufacturers, recording companies, and publishers throughout the country. —30—

How to Pass FCC License Exams

find out how an FCC license means...





1. Collins Radio Company
2. Motorola Communications & Electronics, Inc.
3. Raytheon Manufacturing Company

1. More income for you every week

2. A more interesting job in electronics

The average person spends over 50% of his waking hours on the job (or going to and from the job). Therefore doesn't it make sense to have a job that is really interesting and also pays well?

The chances are very good that if you are reading this magazine you can qualify for the really good jobs in electronics . . . and it won't take long to do it. Your past training and experience in basic electronics (such as radio and TV repair, armed forces electronics, ham operations, etc.) can be the foundation for a profitable career as an "across-the-board" electronics technician.

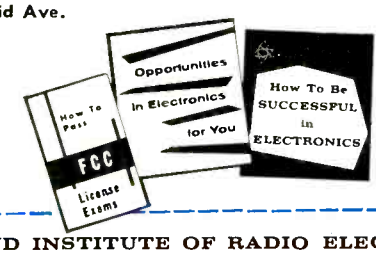
Whether you run your own shop or work for someone else, the real money, the interesting work, is available to the man who can effectively handle the more complex electronic gear. Home receiver repair can provide a good living, but it can't match the opportunities open to a skilled electronics technician.

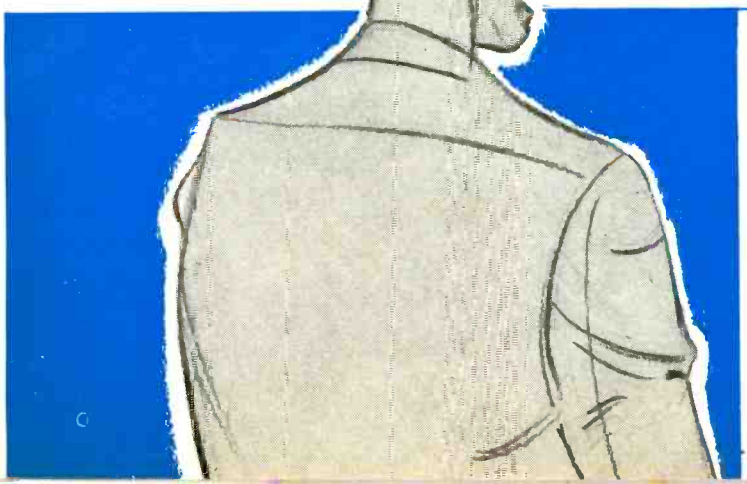
The booklets shown below will show you how you can qualify for a government certificate of competency . . . a commercial FCC License . . . and acquire a really fine technical education. Find out how your success with the FCC examination is guaranteed . . . or your money back.

You will also find out where technicians are needed . . . what a technician needs to know about electronics . . . and many other facts about opportunities for you in electronics.

It will cost you only the price of a postage stamp to get all of the facts. If you are in any type of electronics work . . . or if you have had previous training or experience in electronics . . . you owe it to yourself to ask us to send you information on profitable careers in electronics.

CLEVELAND INSTITUTE OF RADIO ELECTRONICS
Desk RN -27 4900 Euclid Ave. **Cleveland 3, Ohio**





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Please send FREE Booklets prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

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- ☐ Radio-TV Servicing
- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other_____

In what kind of work are you now engaged?_____

In what branch of Electronics are you interested?_____

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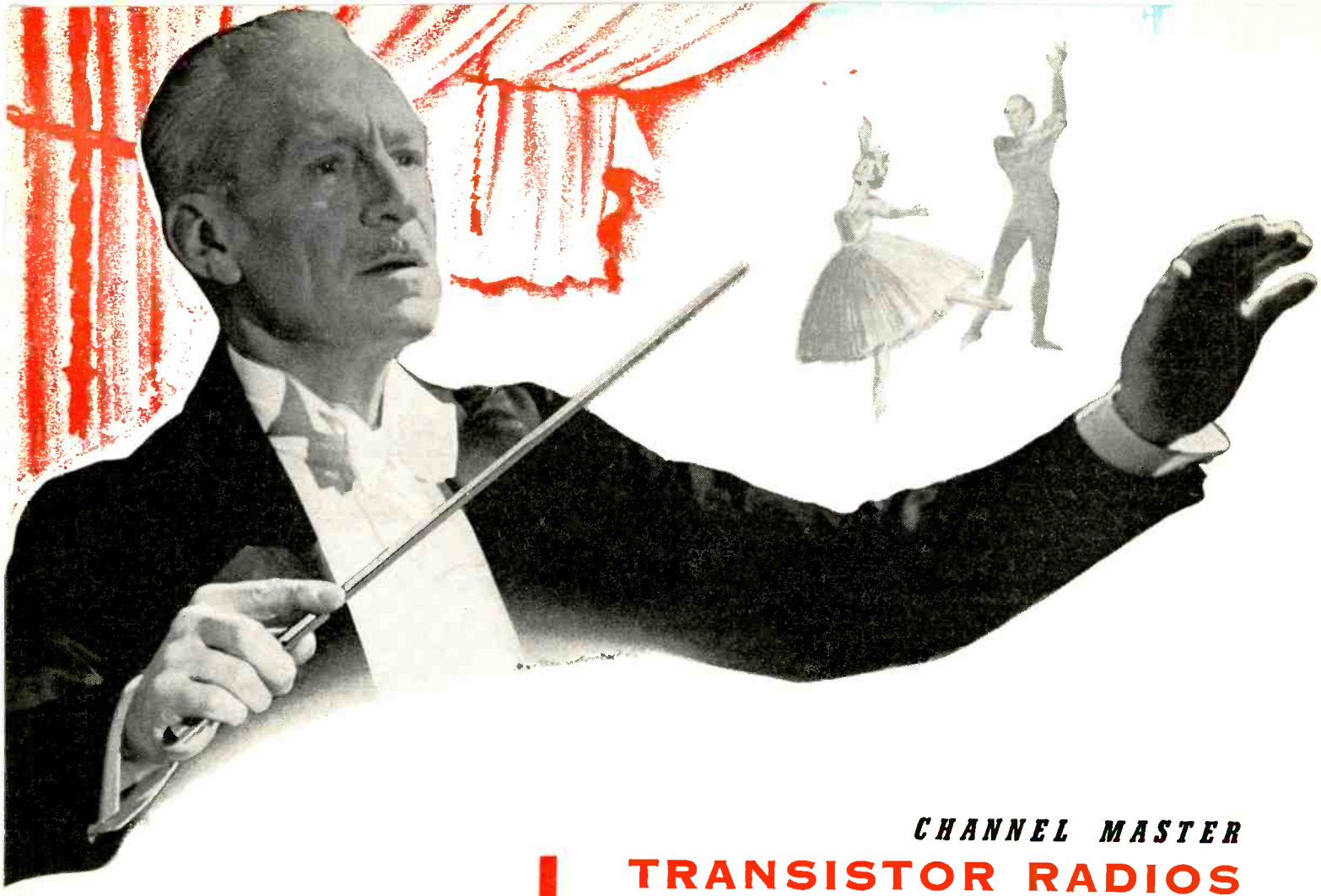
RN-27



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TRANSISTOR RADIOS

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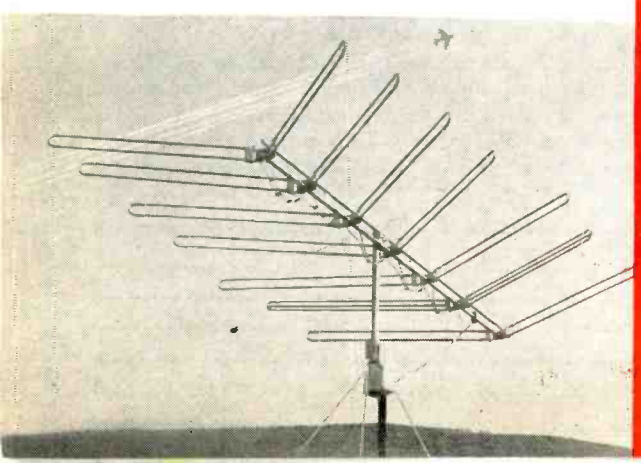
Dealers sell more T-W's than any other fringe-area antenna—by far. The powerful T-W delivers the highest gains and front-to-back ratios of any all-channel VHF antenna. Its rugged construction provides more years of peak performance. And it's nationally advertised on network TV and in leading magazines. Recommend a T-W for your next installation—and help your business grow.

CHANNEL MASTER T-W

The World's Most Powerful TV Antenna



Personal Portable Radio

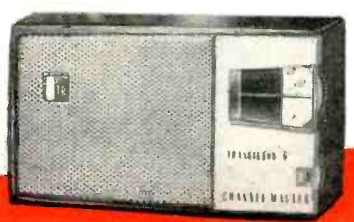
6 transistors, plus 1 diode and 1 thermistor. 5¾" x 3" x 1¾"

Model No. 6506 **$49.95** list including accessories

Pocket Portable Radio

6 transistors, plus 1 diode. 4⅝" x 2¾" x 1¼"

Model No. 6501 **$34.95** list



Never before have any radios made such an instant hit with the American public. And no wonder! These electronic gems are unmatched in sensitivity — even by larger, much more expensive radios. Their smart, modern design... rich tone... and low price make Channel Master transistor radios America's #1 value.

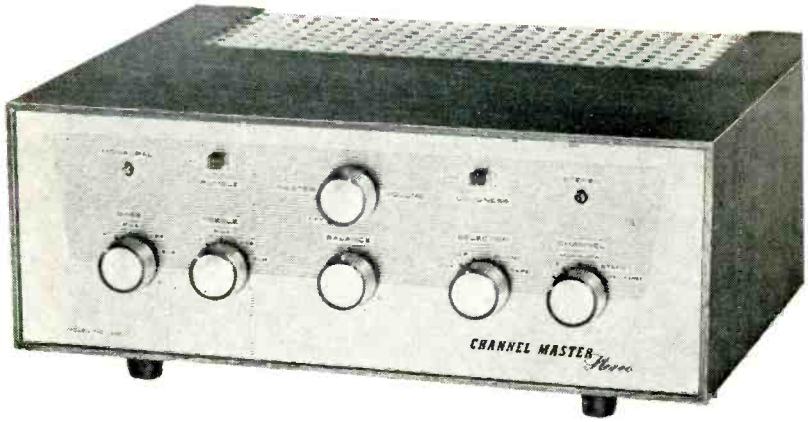
CHANNEL MASTER

works wonders in Sight and Sound

New! CHANNEL MASTER HIGH FIDELITY COMPONENTS

New components with a new idea: the "Practical Approach!" Channel Master's new hi-fi line is designed to eliminate confusion by directing the customer's attention to the 5 basic, practical considerations which apply to the selection of any high fidelity system: Performance, Ease of Operation, Versatility, Styling, and Cost.

The Channel Master line eminently satisfies each of these requirements. These are instruments of superb quality and striking appearance, offered at moderate prices. They reproduce with astonishing accuracy the entire audible spectrum with an absolute minimum of manual controls. The result is a true high fidelity system which satisfies the most discriminating audiophile... and yet can be used and enjoyed by virtually everyone.



Cabinets available in wood or metal.

Stereophonic Amplifier

Model No. 6600

audiophile net $119.95 without cabinet

The Channel Master 6600 stereophonic amplifier is an instrument of flawless electronic craftsmanship, embodying every advanced technical feature for full-range stereophonic sound reproduction. 16 watts on each channel (32 watt peak). Solid brass face panel.

AM/FM Tuner *Model No. 6100*

audiophile net $84.95 without cabinet

This outstanding tuner provides fine performance, pinpoint station selectivity and effortless flywheel tuning. Automatic Gain and Volume Controls on FM and AM prevent overloading by strong signals and maintain constant sound levels. Special multiplex output permits tuner to be adapted for stereophonic FM broadcasting. Solid brass face panel.

Monaural Amplifier *Model No. 6620*

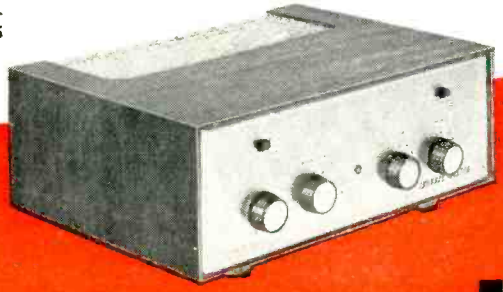
audiophile net $79.95 without cabinet

This superb 20 watt (40 watt peak) amplifier faithfully reproduces every sound audible to the human ear. Modern feed-back circuitry assures minimum distortion and full-frequency range. Special adapter jacks make conversion to a stereo system simple and economical. Solid brass face panel.

Tiny Minstrel Speaker System *brings concert hall realism to the home*

Now, for the first time, full dynamic realism is achieved in a miniature enclosure only 9" x 9" x 16". Through the patented new "Acoustic Transformer" principle the entire air chamber becomes a phase matching air transformer which produces clear, undistorted sound from 50 to 15,000 cycles. The big sound and small size of Channel Master Minstrels make them ideal for flexible, space-saving, low-cost stereo installations.

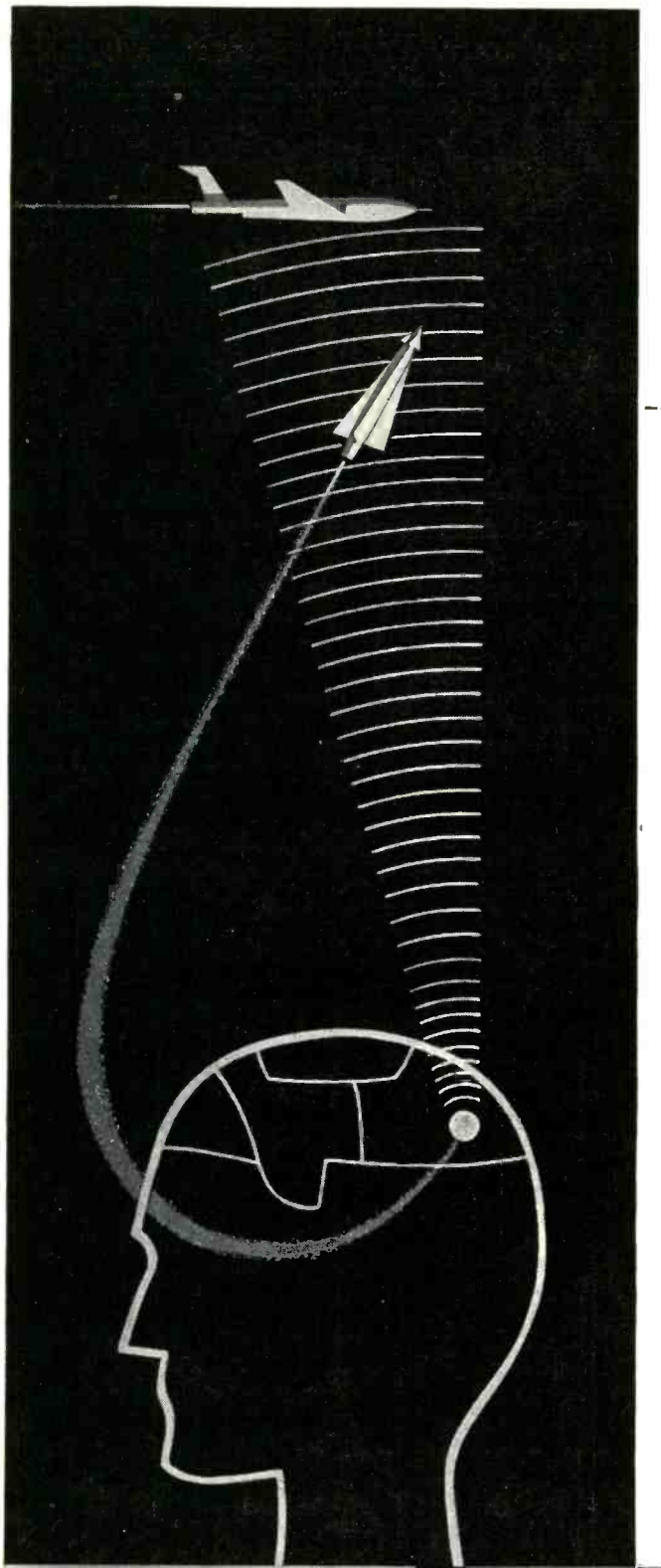
audiophile net $29.95



for product literature contact your CM Distributor or write to

CHANNEL MASTER CORP.

ELLENVILLE, NEW YORK



From Bell Telephone Laboratories...

Brainpower

for the brawny

Nike-Hercules

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

For Hercules has a "brain"—an intellect that makes it a prodigy among today's electronic robots. Bell Telephone Laboratories developed it. Western Electric (prime contractor for the entire missile system) is producing it. Douglas Aircraft Company is giving it its body.

This "brain" is a fully integrated guidance system, almost entirely land-based. Only the vital signal-receiving apparatus is expendable within the missile itself. Other highly practical features: it defies "jamming," is completely mobile, is designed in separate "building block" units which are replaceable in seconds—and is deadly accurate.

Bell Labs scientists and engineers designed the world's largest and most intricate telephone communications network for the Bell System. They developed about half of the Armed Forces' radar equipment during World War II. And they pioneered the nation's *first* successful air defense guided missile system—Nike-Ajax.

They were eminently qualified to give Hercules the brainpower it needed.

BELL TELEPHONE LABORATORIES
World center of communications research and development

Vigilant acquisition radar for Nike-Hercules first detects approach of distant aircraft, pinpoints its location and instantly signals to battery control.

Two tracking-radar antennas, housed in radomes, take over. One feeds target azimuth, elevation, range data to computers; other tracks Hercules.

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

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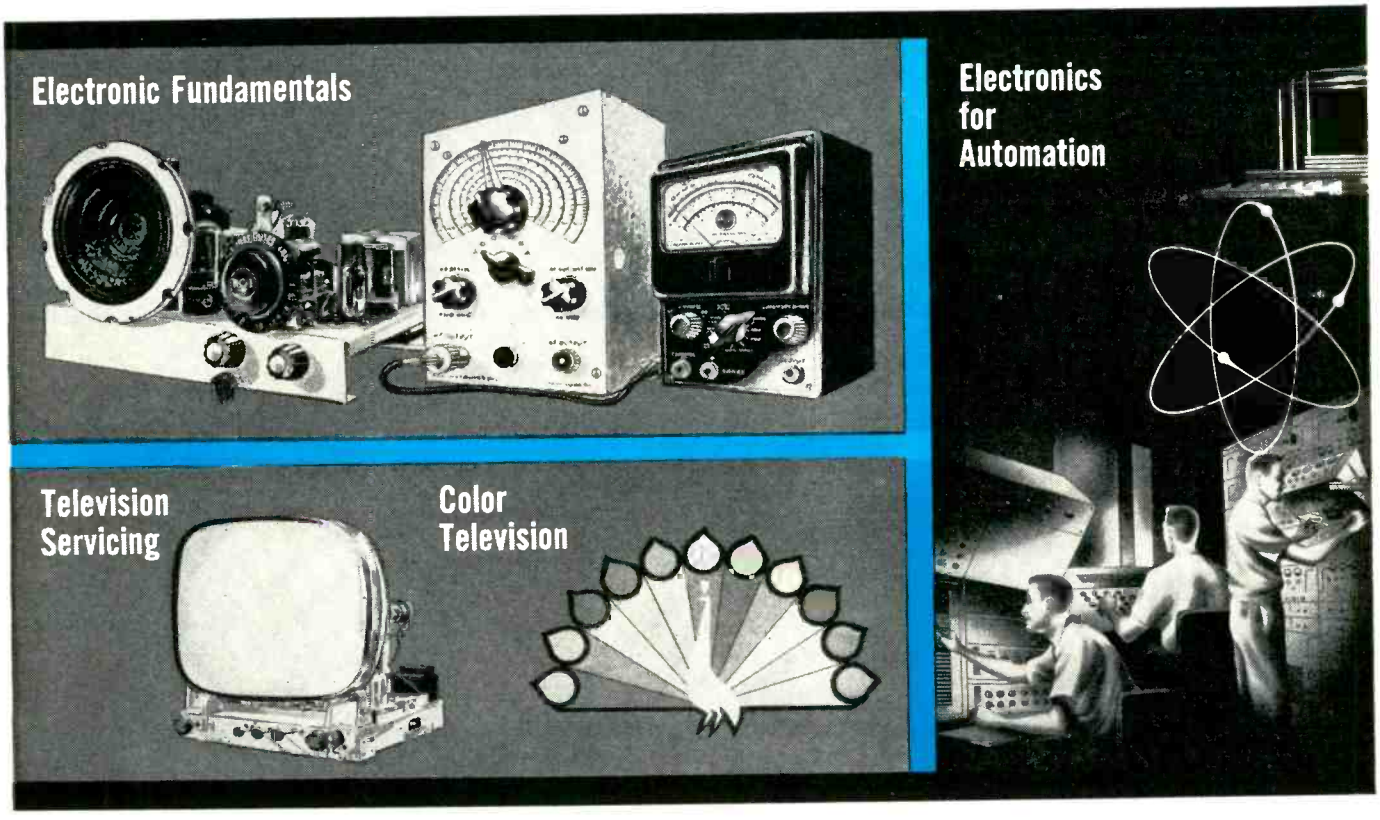

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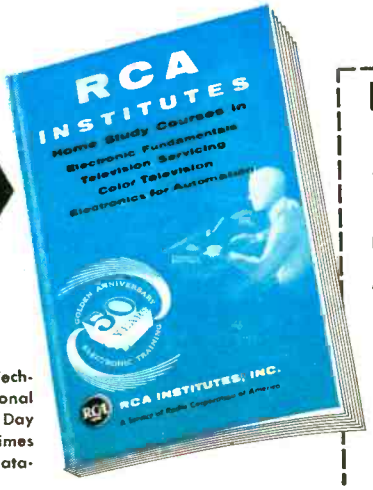

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Get big-speaker performance in a "stereo-compact" enclosure

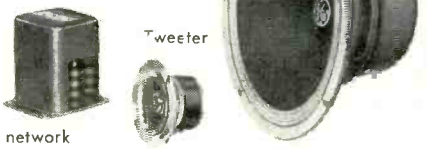
General Electric's LH-12 "Stereo Classic" Speaker System combines enclosure compactness with full, smooth response over the entire audio frequency range. The complete unit — with woofer, tweeter and crossover network — occupies only two cubic feet of space.

But small size is gained through no sacrifice in sound. G.E.'s new Extended Bass design puts out *four times* as much power (+6db) at low frequencies as standard 12" speakers in the same enclosure. For superb stereo sound, we invite you to compare this system with all others, *regardless of size.*

Complete LH-12 Speaker System in four most wanted finishes at **$129.95***. LC-12 and LK-12 Speakers available for separate mounting at **$89.95***.

OUTSTANDING NEW BASS PERFORMANCE

The woofer's high excursion cone and long voice coil *quadruple* power-handling ability. Treated cloth cone suspension increases compliance. Aluminum base voice coil for fast, efficient heat dissipation. All-steel welded construction.



Crossover network

Tweeter

Woofer

LH-6 Bookshelf Speaker System

Only 9" high, 17⅝" wide and 8⅜" deep, yet provides better low-frequency response than speakers tested in enclosures up to twice the size. Perfect solution to problem of getting high quality performance in a limited space. May be positioned on side or end, as shown at right. Also offered as kit without enclosure. From **$49.95 to $57.50*** (Kit form, **$29.95**).

New EN-50 5-cu. ft. enclosure for 12" speakers available in four finishes. **$69.95***

There's a full line of General Electric speakers at your High Fidelity dealer's. Finest performance—sensibly priced.

*Manufacturer's suggested resale prices.

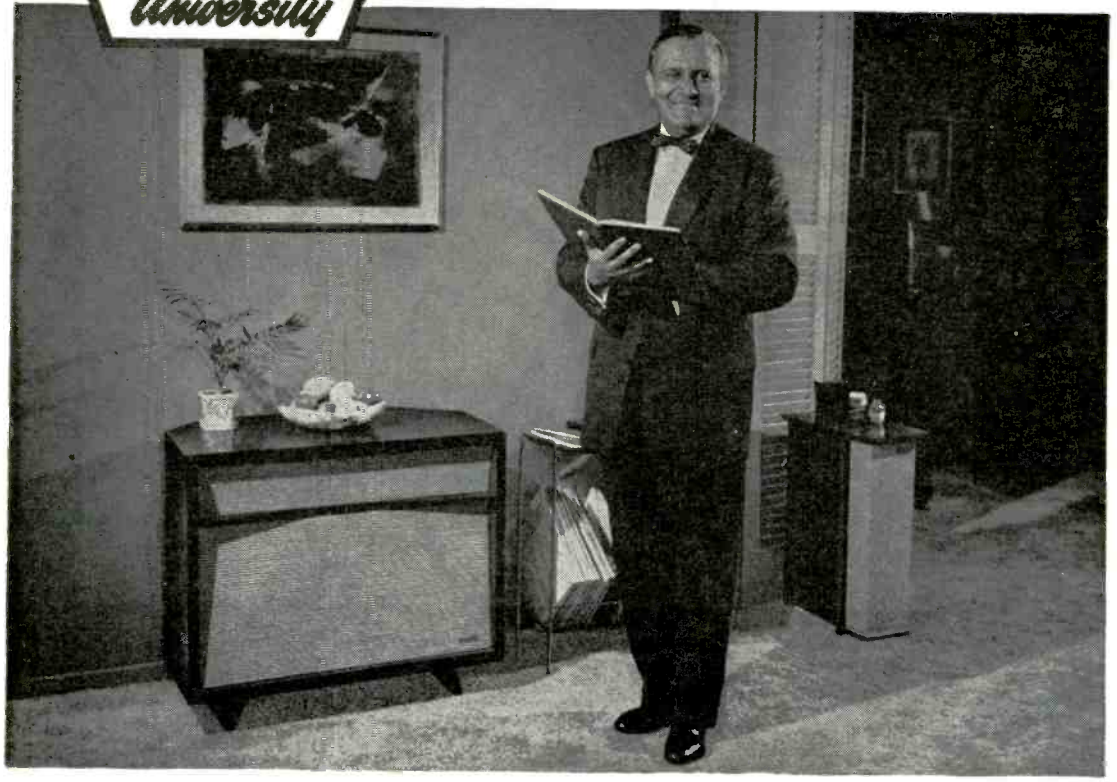
See and hear all the new G-E "Stereo Classic" components at your Hi-Fi dealer's now. For more information and the name of your nearest dealer, write General Electric Company, Specialty Electronic Components Dept., 45J3, W. Genesee St., Auburn, New York.

GENERAL ELECTRIC

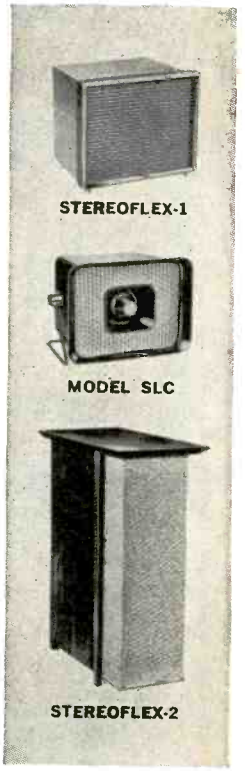
University

FAMOUS MEN OF MUSIC CHOOSE UNIVERSITY

Metropolitan Opera Star Leonard Warren, often referred to as the world's foremost baritone, has been acclaimed in most of today's great opera houses from Italy's La Scala to Buenos Aires' Teatro Colon and Moscow's Bolshoi Theatre. ***For his stereo system, Mr. Warren converted his full-range "Troubadour" quickly, easily and inexpensively with a compact Stereoflex-2.***



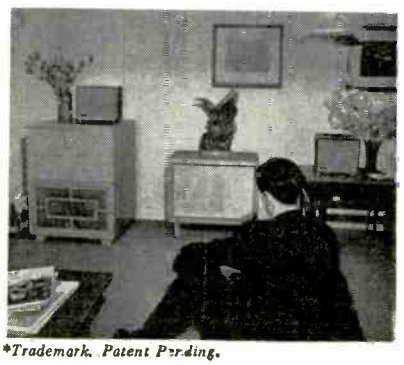
WIDEST SELECTION OF HIGHEST QUALITY "ADD-ON" SPEAKERS...



NEW... for cost and space-saving stereo

UNIVERSITY SLC* and STEREOFLEX*

"ADD-ON" SPEAKERS



**Trademark. Patent Pending.*

Whether converting or starting from scratch....

For those who already possess a full-range monophonic speaker system, or plan to buy one now with an eye to stereo conversion later . . . University can "add" superb stereo at low cost, even in rooms with "no" space for a second speaker. *Here's how:*

Because bass frequencies below 150 cps are strictly non-directional and do not contribute to the stereo effect, they can be reproduced by one woofer—that of the main system. In this case, the system supplies the *combined* bass of *both* channels as well as the full mid and high range of one channel. The mid and high range of the second channel is then provided by one of the three University "add-on" speakers. Because such "add-ons" are not required to produce low bass, they are small in size, easy to place for optimum stereo and decor effect, and priced most modestly. You also save the cost of a second woofer and large enclosure!

How University uses one woofer for two channel bass

This can be achieved in two ways, depending upon the kind of woofer you have. A conventional woofer—with a single voice coil—can receive these frequencies only after they are combined by the special stereo adapter network Model A-1. However, with University's exclusive DUAL VOICE COIL WOOFER† . . . containing two electrically separate voice coils . . . no such network is required. Instead, the stereo amplifiers can simply be connected one to each voice coil, thus feeding the full bass directly to this unique woofer.

Starting from scratch, another attractive and flexible approach would be to use a dual voice coil woofer in an enclosure along with one "add-on," the combination making a very fine monophonic speaker system. Later, you can convert to stereo with a duplicate "add-on," as shown at left. Now, since the woofer's position for stereo is not critical, you can place it almost anywhere in the room . . . and the two compact "add-ons" can easily be positioned for perfect decor and stereo effects . . . regardless of where the woofer has been placed.

Whichever approach you choose, University "add-ons" put you on the cost and space-saving road to true high fidelity stereo.

†University woofers having dual voice coils are models: C-15W, C-12SW, C-15HC and C-12HC. These are employed in speaker systems: Debonaire-12 S-3S; Senior S-5S; Master S-6, S-6S; Dean S-7, S-7S; Classic S-8, S-8S; S-9, S-9S; Ultra Linear S-10, S-10S; S-11, S-11S; Troubadour S-12, S-12S.
(System models in light type are fully stereo adapted. System models in ***bold type****, or any home built system with a dual voice coil woofer, can be easily and inexpensively prepared for stereo with kit SK-1. User net: $5.95)*

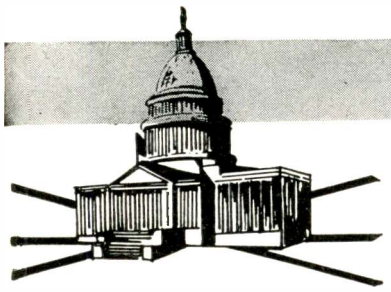
MODEL SLC is housed in an attractive fibreglas shell of charcoal grey with gold anodized grille and adjustable stand, **STEREOFLEX-1**, in a handsome wooden cabinet with fine woven grille cloth. Each occupies less than one cubic foot, making them easy to place on bookshelf, "lite-pole," or wall. Double horn-loaded, with 6" mid-range driver and 2000 cps crossover wide-angle tweeter. **User net:** Model SLC—**$43.50.** Stereoflex-1—Mahogany **$54.50,** Blond or Walnut — **$56.50.**

STEREOFLEX-2 is a slim, elegant unit, with matched woven grille cloth, designed for floor placement and makes an excellent end table. Double horn-loaded with heavy duty compression driver and extended air column for mid-range. Wide-angle driver/horn tweeter with "BRILLIANCE" control, 3000 cps crossover. 25½" x 10" x 19½" d **User net:** Mahogany—**$110.00,** Blond or Walnut—**$113.00.**

MODEL A-1 ADAPTER NETWORK: Required only with speaker systems **not** having dual voice coil woofer. **User net: $30.00.**

FREE
Guide to high fidelity stereo and monophonic speaker systems and components

You'll find complete information on how to select the above and other major types of stereo speaker systems . . . how to adapt your present system to stereo . . . how to choose a monophonic system **now** for efficient conversion to stereo **later**...how to plan economical "do-it-yourself" monophonic/stereo speaker systems. See your dealer, or write Desk S-11, University Loudspeakers, Inc., White Plains, N. Y.



Spot News

Latest Information on the Electronic Industry

By RADIO & TV NEWS' WASHINGTON EDITOR

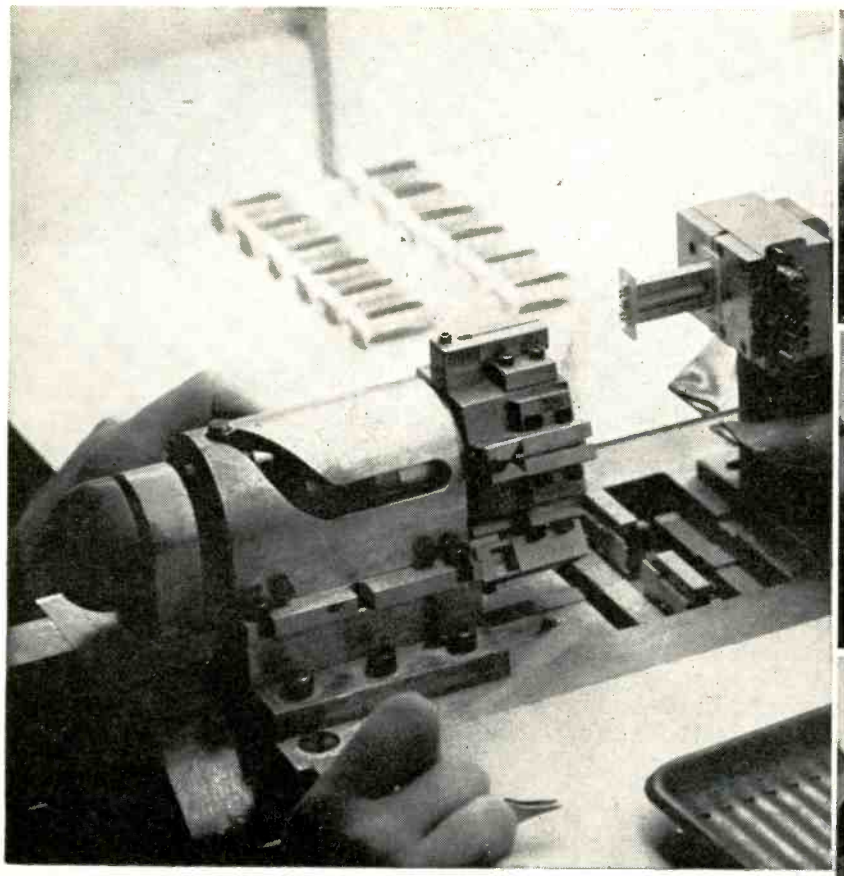
ELECTRONIC BOOM YEAR PREDICTED BY GOVERNMENT EXPERTS--In their annual projection review, the U. S. Department of Commerce, Business, and Defense Services Administration, Electronics Division, said that 1959 will be healthiest on record for electronics. They estimated that home-type radio and television receiver and related-product output would reach a top of $1.5 billion and the output of electronic components, other than tubes and semiconductors, would rise to the same new high. About $250-million would be spent for semiconductor devices, the forecast continued, and about $850-million would be channeled to tubes.

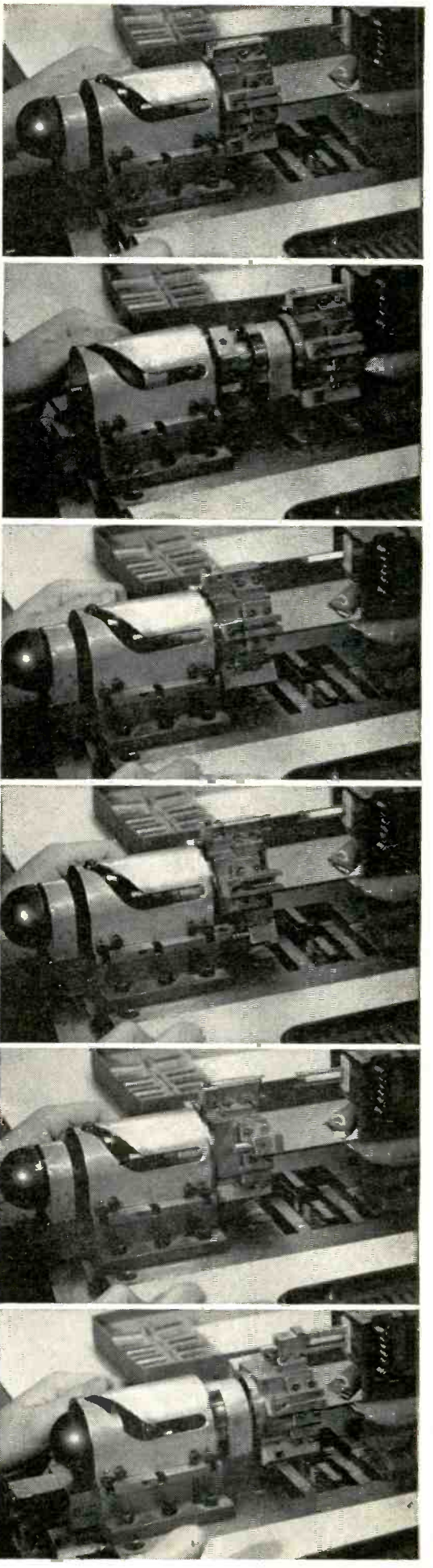
ATLAS RELAY SUCCESS LAYING GROUNDWORK FOR COURIER SATELLITE CONTACT--The orbiting communications relay inside the Atlas missile is the first step toward courier satellites for military communications, the Department of the Army announced recently. The relay was said to show promising advantages in helping to solve the growing traffic jam in the radio-wave spectrum in ground-to-ground military contacts. In addition, it was pointed out, the system suggests a means of eventually using satellite relays to store large numbers of messages, carry them thousands of miles, and release them, on call, to ground stations around the world. To obtain stored messages from the relay in the Atlas, a ground station triggered off the relay transmitter by electronic command. The relay consisted of a pair of transmitters, receivers, and recorders using erasable loops of magnetic tape. The transmitter produced 8 watts of power and used zinc-silver oxide batteries with an estimated life of four to six weeks.

AIRCRAFT RADARS COSTING OVER $10-MILLION ORDERED--Large-scale procurement of radars for civil aircraft has been authorized by Washington. Ten of the radar systems, known as Airport Surface Detection Equipment, costing $1,786,124, have been ordered from Airborne Instrument Labs for installation at some of the nation's busiest airports, including the new jet airport for Washington, D.C. at Chantilly, Va. Another contract calls for $3,022,147 worth of microwave link installations from Collins Radio Company which will include links for civil and military long-range radar and repeater stations. Another order issued covered purchase of 39 basic scan-conversion systems--a $5,729,116 contract to Admiral--to provide daylight displays of long-range radar information for air-traffic control. The equipment features a memory tube with the capability of retaining radar targets on the display for up to 30 minutes and showing a trailing blip on the screen indicating previous positions on the radar target.

NBS DEVELOPS APPARATUS FOR INTERCOMPARISON OF SMALL CAPACITORS--As part of its continuing program to improve the precision and reliability of electrical standards and measurements, the National Bureau of Standards has recently completed apparatus for the precise intercomparison of small capacitors. The apparatus employs a special 3-winding transformer and a bank of very stable capacitors which are combined to balance the unknown capacitance. This apparatus improves both the sensitivity and precision of capacitance measurements made by Bureau laboratories.

FCC REPORTS RECORD YEAR--The annual year-end report of the Federal Communications Commission has revealed that 1958 was a banner year for all phases of the radio and TV industry. Every facet of this burgeoning business set new records--from the number of sets in use to the number of broadcasting and telecasting stations on the air. For complete details on the "health" of the industry, refer to the article "Record Number of Sets in Use During '58" which appears elsewhere in this issue. This should serve as an effective rebuttal to the "gloom-merchants" who are always predicting the imminent collapse of the radio-TV industry. -30-





Large illustration shows operator completing the critical assembly work on a 6V6GTA mount in new CBS-Hytron automatic rotary assembly machine. Strip photos (top to bottom) catch six progressive steps: cathode positioned for insertion into bottom mica . . . cathode being inserted . . . A grid, B grid, and beam plate ready for assembly . . . top mica being added to complete the mount cage.

Automatic tube assembly can cut your call-backs

"Quality always equal . . . or better" is not just a catch phrase at CBS-Hytron. It stems from a determination to prevent troublesome, expensive call-backs. And it is based on building in quality, not trying to test it in.

Here automatic assembly builds in better performance. Operator feeds in each part; presses foot pedal; machine moves part forward and precisely into position. No handling contaminates, distorts or misassembles the parts. Potential failure headaches for you are automatically avoided.

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Stereo Preamplifier HF85

FM Tuner HFT90

Stereo Amplifier-Preamp HF81

Bookshelf Speaker System HFS1

Monaural Integrated Amplifiers: 50, 30, 20, and 12-Watt (use 2 for Stereo)

Speaker System HFS2 36" H x 15¼" W x 11½" D

Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)

Monaural Preamplifiers: HF65, HF61 (stack 2 for Stereo)

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Over 1 MILLION EICO instruments in use throughout the world.

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HF85: Stereo Dual Preamplifer is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source—tape, discs, broadcasts. Superb variable crossover feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any 2 high-quality power amplifiers such as EICO, HF14, HF22, HF30, HF35, HF50, HF60. Kit **$39.95.** Wired **$64.95.** Includes cover.

HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. **"Its performance is excellent, and the operation is uncomplicated."**—HI-FI MUSIC AT HOME. **"Excellent"**—SATURDAY REVIEW. Kit **$69.95.** Wired **$109.95.** Incl. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HF65: superb new design, Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. HF65A Kit **$29.95,** Wired **$44.95.** HF65 (with power supply) Kit **$33.95.** Wired **$49.95.**

HF61: "Rivals the most expensive preamps" — Marshall, AUDIOCRAFT. HF61A Kit **$24.95,** Wired **$37.95,** HF61 (with power supply) Kit **$29.95.** Wired **$44.95.**

MONAURAL POWER AMPLIFIERS (use 2 for STEREO)

HF60: 60-Watt Ultra Linear Power Amplifier with Acro TO-330 Output Xfmr.; **"One of the best-performing amplifiers extant; an excellent buy."** AUDIOCRAFT Kit Report. Kit **$72.95.** Wired **$99.95.** Cover E-2 $4.50.

HF50: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60, same specs at 50W. Kit **$57.95.** Wired **$87.95.** Cover E-2 $4.50.

NEW HF35: 35-Watt Ultra-Linear Power Amplifier. Kit **$47.95.** Wired **$72.95.** Cover E-2 $4.50.

HF30: 30-Watt Power Amplifier. Kit **$39.95.** Wired **$62.95.** Cover E-3 $3.95.

NEW HF22: 22-Watt Power Amplifier. Kit **$38.95.** Wired **$61.95.** Cover E-2 $4.50.

NEW HF14: 14-Watt Power Amplifier. Kit **$23.50.** Wired **$41.50.** Cover E-6 $4.50.

MONAURAL INTEGRATED AMPLIFIERS (use 2 for STEREO)

HF52: 50-Watt Integrated Amplifier with complete "front end" facilities & Chicago Standard Output Transformer. **"Excellent value"**—Hirsch-Houck Labs. Kit **$69.95.** Wired **$109.95.** Cover E-1 $4.50.

HF32: 30-Watt Integrated Amplifier. Kit **$57.95.** Wired **$89.95.** Both include cover.

HF20: 20-Watt Integrated Amplifier. "Well-engineered" — Stocklin, RADIO TV NEWS. Kit **$49.95.** Wired **$79.95.** Cover E-1 $4.50.

HF12: 12-Watt Integrated Amplifier. "Packs a wallop"—POP. ELECTRONICS. Kit **$34.95.** Wired **$57.95.**

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HFS1: Bookshelf Speaker System, complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. Capacity 25 w. 8 ohms. HWD: 11" x 23" x 9". Wiring time 15 min. Price **$39.95.**

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HFT90: surpasses wired tuners up to 3X its cost. Prewired, pre-aligned, temperature-compensated "front end" — drift-free. Precision "eye-tronic" tuning. Sensitivity 1.5 uv for 20 db quieting — 6X that of other kit tuners. Response 20-20,000 cps ±1 db. K-follower & multiplex outputs. **"One of the best buys you can get in high fidelity kits."** — AUDIOCRAFT KIT REPORT. Kit **$39.95*.** Wired **$65.95*.** Cover $3.95.

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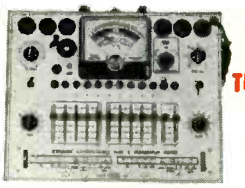

NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. Tests all receiving tubes (and picture tubes with adapter). Composite indication of Gm, Gp & peak emission. Simultaneous sel of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). New series-string voltages: for 600, 450, 300 ma types. Sensitive 200 ua meter. 5 ranges meter sensitivity (1% shunts & 5% pot). 10 SIX-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. Direct-reading of inter-element leakage in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors: separate meter readings of collector leakage current & Beta using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. CRA Adapter $4.50

NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased inereductor for excellent linearity. Extremely flat RF output: new AGC circuit automatically adjusts osc. for max. output on each band with min. ampl. variations. Exceptional tuning accuracy: edge-lit hairlines eliminate parallax. Swept Osc. Range 3-216 mc in 5 fund. bands. Variable Marker Range 2-75 mc in 3 fund. bands; 60-225 mc on harmonic band. 4.5 mc Xtal Marker Osc., xtal supplied. Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

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• Features DC Amplifiers!

Flat from DC-4.5 mc, usable to 10 mc. VERT. AMPL.: sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull thruout; K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. SWEEP: perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); preset TV V & H positions; auto. sync. ampl. & lim. PLUS: direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

5" PUSH-PULL Oscilloscope #425: Kit $44.95, Wired $79.95.
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NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. 6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%; 6:1 vernier tuning & excellent spread at most important alignment freqs. Etched tuning dial, plexiglass windows, edge-lit hairlines. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. amplifier: only 3.0 v needed for 30% mod. Turret-mounted coils slug-tuned for max. accuracy. Fine & Coarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5-way jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

NEW! PEAK-to-PEAK VTVM #232 & UNI-PROBE (pat. pend.)

KIT $29.95 WIRED $49.95

Half-turn of probe tip selects DC or AC-Ohms.

Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide ranges & versatility. Calibration without removing from cabinet. New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. 7 non-skip ranges on every function. 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. Zero center. One zero-adj. for all functions & ranges. 1% precision ceramic multiplier resistors. Measure directly peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

New! Series/Parallel R-C COMBINATION BOX #1140

KIT $13.95 WIRED $19.95

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KIT $34.95 Wired $49.95

- tests 600 mil series string type tubes
- illuminated roll-chart

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6V & 12V BATTERY ELIMINATOR & CHARGER #1050

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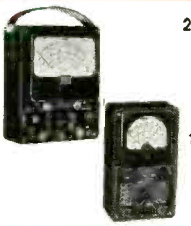
Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95

New! Miniaturized MULTI-SIGNAL TRACER #145A

KIT $19.95 WIRED $28.95



20,000 Ohms/Volt V-O-M #565

KIT 24.95 Wired $29.95

1000 Ohms/Volt V-O-M #536

KIT $12.90 Wired $14.90

Reads 0.5 ohms −500 megs, 10 mmfd−5000 mfd, power factor.

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R-C BRIDGE & R-C-L COMPARATOR #950B

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
High Voltage Probe-1		$6.95
High Voltage Probe-2		$4.95
SCOPE PROBES		
Demodulator	$3.75	$5.75
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

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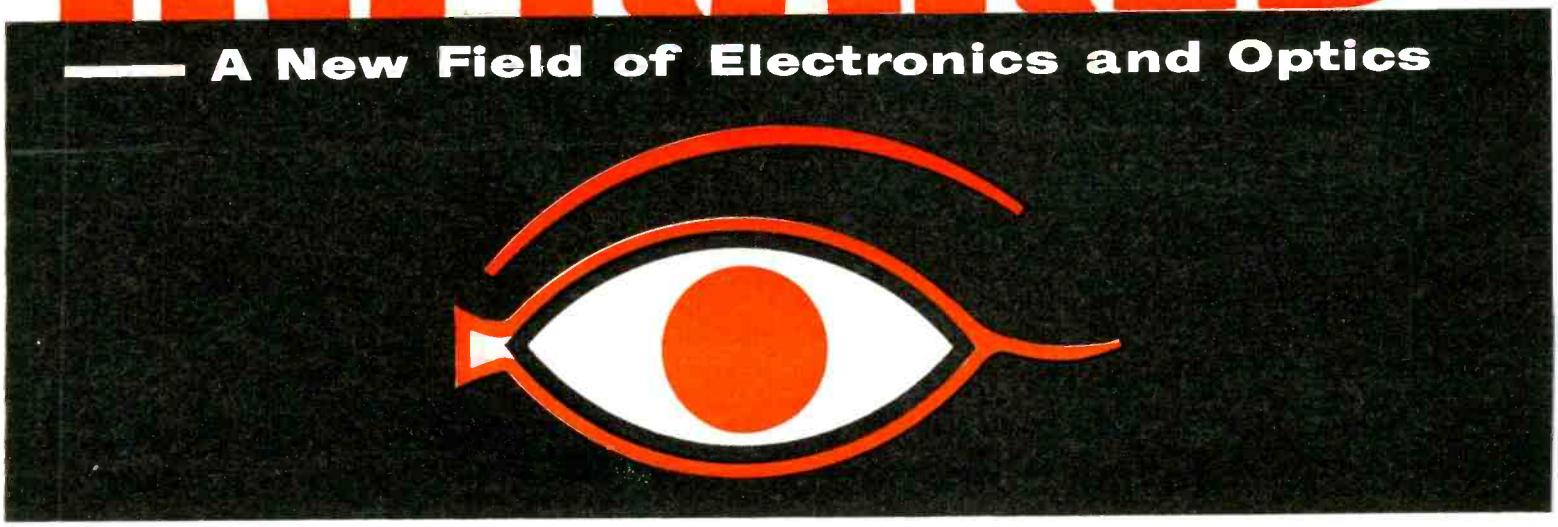
INFRARED

— A New Field of Electronics and Optics



By **PAUL BERNARD**
and
NATHAN BUITENKANT
Barnes Engineering Co.
Stamford, Connecticut

Taking pictures in total darkness, tracking missiles with extreme accuracy and at close ranges—these are but a few of the many uses of IR radiation.

INFRARED radiation has been known for almost 160 years. In the year 1800 William Herschel placed thermometers along a spectrum of the sun's rays which had been dispersed by a glass prism. The thermometers were heated not only in the visible portions of the spectrum but also at the end of the spectrum beyond the visible red. It was as if energy from the sun were present here too, even though invisible. This invisible energy "below red," became known as infrared radiation. But the properties of this remarkable portion of the spectrum were not put to use until more than a century later. Then, from 1920 to 1935, a number of infrared instruments were developed for identifying unknown materials and analyzing chemical compounds.

World War II brought the need for extensive military applications of infrared and such devices as the "sniperscope" and "snooperscope" were developed. These were "active" infrared devices in the sense that they required their targets to be illuminated or irradiated by self-contained infrared spotlights. After World War II the major developments in infrared devices were in the field of "passive" equipment requiring no form of illumination. Such equipment makes use of the fact that all objects at temperatures above absolute zero (−273°C) emit radiation, and can be detected and located by means of sensitive detectors.

Passive infrared systems have been employed by the military in air-to-air, air-to-ground, ground-to-ground, and ground-to-air applications. Such equipment can search, detect, warn, identify, track, and guide. Infrared thermograph equipment has been built that will print pictures of people and objects in total darkness (Fig. 1).

Tracking is an extremely important application of infrared, which takes over from radar at close range to provide very high resolution results. The U. S. Navy "Sidewinder" is an example of an infrared-guided air-to-air missile which can detect an enemy aircraft at a distance of seven miles, track it down at twice the speed of sound, and make a direct hit. The high-resolution infrared tracker shown on the cover and in Fig. 3 is designed to track high-speed airborne targets in daylight or in complete darkness.

Infrared provides much better definition than radar. The resolving power of a radar antenna or infrared optical system increases as its diameter is

INCREASING FREQUENCY →

Radio	Communications	Navigation	Radar	**Infrared**	Visible Light	Ultraviolet	X-rays (soft)	X-rays (hard)	Gamma Rays

← **INCREASING WAVELENGTH**

Fig. 1. Infrared photo (thermograph) taken in total darkness. In this view black areas are at a temperature of 75 degrees F or colder, and white areas are at 133 degrees or hotter. Note that the pipe bowl is the hottest object in the photograph.

made larger. Since useful infrared wavelengths are on the order of 1000 times shorter than those of the latest radars, infrared systems provide detail that is unobtainable with radar. For example, a microwave radar operating at 8 millimeter wavelength and with an antenna 12 inches in diameter cannot identify targets at 5-mile range as being separate unless they are laterally separated by more than ¼ mile. On the other hand an infrared system with a 4-inch mirror can easily identify the individual engines on a plane at the same range.

There are also many industrial uses of infrared. Infrared radiometers can monitor and control the temperatures of plastics, elastomers, ceramics, textiles, paper, glass, and metals, in all physical states and forms; and measure the temperature distributions of moving and rotating objects. Other infrared applications include non-destructive testing, machine maintenance, and aircraft and missile testing. An interesting new application is the use of infrared to detect "hot boxes" on railroad freight cars moving at speeds up to 80 miles an hour and to signal ahead to the next station the presence of hot boxes which may cause stoppage or derailment. Such hot box detectors can save many thousands of hours annually by eliminating the need to stop trains for manual inspection.

Infrared has many vitally important uses in industrial and scientific laboratories. For example, the infrared spectrometer is used to analyze chemical substances and identify unknown material. Infrared thermographs showing temperature distributions over the human body are being used in cancer research. Agriculture experts are using infrared to investigate temperature differences over supposedly uniform areas of plant life. Meteorologists are using infrared devices to measure the temperatures of sky, air, earth, and sea water; the results promise to be of great value in long-range weather prediction.

Infrared Radiation

Radiant energy is energy which is propagated through space, at the speed of light, by transfer of electromagnetic vibrations. There is a continuous spectrum of possible frequencies of these vibrations. *Gamma* rays, x-rays, ultraviolet, light, infrared, microwaves, and radio waves are all forms of radiant energy, and their location in the electromagnetic spectrum can be determined only by their frequencies. They all exhibit wave properties. High-frequency radiation is of short wavelength and low-frequency radiation is of long wavelength. (Refer to chart at bottom of the previous page.)

The infrared portion of the spectrum covers the wavelengths from about 0.75×10^{-6} meter to about 1000×10^{-6} meter (Fig. 4.). These wavelengths are so short that a smaller unit of length, the *micron* (equals 10^{-6} meter), is commonly used. Thus the infrared spectrum covers the range from about 0.75 micron to about 1000 microns. For convenience this band is said to consist of the near infrared (0.75 to 1.2 microns), intermediate infrared (1.2 to 7 microns) and far infrared (7 to 1000 microns) regions.

The molecules making up all matter are in a state of constant motion. This motion increases as the object's temperature is raised and decreases as the

Fig. 2. Black body radiation curves at various temperatures. Note the shift of the peak of maximum radiation that occurs.

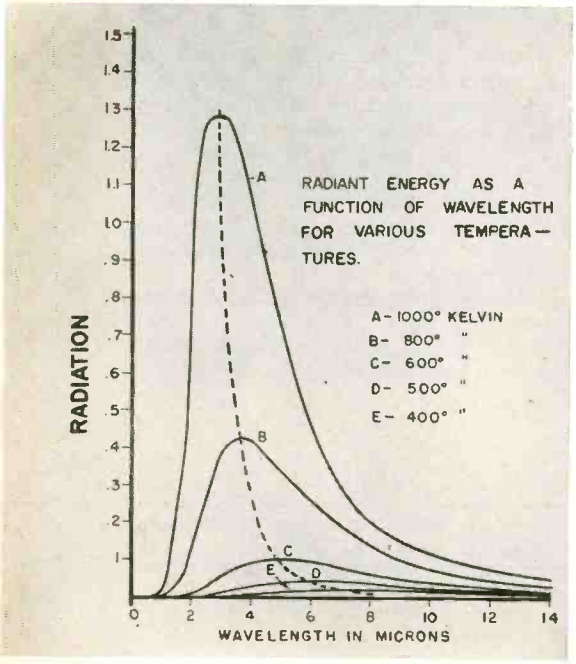
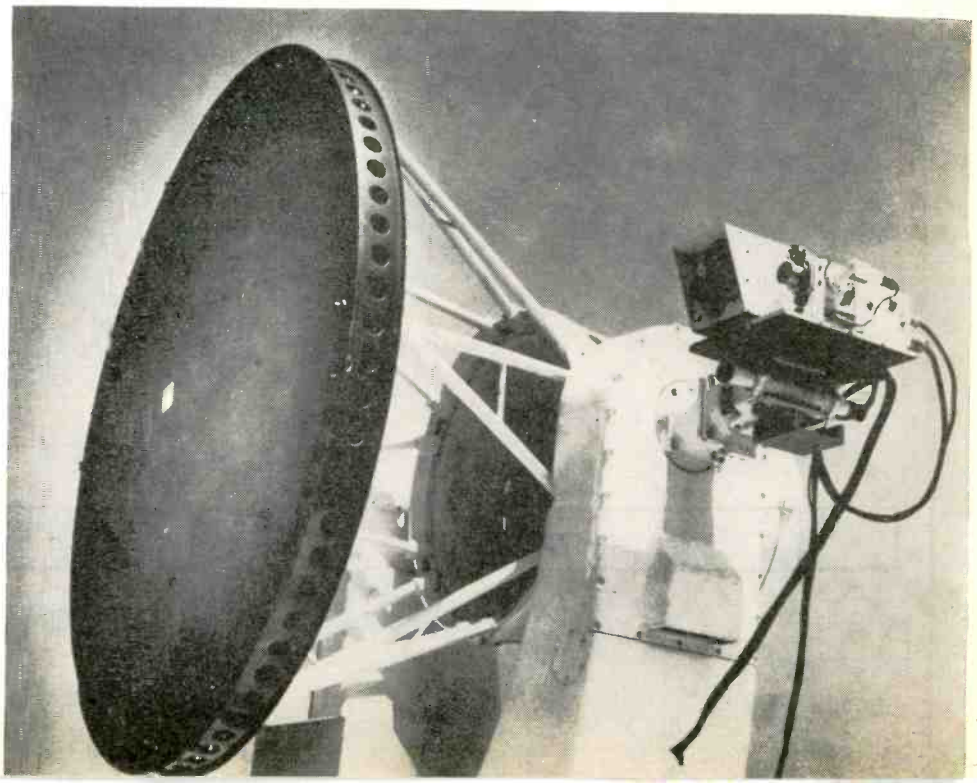


Fig. 3. High-resolution infrared tracker installed at Patrick Air Force Base. Photo shows extreme compactness of infrared system compared to antenna of tracking radar on which it is mounted and with which it moves. See text for details.



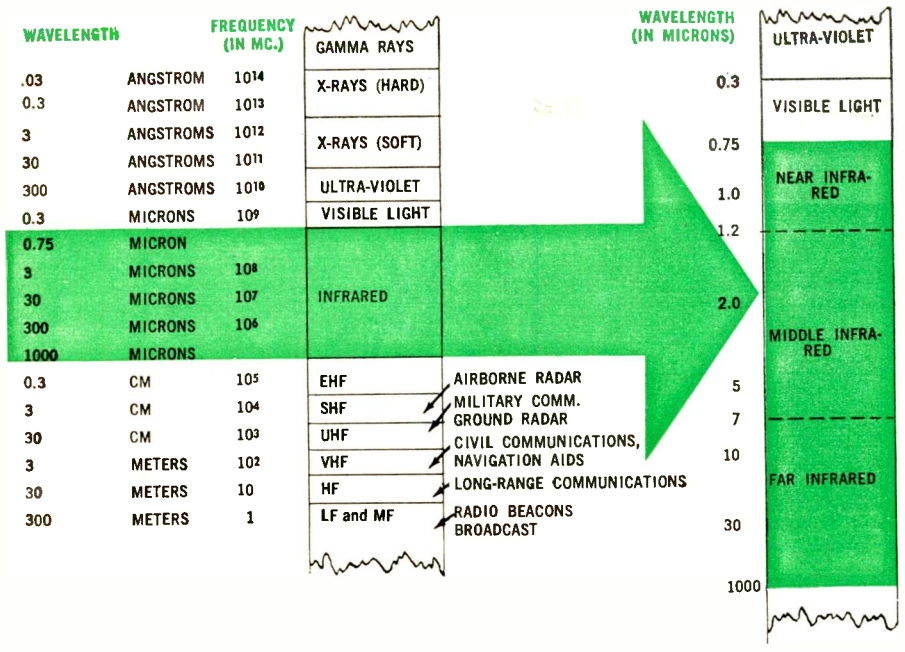


Fig. 4. Diagram of the known electromagnetic spectrum showing the near, intermediate or middle, and far infrared bands located between visible light and microwaves.

temperature is lowered. At the lowest temperature possible (−273°C), all molecular motion stops. Since all molecules are made up of electrical charges, the oscillations of these molecules cause the radiation of electromagnetic energy. The intensity, frequency, and wavelength of this electromagnetic energy are controlled by the temperature and size of the source and by an interesting property known as the *emissivity* of the material.

When the electromagnetic energy emitted by a source reaches another body, part may be reflected, part may be transmitted, and part may be absorbed to cause heating. Thus infrared radiation is intimately connected with heat, but cannot itself be called heat waves, because it is fundamentally similar to radio waves and light and can be transmitted through vacuum. Other means of heat transmission, such as conduction and convection, require physical media, such as air, or physical contact between the source and the receiver.

The standard used in infrared work is the "black body." The black body is an ideal emitter for which the total radiated energy and the spectral distribution of this energy are known. Since the black body is an ideal, it provides only a theoretical relationship between the temperature and radiation. In order to measure practically the relation between temperature and radiation, we need a practical black body which simulates the desired characteristics. Black-body simulators are usually electrically heated, insulated cavities with small apertures. The black-body simulator and its precision temperature controller comprise a radiation reference source that links measurable temperatures and emitted radiation.

The infrared energy radiated by a black body covers a wide range of frequencies and wavelengths. The wavelength at which the maximum or peak radiation occurs is determined by the temperature of the black body as shown in Fig. 2. As the temperature increases, the peak radiation shifts to shorter wavelengths and the total amount of the radiated energy increases.

Emissivity is an extremely important property. It is defined as the ratio of the radiation emitted by an object to the radiation that would be emitted by a black body at the same temperature. The emissivity of a black body is 1 and the emissivity of all practical materials is less than 1. This property depends on the material and its finish. Dielectrics and insulators in general have high emissivities and metals and other conductors have low emissivities. Polished surfaces have lower emissivities than matte surfaces. The emissivity of a mirrored silver surface is approximately 0.02 and the emissivity of matte lampblack is about 0.95.

Transmission of Infrared

All electromagnetic radiation is transmitted in accordance with the inverse-square law. This states that the intensity of the energy radiated by a source varies inversely as the square of the distance from the source. Thus the energy at 2 miles from a source would be ¼ of the energy which would exist at a distance of 1 mile from the source. These statements hold true only in a vacuum and do not take into account the effect of the atmosphere.

The atmosphere modifies the transmission of infrared radiation quite markedly. Over short distances, such as used in measuring radiation in laboratories, atmospheric attenuation is negligible. However, over the greater distances which separate military infrared devices from their targets, the problems of infrared transmission through the atmosphere become rather serious.

Atmospheric attenuation is caused by water vapor, carbon dioxide, and other gases present in the air, as well as by particles of dust and other substances. There is less attenuation at increasing altitude and especially with lowered water content. The reason for this is that the atmosphere becomes thinner at higher altitudes; so that at altitudes above about 100,000 feet there is comparatively little attenuation. At still greater altitudes, such as those traversed by satellites, atmospheric attenuation of infrared is almost non-existent, because the atmosphere itself is almost non-existent. As shown in Fig. 5, the atmosphere does not absorb all infrared wavelengths uniformly. Instead most absorption occurs quite definitely at the wavelengths at which

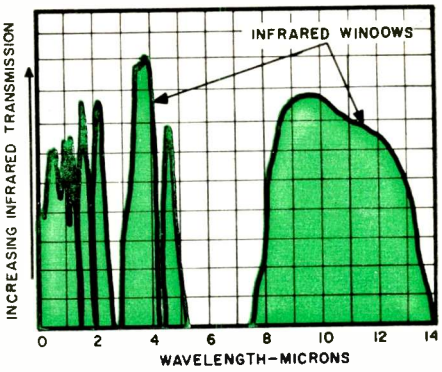


Fig. 5. The atmosphere does not transmit infrared uniformly at all wavelengths. Windows are regions of high transmission.

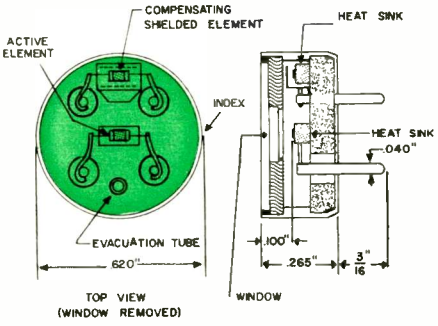
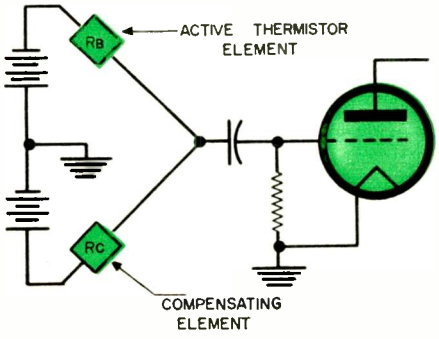


Fig. 6. Construction of typical thermistor bolometer detector. The "active" flake is mounted so that it can be exposed to radiation, while the "compensating" flake is shielded from radiation and is used to keep arrangement balanced.

Fig. 7. Circuit of the thermistor bolometer bridge, showing preamp coupling.



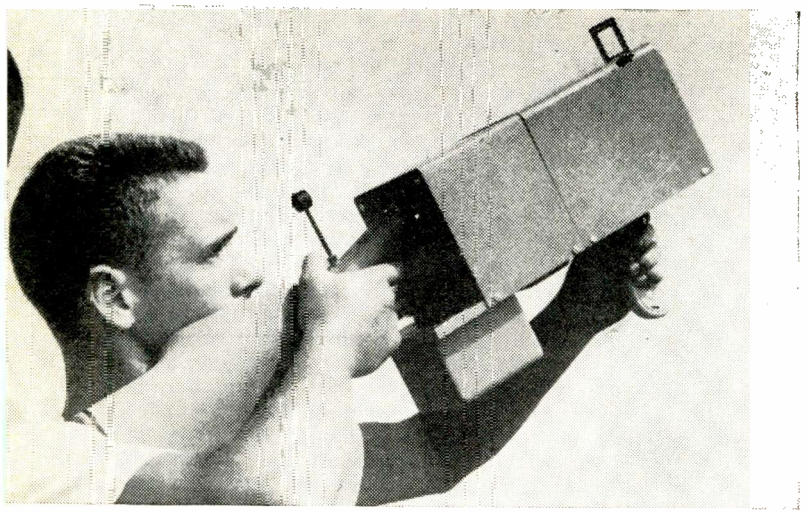


Fig. 8. Hand-held radiometer is employed to measure radiation from intercontinental ballistic missile re-entering atmosphere.

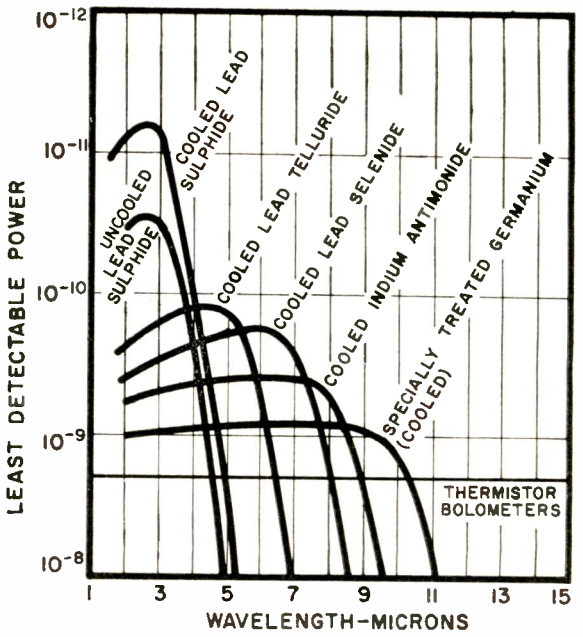


Fig. 9. Curves shown at the right illustrate the relative sensitivities of various infrared detectors in common usage.

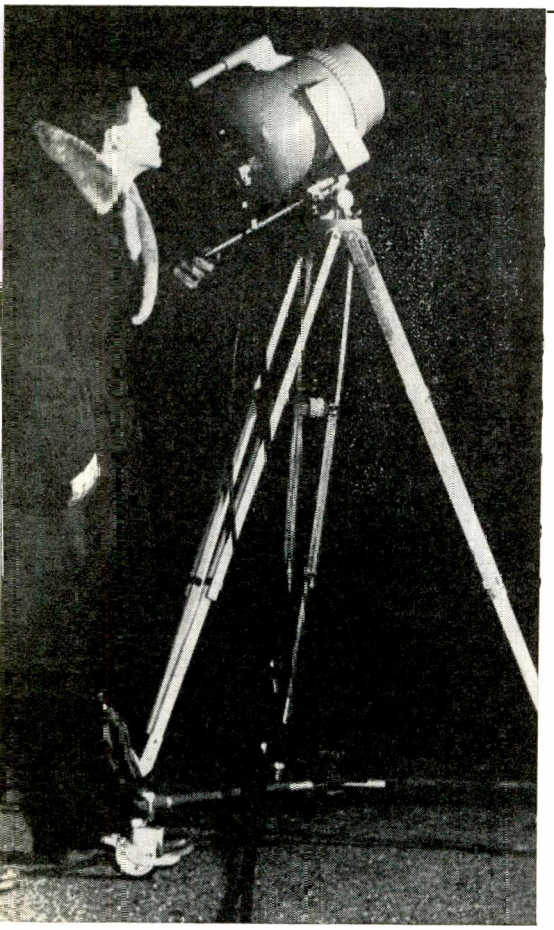
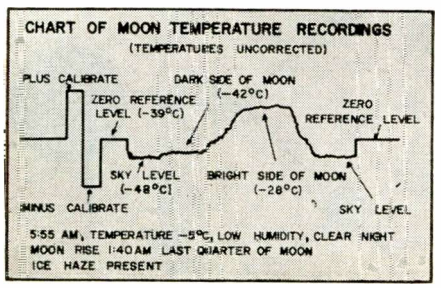


Fig. 10. Measuring moon's temperature (above) along with chart of actual recording.



the molecules of water vapor, carbon dioxide, and other atmospheric gases resonate and absorb energy from the infrared radiation which passes through. This highly selective absorption of infrared radiation causes a "window" effect. These windows occur at wavelength regions where absorption by carbon dioxide and water vapor is at a minimum. Depending upon altitude and weather conditions, these windows can be used by employing filters which transmit only at the window wavelengths.

The principles described so far are fully exploited in modern infrared equipment that is able to perform near miracles of accurate tracking and detection at close ranges. Such equipment uses both the sciences of optics and electronics to do its job. Now let us probe a little deeper into the details of the type of components and systems needed in this type of equipment and its expanding applications.

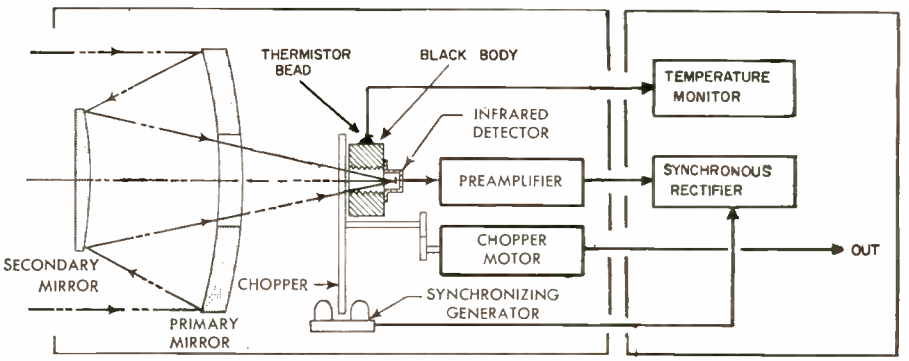
Optical Systems

Most infrared devices use special optical systems along with special detectors. The performance of infrared detectors improves as the detectors are made smaller. Therefore very small detectors are used (on the order of 1 millimeter by 1 millimeter square) and the radiation lost because of this tiny size is recovered by placing the detector at the focal point of an optical collecting system. The field of view, or that portion of space which is seen by the detector, is determined by the area of the detector and by the diameter and focal length of the optical system. Optical systems in infrared are like antennas in microwave receivers. The optical gain of an optical system is equal to the ratio of its effective area to the effective area of the detector. Gains of 20,000 times or more are easily obtained with compact optical systems; such optical gain is completely free of the noise which is characteristic of electronic amplification.

Between the source and the detecting device there is not only the atmosphere and one or more optical systems, but infrared-transmitting elements such as windows or domes in airplanes to shield or protect infrared devices from high-speed air currents.

When radiation strikes solid materials, some of it may be reflected, some may be absorbed, and some may be transmitted. For example, glasses transmit most of the visible energy which impinges upon them; they reflect less, and absorb still less. The

Fig. 11. The block diagram shown below is that of a basic radiometer system.



properties of glasses and most other materials are usually quite different at infrared wavelengths than they are at visible wavelengths. Many materials which are transparent in the visible spectrum are opaque to infrared wavelengths; while some substances which are opaque to the visible are transparent to infrared wavelengths. Most glass transmits up to 2.0 or 2.5 micron, just beyond the visible spectrum. Quartz transmits out to about 4 microns. Rock salt and potassium bromide, which transmit out to 15 and 40 microns respectively, have been used for many years in instruments such as infrared spectrometers. During and since World War II, new materials have been developed and the long-wavelength properties of older materials have been discovered. These materials include the German-developed KRS-5, arsenic trisulfide, sapphire, magnesium oxide, high-purity germanium and silicon, indium antimonide, and certain new glasses. While many new materials with remarkable infrared properties are yet to come, there is a wide enough variety of existing materials to permit the design of new scientific instruments, industrial devices, and military systems.

To eliminate as a factor from optical systems the infrared transmission properties of materials, front-surfaced mirrors are used. Mirrors uniformly reflect wavelengths from ultraviolet out through the far infrared. They are unlike lenses, in this regard, since these do not transmit radiation equally at all wavelengths. A large number of high-performance optical mirror systems are in use in infrared equipment; many of them were developed earlier for astronomical telescopes.

Infrared Detectors

Infrared detectors are used to obtain information from radiation picked up by infrared gear. Such a detector converts incident radiant energy into another form of energy which can be displayed and/or measured. The outputs most frequently used are electrical signals, which can easily be processed, displayed, and measured. Since two of the major effects of radiation on matter are the thermal effect and the photoelectric effect, the two major groups of radiation detectors are thermal detectors and photodetectors.

Thermal detectors respond to heating effects which are usually caused by infrared radiation of longer wavelengths. Thermal detectors are power detectors: their output is proportional to the total energy of the absorbed radiation. These detectors are usually blackened to increase the absorption of incident radiation and to reduce reflection and transmission. Thermal detectors make use of the thermal effects of radiation in several ways. Thermocouples and thermopiles employ the effect whereby voltages are generated when junctions of dissimilar metals are heated. Pneumatic cells employ the expansion of gases heated by radiation to move diaphragms. Bolometers employ the changes in resistance of solids when heated or cooled.

An extremely important group of thermal detectors are thermistor bolometers. Thermistors are heat sensitive resistors which exhibit large changes of resistance with temperature. When used as radiation detectors, they are made in small and very thin flakes and are solidly backed by heat sinks of high thermal conductivity for fast response to changes in radiation. A thermistor bolometer is constructed by using a closely matched pair of such flakes in an arrangement like that shown in Fig. 6. The detector assembly is quite rugged and resistant to the vibration, shock, temperature variations, high humidity, and other extreme environmental conditions found in industrial and military applications.

The bolometer is usually operated in a bridge circuit as shown in Fig. 7, with the two flakes equally and oppositely biased. The output terminal, which is the junction of the two flakes, is thus maintained near ground potential to reduce noise and microphonics. Since the two flakes are closely matched, there is little voltage drift of the output terminal with changes in ambient temperatures. When the bolometer is exposed to radiation, the active flake is heated; its temperature rises, and its resistance decreases. Since the compensating flake is shielded, its resistance is unaffected by the radiation. The output voltage at the junction of the two flakes therefore changes by an amount which is precisely proportional, over a tremendous dynamic range, to the power of the incident radiation.

Photodetectors respond to infrared radiation of shorter wavelengths. Fig. 9 shows that while thermal detectors respond almost equally to radiation at all wavelengths, most photodetectors have some long-wavelength limit be-

(*Continued on page* 151)

COVER STORY

OUR cover and Fig. 3 show a high-resolution infrared tracker in use at the Air Force Missile Test Center's firing range, Cape Canaveral, Patrick Air Force Base. It was developed and installed for the U.S. Air Force by Barnes Engineering Company of Stamford, Connecticut. A recent launch of an "Atlas" is shown. The equipment is used to track missiles during launching and early flight. It provides the range safety officer with the information he must have to prevent the missile from passing outside the firing range limits as well as providing very important trajectory data to missile designers.

These vital functions cannot be accomplished by other existing equipment. During launching and early flight, radar screens are completely cluttered by multiple reflections from surrounding structures and from the ground itself. Optical and photographic equipment frequently cannot be used because of the enormous amounts of obscuring dust and smoke that are present.

Considering the functions it performs, the infrared tracker is extremely compact: the photos clearly show the size of its optical head compared to the radar antenna upon which it is mounted. The weight of the optical unit is only 22 pounds; a small control panel and oscilloscope display unit are mounted inside the radar van.

In use, the tracker is trained upon the missile before take-off. Then the exhaust flame appears, the tracker locks onto it and automatically follows the flame throughout powered flight, to ranges in excess of ten miles. As the missile attains high altitudes and long ranges, tracking is manually or automatically switched to the radar, which is used only for such long-range tracking. The infrared tracking is so precise that, in the display unit of the closed-circuit TV system, provided as an accessory to the tracker, the missile flame remains locked at the exact center of the screen. If tracking is purposely deflected by the operator, the infrared system quickly re-acquires the target and brings it back to the center of the screen.

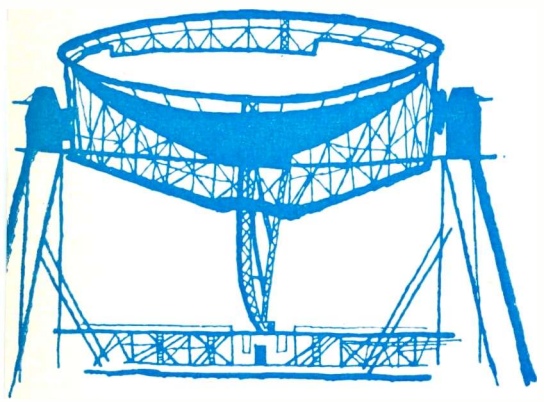
The infrared tracker supplies electrical azimuth and elevation signals to a tracking servo system. In addition, it provides similar signals to its own display system, which graphically shows the operator the accuracy with which tracking is being performed both by the infrared and radar systems. The tracker has a 4° x 4° acquisition field. Once a target is brought within this field, the tracker generates coarse azimuth and elevation error signals to drive the tracking servo at maximum slewing rate and to bring the target rapidly to the center of the field of view. When the target enters the central (3 mil x 3 mil) field of view, proportional control azimuth and elevation signals are transmitted to the tracking servo. The tracker is quickly centered on the target and tracking continues with an accuracy of 0.25 angular mil (1 angular mil = 1/6400 of 360°) or better. There is less than 400 microseconds delay between the time that a tracking error takes place and a proportional correcting signal occurs. This assures accurate tracking of high-speed evasive targets.

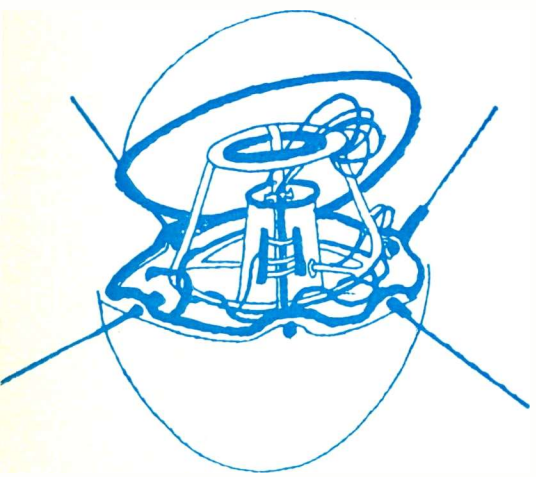
The tracker is of such light, compact, and rugged construction that it is suitable for use in aircraft. In such installations it can be used to track missiles, drones, and other aircraft in flight with an accuracy many times superior to radar. In aircraft or on shipboard the tracker can be used as downrange equipment to track the re-entering nose cones of missiles, because sufficient heat is generated by re-entry to provide adequate infrared energy for tracking. -30-

(Cover: Official U.S. Air Force photo)

IGY an eighteen-month report

The recently concluded "International Geophysical Year" was an outstanding example of the tremendous results which can be achieved when nations band together to tackle a common problem. The data obtained during IGY holds out hopes for a safer, more comfortable future for us and our descendents.





AS the Old Year drew to its close so did the massive cooperative scientific project known as the "International Geophysical Year"—a period which actually covered eighteen months. Although formally "closed," many of the projects and accumulation of data will continue on a semi-permanent and/or permanent basis.

Some 30,000 scientists and technicians in 66 countries contributed to this unprecedented program of global observation and experiment, seeking greater understanding of the earth's interior, oceans, atmosphere, and the space around it. There were 4000 principal stations scattered throughout the globe with several thousand additional temporary and volunteer sites and stations which could be called upon for specific data.

It has been estimated that the U. S. contribution to the program entailed an expenditure of about $100,000,000 excluding logistic support. The world-wide program may have cost about $750,000,000. Including logistic support, the total effort may bring this total up to a billion and a half dollars!

What did this vast sum "buy"? Although it may be years before all the results can be completely evaluated, certain findings have emerged which are of immediate interest and application.

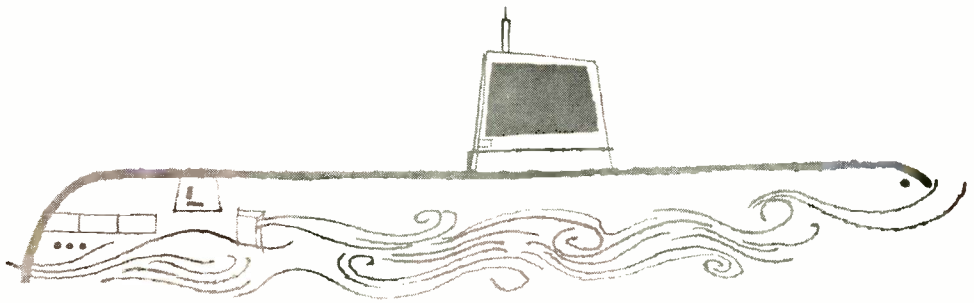
Constant surveillance of the sun during the greatest activity in its known history permitted the calling of about 40 world-wide "alerts" during which scientists intensified their observations of the many and varied effects of great solar flares. The scientists were able to collect unprecedented data on the interrelationships of upper atmosphere phenomena when the earth passed through a remarkably intense solar cloud on February 11, 1958 causing the best-observed aurora in history. They also had the opportunity of observing the first man-made aurora in history at Apia, Samoa on August 1, 1958—a phenomenon evidently related to nuclear testing at the time.

Electronics & Radio

In the field of electronics and radio propagation several interesting effects were noted which may serve as new transmission media in the future. The fact that a variety of rockets was available to researchers—both as test instruments themselves and as vehicles for launching satellites and other high-altitude equipment—cannot be underestimated. That so much new and interesting data is now available can be directly attributed to the fact that these giants, basically military weapons, could be harnessed to the gathering of vital facts about the upper atmosphere.

Probably one of the most significant on-board satellite experiments appears to be the work of Dr. James A. Van Allen of Iowa in establishing the existence of *equatorial electrojet,* a narrow band girdling the earth's magnetic equator and flowing eastward when the sun is overhead. Data obtained from balloon rockets sent through the electrojet seemed to indicate that the jet consists of two currents, one atop the other. The lower extended from 60 to 69 miles above the earth while the bottom of the second current was 73 miles above the earth with the top of the band out of the range of the "rockoons." This radiation was interpreted as corpuscular in nature and lead to the conclusion that this great radiation belt around the earth consisted of charged particles, temporarily trapped in the earth's magnetic field. The scientists conjectured that the aurora is related to this trapped radiation and is caused by particle leakage from the belt. This suggests that solar plasma is the source of particles. These studies, combined with other results obtained during IGY, begin to relate a variety of atmospheric and spatial phenomena in an exciting and meaningful way, suggesting that major advances are in the process of being made and formulated.

Also of interest were the special studies made regarding the nature of the ionosphere close to the geographical poles during periods of prolonged solar absence. At the South Pole Stations, for instance, the ionosphere is subjected to extended exposure and to solar ionizing radiations during the long summer day while it is screened for several months during the polar night. This phenomenon might be considered to have an adverse effect on year-around communications—such as the two-way radio service required by the trans-polar flights of commercial aircraft. Surprisingly enough, the IGY investigators found that the ionization reached a summer saturation of about 4.5×10^5 electrons per cubic centimeter which was capable of supporting trans-polar communications up to 22 mc. Throughout the winter night it was



found that the F-layer persists but that this usually rather uniform layer appeared to break up into cloud formations. Despite this, a density of 2×10^5 electrons per cubic centimeter—a typical reading—was sufficient to support trans-polar communications up to 14 mc. in the absence of ionospheric storms.

Considerable work was also done on the subject of backscatter—both that requiring reflections continuously from large regions and that where reflection geometry requires the backscatter oblique-incidence technique. Analysis of the data obtained revealed that tilts in the F-region permit radio-wave propagation over great distances without ground reflections. Tilts or horizontal gradients allow the propagation of radio waves over long distances by successive reflections from the curved F-layer until a particular tilt directs the energy to earth. Propagation over distances in excess of 6000 miles was a frequently observed phenomenon.

Another interesting project concerned "whistlers." The data gathered seems to point to a marked dependence on the frequency of occurrence from place to place. Activity appeared to increase northward from none at all at Huancayo, Peru up to Hanover, N. H., where a variety of very-low-frequency phenomena were recorded, and then diminishes nearly to the vanishing point at Frobisher Bay and Thule, Greenland.

Another group reported a peculiar signal enhancement on a 49.84 mc. circuit operating between the Philippines and Okinawa—a circuit which had been set up to measure sporadic-E. The enhancement of the signal strength commenced about 2 hours after sunset and continued until about midnight, being particularly strong during the autumnal equinox. This phenomenon seemed to be attributable to F-region scatter. Studies carried out on the circuit seemed to indicate F-region reflections from the path midpoint at 187 miles. The returned echo appeared to be similar to those returned from extensive aurora curtains and may represent blobs of ionization oriented along the earth's magnetic field.

Other Results

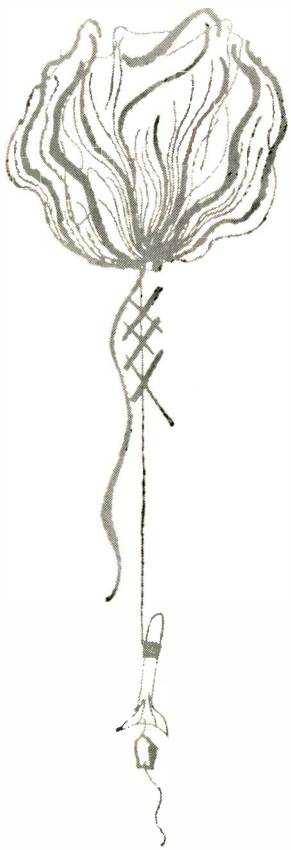
Among other results obtained by the scientists was evidence that magnetic fields associated with sunspots revealed them to be as much as 8000 times greater than at the earth's equator; that the cosmic-ray intensity cycle runs opposite to and somewhat behind the sunspot cycle; while the existence of magnetic fields in space was due to the fact that cosmic rays do not approach the earth's magnetic field as expected but instead show a bias to the west; and that radio signals caused by lightning flashes curve far out through space to the opposite hemisphere, indicating the existence of an ionized medium in space denser than anticipated and possibly consisting of the sun's corona—greatly attenuated.

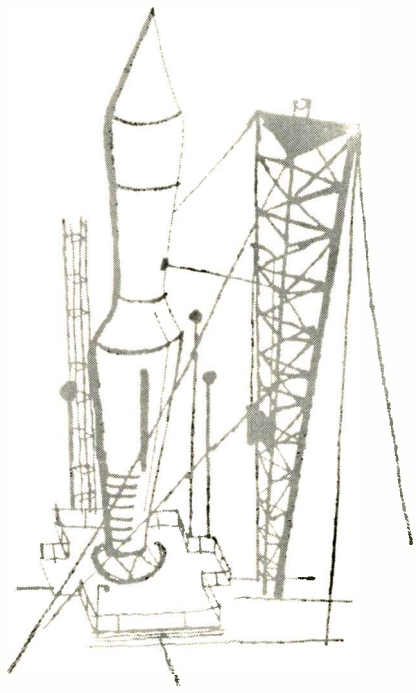
Information gathered by the satellites in orbit during the period the IGY studies were under way revealed that the interior satellite temperatures were controllable within limits of easy human tolerance and that micrometeorite density was not the problem originally anticipated. Such satellite observations suggested that the upper atmosphere is at least ten times denser than previously thought on the basis of ground observations. The satellite trackers detected an antipodal "echo" of satellite signals, coming from the side of the earth opposite the satellite, due to the unexpected "ducting" of the signals by the ionosphere.

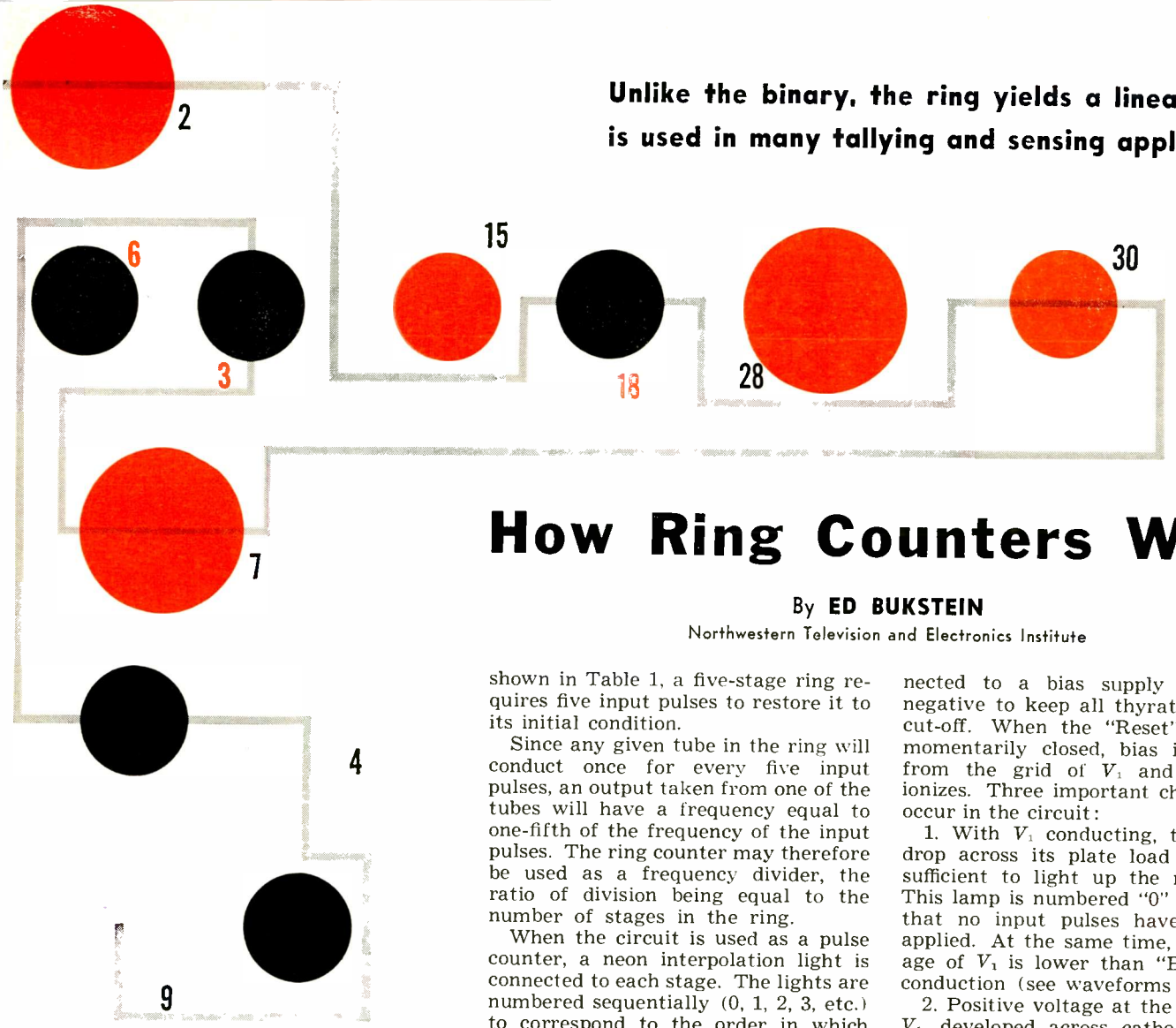
In the weeks, months, and even years that lie ahead, scientists throughout the civilized world will be referring to the reams of priceless data patiently garnered by thousands of skilled specialists stationed throughout the globe—from the icy wastes of the arctic to the steaming jungles of the tropics. The information they have been able to collate from instruments soaring high above the earth's surface and miles down on the ocean floor promises a better and more comfortable existence for mankind—both in our generation and in the future.

Improved radio communications, more knowledge about weather forecasting, more information about the space surrounding our earth in preparation for putting man in space will all grow out of some of the IGY findings.

An additional bonus in the form of freely extended international cooperation between "traditional enemies" may have a far-reaching effect which can't be evaluated on the data-processing machines but may make itself felt in the slackening of international tensions and a freer exchange of data among the world's scientists. —30—







Unlike the binary, the ring yields a linear count; is used in many tallying and sensing applications.

How Ring Counters Work

By **ED BUKSTEIN**
Northwestern Television and Electronics Institute

INPUT PULSES	STAGE CONDUCTING	STAGES CUT OFF
Start	1st	2nd, 3rd, 4th, 5th
1	2nd	1st, 3rd, 4th, 5th
2	3rd	1st, 2nd, 4th, 5th
3	4th	1st, 2nd, 3rd, 5th
4	5th	1st, 2nd, 3rd, 4th
5	1st	2nd, 3rd, 4th, 5th

Table 1. Sequence of switching action in a five-stage ring-counting circuit.

THE RING counter, as the name implies, consists of a number of stages connected as a complete ring or loop. Initially, one of the stages is conducting and all other stages are cut off. When an input pulse is applied to the circuit, the stage previously conducting is driven to cut-off and the following tube in the ring becomes conductive. Since the conducting condition advances around the ring one stage at a time, the circuit is sometimes referred to as a *linear* counter.

Table 1 shows the switching actions which occur in a five-stage ring counter. Because each input pulse transfers the conducting condition to the following stage of the ring, the number of input pulses required to restore the circuit to its initial condition is equal to the number of stages in the ring. As shown in Table 1, a five-stage ring requires five input pulses to restore it to its initial condition.

Since any given tube in the ring will conduct once for every five input pulses, an output taken from one of the tubes will have a frequency equal to one-fifth of the frequency of the input pulses. The ring counter may therefore be used as a frequency divider, the ratio of division being equal to the number of stages in the ring.

When the circuit is used as a pulse counter, a neon interpolation light is connected to each stage. The lights are numbered sequentially (0, 1, 2, 3, etc.) to correspond to the order in which they light up when input pulses are applied. Mounted on the front panel of the instrument, the lights therefore provide an indication of the number of input pulses.

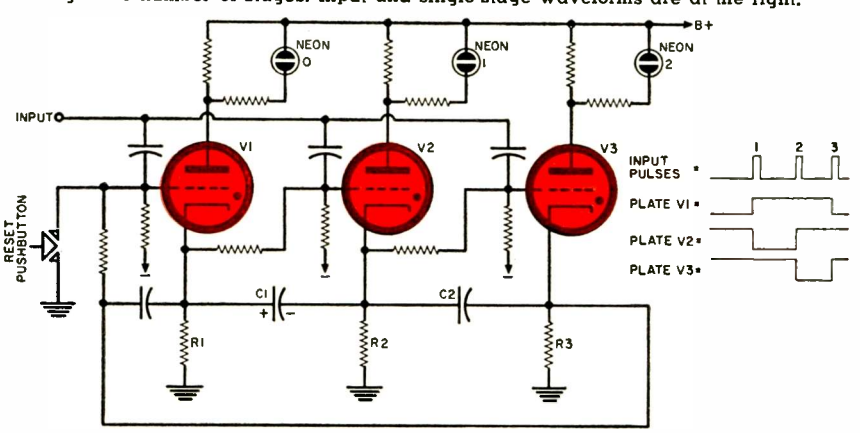
So much for *what* the ring counter does. We may now consider *how* it performs its function. The circuit diagram of a ring counter using thyratron tubes appears in Fig. 1. For simplicity, only three stages are shown, but the circuit can be extended to include a greater number. The grid of each stage is connected to a bias supply sufficiently negative to keep all thyratrons below cut-off. When the "Reset" switch is momentarily closed, bias is removed from the grid of V_1 and this tube ionizes. Three important changes now occur in the circuit:

1. With V_1 conducting, the voltage drop across its plate load resistor is sufficient to light up the neon lamp. This lamp is numbered "0" to indicate that no input pulses have yet been applied. At the same time, plate voltage of V_1 is lower than "B+" during conduction (see waveforms of Fig. 1).

2. Positive voltage at the cathode of V_1, developed across cathode resistor R_1, causes capacitor C_1 to charge to the polarity shown. Charging electrons flow up from ground through resistor R_2.

3. A portion of the positive voltage at the cathode of V_1 is applied to the grid of V_2 through a dropping resistor (see Fig. 1). The circuit is designed so that this voltage is *not* quite enough to overcome the negative voltage keeping V_2 cut off. However, this positive voltage is enough to cancel out most of the cut-off bias, so that V_2 is now just be-

Fig. 1. A thyratron ring counter using three stages. The tubes ionize in succession as input pulses are applied. The circuit may be extended to a greater number of stages. Input and single-stage waveforms are at the right.



low the point at which tube will fire.

So much for the initial conditions. If a positive pulse is now applied to the input terminal of the entire circuit, the second tube in the ring (V_2) will become conductive, the tube previously conducting (V_1) will become cut off, and the final tube (V_3) will remain cut off. This action occurs as follows:

1. Since initial circuit action biased V_2 just below the firing point, it will ionize when the positive input pulse reaches its grid.

2. As a result of current drawn by V_2, a voltage drop appears across its cathode resistor, R_2. This voltage, adding in series with the previously accumulated charge on C_1, is applied to the cathode of V_1. The positive potential at the V_1 cathode is now higher than the potential at the V_1 plate. V_1 therefore de-ionizes.

3. Since V_2 is now conducting, the neon lamp in its plate circuit will glow. This lamp is numbered "1" to indicate that one pulse has been applied to the entire circuit.

4. The input pulse has not been strong enough to overcome the high negative bias of V_3 (see waveforms of Fig. 1 for conditions of plate voltage at all three tubes). However, a portion of the positive voltage at the cathode of V_2 is now applied to the grid of V_3, biasing it, in turn, just below its firing point. Also, capacitor C_2 is charged by current flowing up from ground through R_3.

The circuit action already described continues from stage to stage successively as each pulse is applied. Because V_3 is biased just below the firing point, it will ionize when the next positive pulse is applied to the input terminal.

corners that may result if the stray capacitance of the circuit is excessive. It is of interest to note that an output taken from the plate of *any* of the tubes will have a frequency that is one-third the frequency of the input pulses.

Because the ring-of-three circuit has three stable states, it is sometimes referred to as a *ternary* circuit. The *Walkirt Co.* ternary counter shown in Fig. 2 uses vacuum tubes and is therefore capable of higher switching speeds than the thyratron ring counter.

Each plate of this circuit is resistively coupled to the grids of the other two tubes through 270,000-ohm resistors. As a result, only one tube at a time can conduct. When V_1 is conducting, for example, its plate voltage will be low and the grids of V_2 and V_3 will also be at a low potential. Tubes V_2 and V_3 are therefore cut off when V_1 conducts.

The initial condition of the circuit (V_1 conducting) is established by applying a *positive* pulse to the "Reset" terminal. If a *negative* pulse (in this type of ternary) is now applied to the "Input" terminal of the circuit, tube V_1 will cut off and tube V_2 will become conductive. This action occurs as follows:

The negative input pulse is applied, through the plate-load and coupling resistors, to all three grids. Since V_1 is the only tube conducting at this time, it is the only tube affected by the input pulse. Tube V_1 therefore cuts off and its plate voltage increases. This increase is coupled to the grids of V_2 and V_3.

Only V_2 becomes conductive, however, because the coupling to its grid is accomplished through a parallel

(*Continued on page* 158)

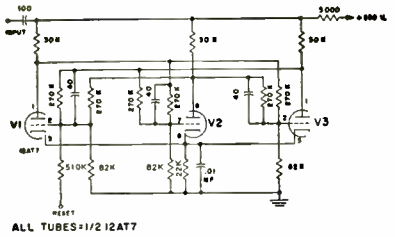
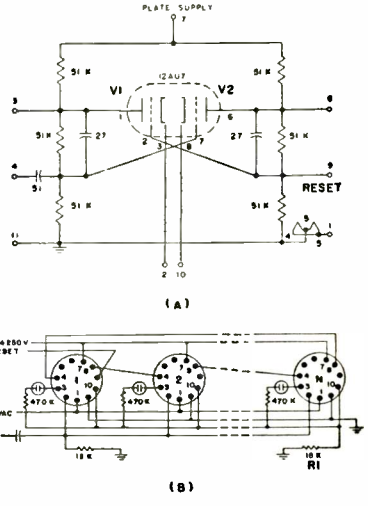


Fig. 2. Each plate in this ternary is connected to the grids of the other tubes so that only one at a time can conduct.

Fig. 3. Each flip-flop stage (A) in this counter is a separate plug-in unit. All are interconnected as in (B).



INPUT PULSES	STAGES 1st	2nd	3rd	4th	5th	6th	7th	8th
Start	0	1	1	1	1	1	1	1
1	1	0	1	1	1	1	1	1
2	1	1	0	1	1	1	1	1
3	1	1	1	0	1	1	1	1
4	1	1	1	1	0	1	1	1
5	1	1	1	1	1	0	1	1
6	1	1	1	1	1	1	0	1
7	1	1	1	1	1	1	1	0
8	0	1	1	1	1	1	1	1

Table 2. Switching action in 8-stage ring circuit of type shown in Fig. 3.

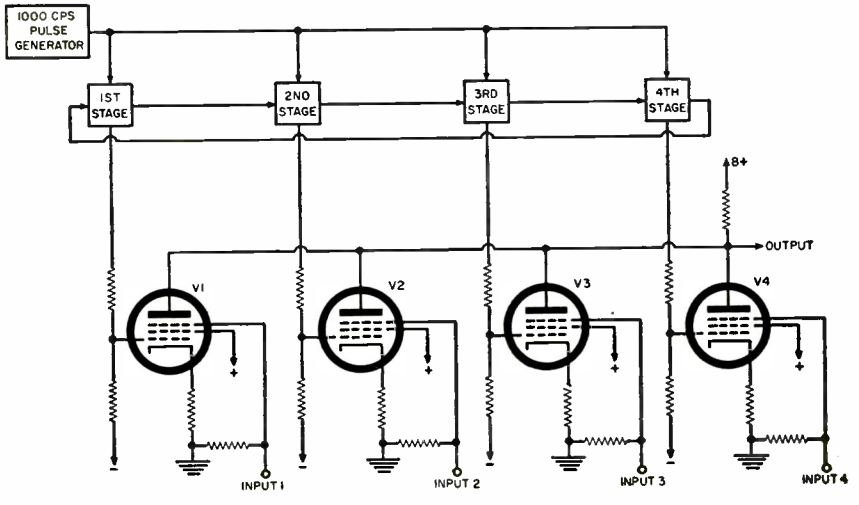
INPUT PULSES	RING STAGES 1st	2nd	3rd	4th	5th	Binary
Start	0	1	1	1	1	0
1	1	0	1	1	1	0
2	1	1	0	1	1	0
3	1	1	1	0	1	0
4	1	1	1	1	0	0
5	0	1	1	1	1	1
6	1	0	1	1	1	1
7	1	1	0	1	1	1
8	1	1	1	0	1	1
9	1	1	1	1	0	1
10	0	1	1	1	1	0

Table 3. Sequence in counter of Fig. 5.

A voltage drop will then appear across resistor R_3 and this drop will add in series with the charge on C_2. As a result, the cathode of V_2 will be more positive than its plate, and V_2 will deionize. Because the next (second) input pulse causes V_3 to ionize, neon lamp number 2 will glow to indicate that two input pulses have now been applied to the input terminal.

Thyratron V_1 follows V_3 in this continuous circle or ring. Accordingly, when the third input pulse is applied, V_1 will ionize and V_3 will return to cut-off. The circuit will now be back to its initial condition. As indicated by the waveforms in Fig. 1, the plate voltage of a thyratron is high when the gas is deionized and low when the tube is conducting. The waveforms are idealized in that they do not show such distortions as the rounding of the leading

Fig. 4. How a ring counter (blocks at the top) may be used to control gate tubes (below). Pulses applied to the gates appear in succession at output.

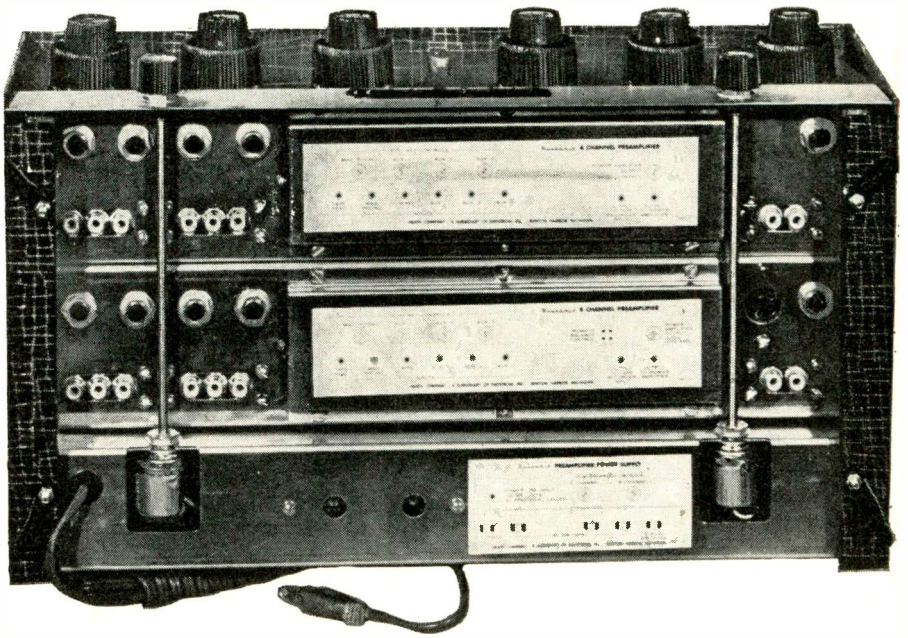


RADIO & TV NEWS
LAB TESTED

Over-all view of the Heath Model SP-2 high-fidelity stereo preamplifier.

a NEW idea in a Stereo Preamp

An unusual design—a monophonic unit now which can be later converted to stereo.



Bottom view of preamp. All of the input and output jacks and level controls are mounted in special areas at the bottom of the unit.

A RELATIVE newcomer to the field of high-fidelity components is the *Heath* Model SP-2 monophonic-stereo preamplifier. There are several unusual features incorporated in this design. As shown above, all of the non-operating controls and jacks are mounted at the bottom rather than the rear as is more conventional. Instead of making all interconnections from the rear, it is only necessary to lift the preamplifier from the front and make the required adjustments and connections. The other feature is more of a convenience for the consumer who would prefer a monophonic system at the present time and probably would like to convert to stereo at a later date.

The *Heath Company* has made available a Model SP-1 which in all respects looks the same as the unit shown at the top of this page but is solely for monophonic use. Instead of dual knobs for the operating controls, single knobs are used. If at a later date stereo operation is desired, a conversion kit (Model C-SP-1) is available. This kit contains all of the necessary components for converting the monophonic unit to the stereo mode.

Another feature which is rather unique is the use of a 20-foot shielded extension cable with a balance control at its end. This makes possible a more accurate balance adjustment between the left and right channels from an ideal position in the listening area. This cable is just an added feature for those who may find it useful. However, it can be removed from the chassis and balance adjustment then made directly at the preamplifier. We disliked the idea of tripping over the cable but must admit that a more accurate balance adjustment can be made from the center of the room than at the preamplifier itself.

As pointed out in previous articles, preamplifiers or master control units require separate power amplifiers to complete a system. This, of course, differs from an integrated set-up where the preamplifier and power amplifier are combined on a single chassis. Since economy was the keynote in the design of this unit, only the basic function controls are provided. Each channel has an eight-position selector switch, bass, treble, level, and loudness control. In addition, a scratch filter for Channel A and a four-position function switch for either monophonic or stereo operation is provided.

There are other preamplifiers on the market at a much higher price which include additional controls or switches not provided in the *Heath* unit. For example, phase reversal, reverse channels, level indicators, special pilot lights, and provision for a third channel are not included in the SP-2. These controls may be considered added con-

veniences that may or may not be required by all users.

Performance

As is customary with units of this type a sample kit was built and tested in our own lab. We were extremely pleased with its performance. The circuit itself is not too unusual. Three tubes are used in each of the two channels with a cathode-follower output stage eliminating the possibility of losses in the interconnecting cable to the power amplifier.

Our test results are as follows:

Frequency Response: ± 3 db from 30 to 15,000 cps with tuner controls mechanically centered. With the controls electrically centered (in our case bass control at 1 o'clock and treble control between 10 and 11 o'clock) the frequency response was ± 1 db for the same range.

Loudness Control: Of sufficient range and provides boosting of both the low and high ends.

Scratch Filter: Effective only on Channel A, giving excellent results. When in the 5-kc. position the output is down .8 db at 5 kc. and 32 db at 10 kc. with respect to the 1 kc. output. In the 7-kc. position the output is down 2 db at 7 kc. and 20 db at 10 kc.

Equalization: Within ± 1½ db of the RIAA standard curve from 30 to 15,000 cps.

Bass Control: −17 db and + 15.2 db at 30 cps at the extreme settings.

Treble Control: −12.5 db and + 14 db at 15 kc. at the extreme settings.

Sensitivity: For 1-volt output, all high-level inputs, .117 v.; microphone, .005 v.; magnetic cartridge, .0007 v.; and tape input, .00104 v.

Hum and Noise: For high-level inputs for both shorted and open input conditions, −54 db. Low-level inputs average −34.3 db for both open and shorted input conditions. These figures are with respect to 1-volt output, at maximum sensitivity. For 6 mv. input *Heath Company* claims hum and noise is down −56 db.

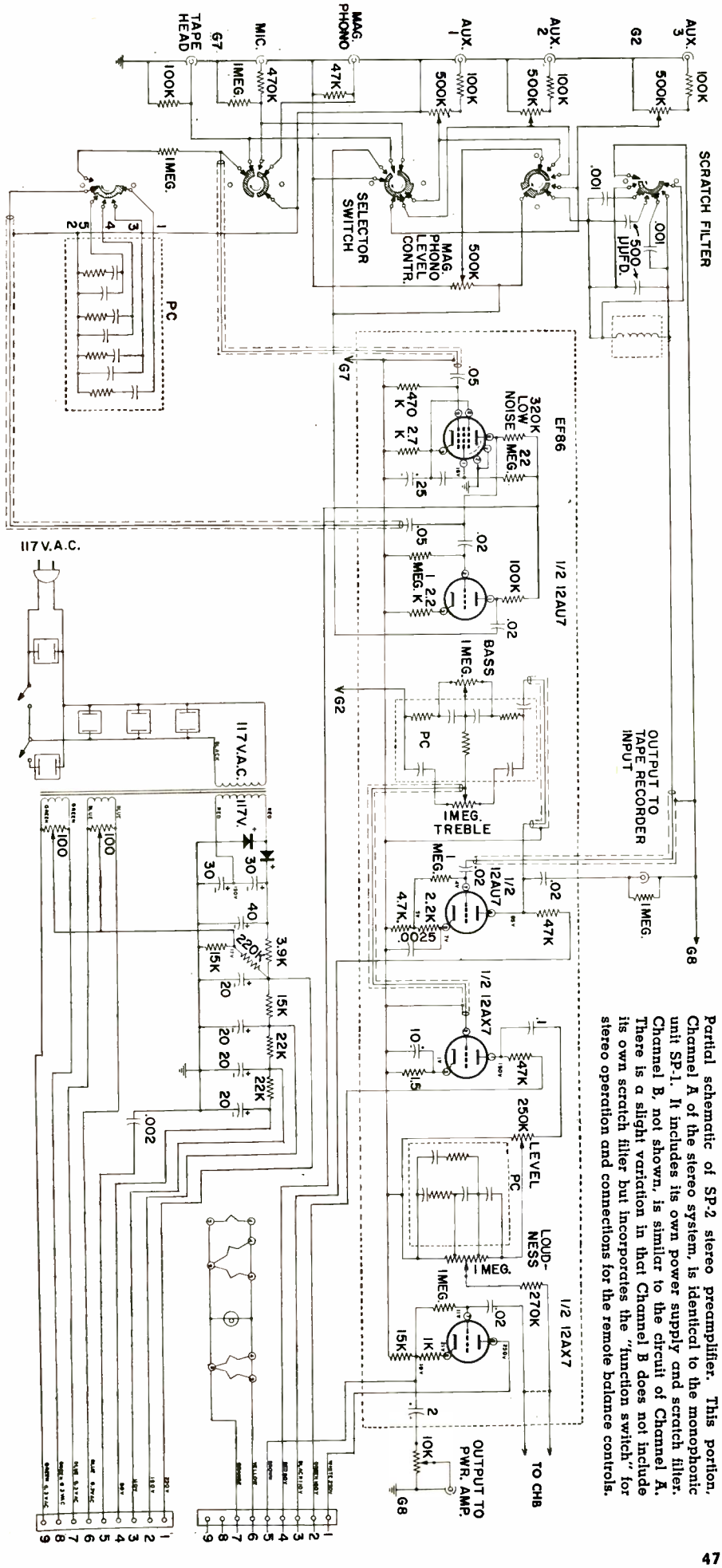
IM Distortion: For high-level inputs, .118% for 1 v. input and 1 v. output conditions; .15% for .5 v. input and 2 v. output conditions.

Harmonic Distortion: .21% at 30 cps; .33% at 1000 cps; and .14% at 15 kc. All of these figures were obtained under operating conditions of .5 volt input and 2 v. output.

Channel Separation: 58 db at 1000 cps.

These are just some of the basic results obtained. The unit proved to be extremely stable and under listening conditions we found that this stereo preamplifier has exceptional performance.

Four individual printed-circuit boards and networks are supplied for each channel which not only simplified the construction but eliminated, to a major degree, possible wiring errors. There is hardly any doubt that if one follows the construction manual supplied with the kit, proper operation is virtually assured. —30—

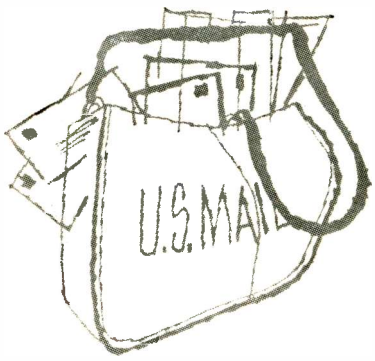


Partial schematic of SP-2 stereo preamplifier. This portion, Channel A of the stereo system, is identical to the monophonic unit SP-1. It includes its own power supply and scratch filter. Channel B, not shown, is similar to the circuit of Channel A. There is a slight variation in that Channel B does not include its own scratch filter but incorporates the "function switch" for stereo operation and connections for the remote balance controls.

PROMOTING a Small Business

By **WILLIAM LEONARD**

Successful promotion for small service dealers is best accomplished with specialized methods.



THE SUCCESSFUL management of any business, irrespective of its size, in our present-day economic system, requires a lot of physical endurance and a good measure of merchandising skill and business acumen. There is a constant parade of small businesses opening and closing in practically every business center. Each of these businesses was started with a great deal of confidence and enthusiasm. When the curtain fell on them at the end of two months, six months, or a year, the disillusioned proprietors had whole batteries of reasons to explain the failures of their ventures. It is seldom that the real reason for failure is included in such a catalogue of excuses.

The controlling factor in the success or failure of any such venture is the volume of profitable business it is able to develop and maintain. In a conventional retail establishment, this means the sale of merchandise. It means the sale of enough merchandise at a sufficient gross profit to pay all of the overhead and operating expenses, and to provide the owner with an adequate salary for himself.

An electronic service business differs from a conventional retail store in that its major commodity is time, knowledge, and skill. Knowledge and skill are intangible products. A customer may marvel at a technician's ability to comprehend the complex wiring of a TV set, yet gripe at paying a reasonable price for that ability to fix her set. While *time* is a very tangible commodity to a service dealer who must pay for it, it has a low dollars-and-cents value in the eyes of the average customer. This also applies to the high cost of the transportation required in providing TV service in the home. In brief, the major income of a service business must be developed from the sale of intangibles that people dislike having to pay for.

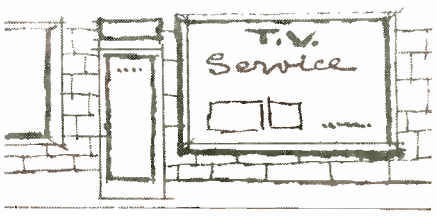
A very interesting facet of human behavior is that we like good showmanship and are inclined to give secondary consideration to the cost of products that are presented to us in an atmosphere of adroit and subtle showmanship. This normal, human factor is quite important in the merchandising of a service business. It is the door to consistently good customer relations when it is woven into the fabric of the everyday operations of an electronic service business.

It is elemental that, while the electronic service industry has sharp seasonal variations, the service dealer must meet his overhead, operating, and living expenses with clock-like regularity fifty-two weeks every year. Where a merchandising-wise retailer can build his cash reserves by pushing the fast-selling seasonal items in his field, the service dealer has only a limited number of hours each day that he can sell. He cannot realize the same percentage of increase in the sale of his time during seasonal booms that the retail merchant can with the specialized products he handles.

Another factor that the service dealer must constantly bear in mind is that the main product he sells—service—is one the average customer neither plans for nor wants to buy. The need for service usually happens unexpectedly. It disturbs the family members because the breakdown may have deprived them of enjoying some of their favorite programs. Also, it may have occurred at a time when the family's cash reserves were at a very low point. These two factors establish the "normal" psychological atmosphere in which the dealer must transact business with his customers.

In the light of its seasonal variations and the psychological factors involved in selling service, it is apparent that some types of promotion and advertising are superior to others in the merchandising of a service business. The limited amount of money the service dealer has available for advertising makes it necessary for him to spend these few available dollars on types of promotions that are especially suited to his type of business.

The most important element in the promotion of any business that deals directly with the public is the appearance and demeanor of the owner and his employees. While a service dealer may feel sometimes that all of his customers are ungrateful chiselers, he must constantly guard against allowing this feeling to creep into his conversation. A technician's personal appearance and the procedure he uses when working on sets in the home may seem unimportant to the technician himself, but they are very important in the set owner's appraisal of what he is getting for the dollars he pays for the service.



The second important element in good sales promotion is the appearance of the business establishment. Does it look like a successful business? People like to deal with successful businesses. The store front and show windows will pay dividends in profitable business if they are utilized intelligently by the service dealer.

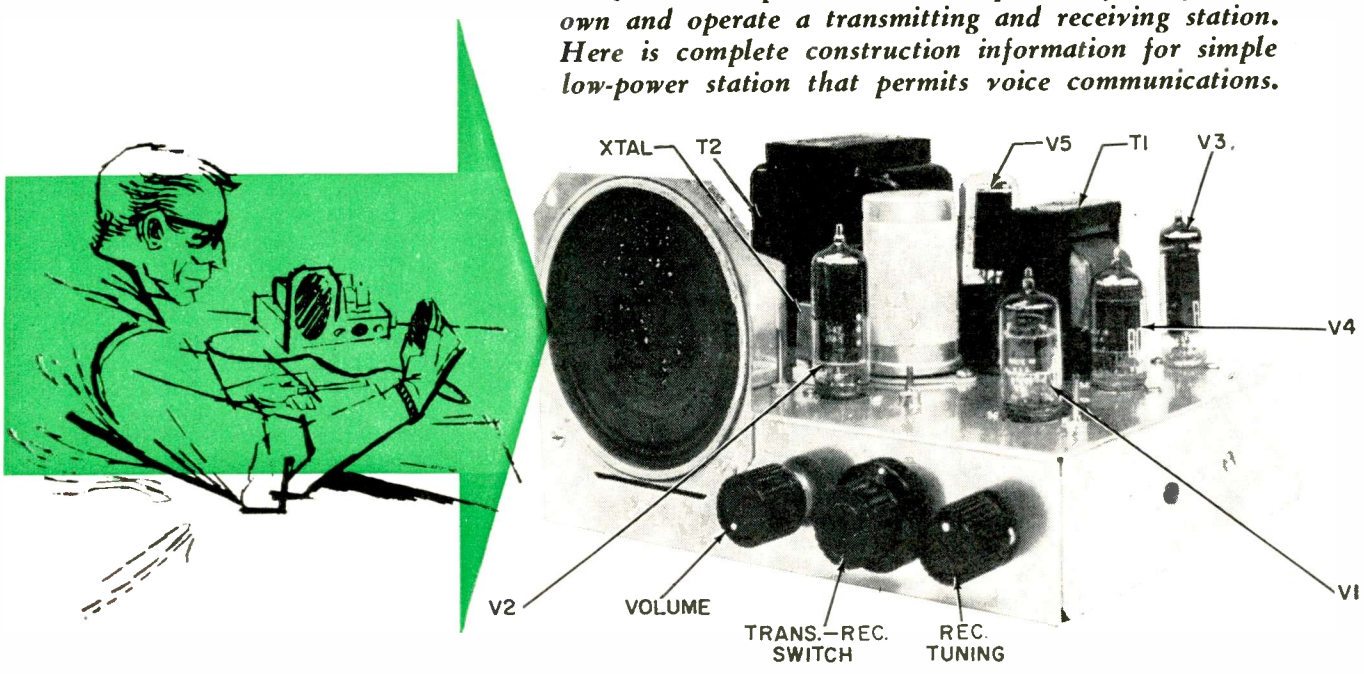
Maintaining a good front is vitally important in promoting service. Included in this good front are the personal appearance and demeanor of the owner and his employees, the use of a studied service procedure in the home, an attractive-looking store front, and window displays that indicate a dynamic, successful business. While these things are not expensive to do, they are elements of merchandising that must be woven into the everyday pattern of the business operation. They can be incorporated into a business only through careful planning of a long-range program.

In this era of intense competition, shifting population, and mass promotions, the owner of any small business must be both an opportunist and an imaginative promotor to keep his name and business facilities before a substantial number of potential customers. Although every home is a prospective customer for TV service on an average of once a year, a dealer must maintain some type of regular communication with them to get a fair share of this business.

(*Continued on page* 161)

By **DONALD L. STONER**

The recent FCC decision to open the 11-meter band for Citizens Band operation makes it possible for anyone to own and operate a transmitting and receiving station. Here is complete construction information for simple low-power station that permits voice communications.



Over-all view of the complete Citizens Band transceiver is shown in this photo.

Build This Citizens Band Transceiver

DID you know that now you can build a radiotelephone transceiver and talk on a short-wave band *without* having to obtain an amateur radio license? The recent FCC decision to open the 11-meter band to Class D Citizens Band operation makes it possible for *anyone* (except those under 18 and aliens) to own and operate a short-wave transmitting and receiving station!

Up to the time of the new ruling, the Citizens Band was located between 460 and 470 mc. If you were operating on this band, you might be fortunate enough to talk clear across the city with the help of lofty antennas at each end of the "circuit"! Not only that, but you *had to* use commercially built equipment. The FCC would not license home-made equipment unless such gear had "type approval." A type approval test would not be made on less than 100 production units. Obviously the experimenter couldn't do this just to get on the air!

The recent 11-meter ruling has changed everything. Hams and SWL's know from experience that signals on the 11-meter band can travel to the far corners of the earth. It is not at all uncommon to hear stations coming in from clear across the country *every day* during the winter and on most days during the summer.

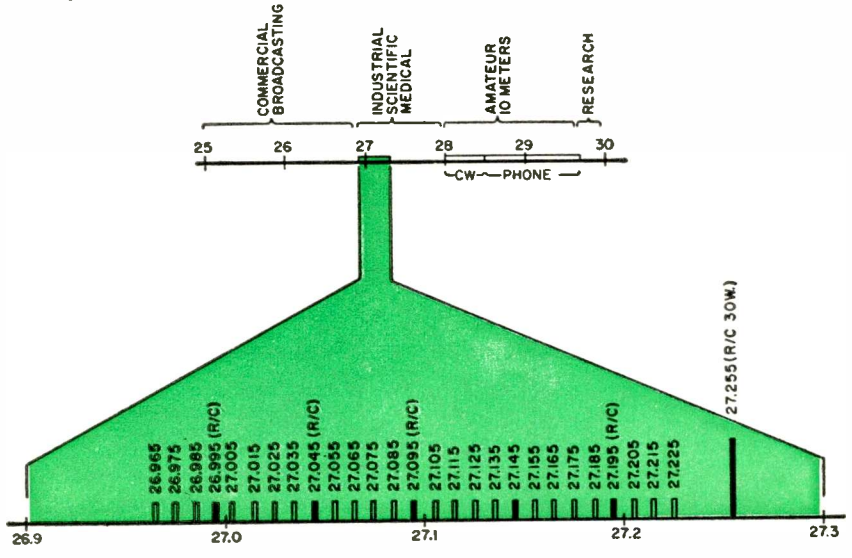
Twenty-two channels have been assigned for voice communication in this new band plus six more for radio-control applications. These frequencies are shown in the chart of Fig. 1.

Although you are limited to a maximum power input of 5 watts, don't "pooh-pooh" this Citizens Band transceiver as a "peanut-whistle." Even with 5 watts, it is perfectly capable of transmitting and receiving over distances of 3000 miles or more when Old Mother Nature has the ionosphere in good working order.

Even though you do not have to go through the rigors of obtaining an amateur license to operate on the 11-meter band, you do have to register your station with the FCC. Obtaining a Class D station permit is merely a formality. Simply send a card or letter to your local FCC field office and request the "Revised Form 505." When you receive this form, fill it out (describing this transceiver) and return it to the Federal Communications Commission, Washington 25, D.C. Do not send the form to the local field office, but directly to Washington. Allow enough time for FCC personnel to process your application and send your permit.

The transceiver uses a total of five tubes. A 12AX7 and a 6AQ5 are used in the combination amplifier and modulator. The transmitter and receiver are simplified to the point where only one tube is used in each circuit. The fifth

Fig. 1. Frequency allocation chart showing the channels in the Citizens Band.



tube, a 5Y3, is used as a rectifier in the power supply. The entire transceiver is built on a 7" x 9" x 2" aluminum chassis and includes the speaker and power supply. The construction of a cabinet (preferably of wood) to house the unit is left up to the builder.

How It Works

The unit is called a transceiver because the power supply and audio amplifier are common to both transmitter and receiver. This type of circuitry conserves tubes and components by making them do "double duty." (Fig. 2)

Eleven-meter signals are picked up on the antenna and fed to the transceiver through a connector on the rear apron of the chassis. One section of the "transmit-receive" switch, S_1, transfers the antenna from the receiving to the transmitting mode.

The receiver is an extremely sensitive one-tube circuit, consisting of a type 6AN8 pentode-triode. The pentode section of the 6AN8 is connected as a radio-frequency amplifier; the triode section of the tube is connected as a superregenerative detector. Even though the circuit is relatively uncomplicated, it is capable of detecting signals as weak as one microvolt. The audio recovered from the detector is applied to the volume control. A regeneration control (on the rear apron) sets the proper operating point for the detector and is adjusted for maximum sensitivity.

A small portion of the audio-frequency voltage on the volume control, R_{17}, is fed to the audio-frequency amplifier which consists of one half of a 12AX7 as a voltage amplifier and a 6AQ5A power amplifier. These two stages amplify the audio output of the detector to a level that is sufficient to operate the speaker.

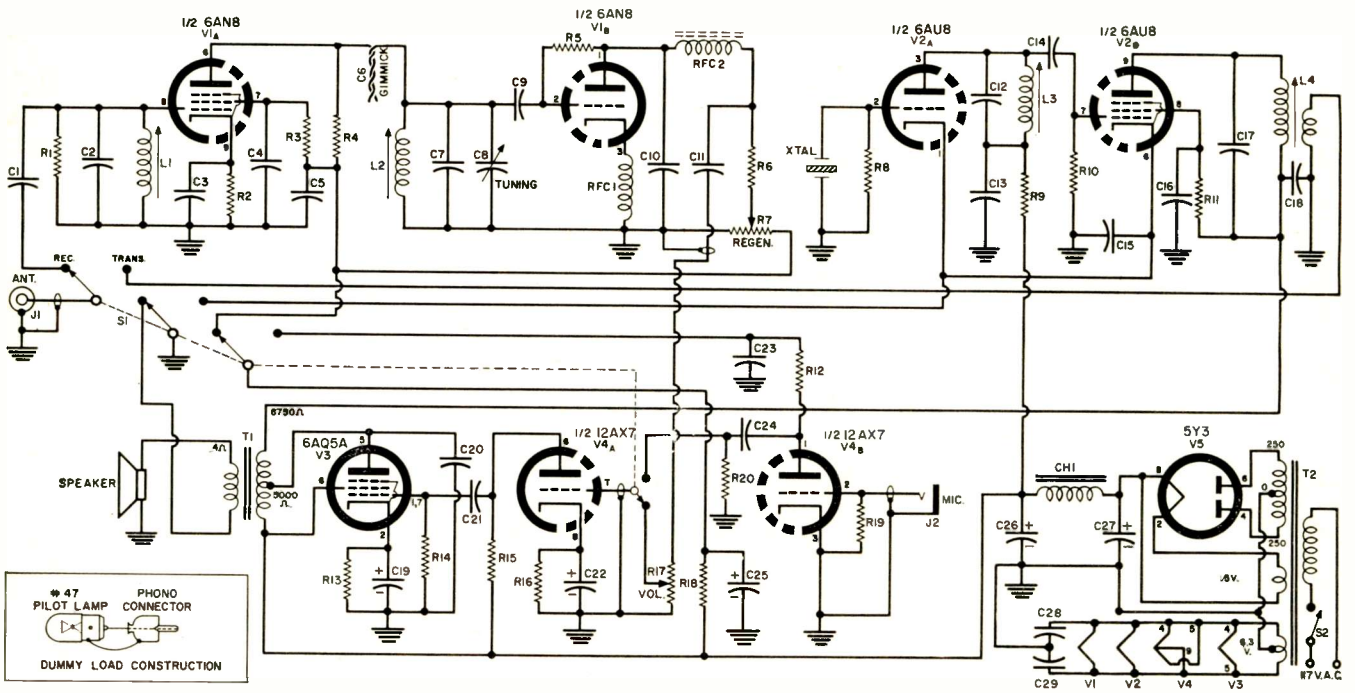
The voltage produced by the crystal mike is even less than the signal coming from the detector. Therefore, a speech amplifier is used when transmitting. This circuit (the other half of the 12AX7) amplifies the tiny microphone voltage about 20 times. The signal is further amplified by the 12AX7-6AQ5A circuits until it is strong enough to modulate the transmitter.

The transmitter section also consists of a simplified one-tube circuit. A type 6AU8 triode-pentode is used as a crystal-controlled oscillator and power amplifier. The crystal is a third overtone type and its frequency is selected to fit one of the Class D channels shown in Fig. 1. The Federal Communications Commission rules for Citizens Band operation require that the transmitter have a frequency stability of at least .005%. The crystal used in this circuit must have this frequency tolerance. When used in a conservative circuit, such as this, the overall transmitter stability will be within the FCC specifications.

The oscillator uses the triode section of the 6AU8 and is the circuit recommended by the crystal manufacturer. The plate circuit is tuned to the crystal frequency (one of the Class D channels) and the radio-frequency energy from this stage drives the power amplifier. The power amplifier stage boosts the power to just slightly less than the legal power limit of five watts. The modulated power output of this stage is coupled to the antenna through L_4, a link coil, and switch S_1. When a "dummy antenna," such as a #47 pilot lamp, is connected to the antenna jack, the r.f. energy will light the bulb to full brillance.

Regarding the maximum power input, the regulations go something like this: The maximum plate power input to the anode circuit of the electron tube or tubes which supply power to

Fig. 2. Complete schematic diagram of the transceiver. Note that V_3, V_4, and V_5 are used both on transmit and receive.



R_1—2700 ohm, ½ w. res.
R_2—470 ohm, ½ w. res.
R_3, R_{15}—220,000 ohm, ½ w. res.
R_4—4700 ohm, ½ w. res.
R_5, R_{19}—10 megohm, ½ w. res.
R_6—180,000 ohm, ½ w. res.
R_7—250,000 ohm linear taper pot
R_8—47,000 ohm, ½ w. res.
R_9, R_{11}—22,000 ohm, 2 w. res.
R_{10}—22,000 ohm, ½ w. res.
R_{12}—470,000 ohm, ½ w. res.
R_{13}—500 ohm, 10 w. wirewound res.
R_{14}—270,000 ohm, ½ w. res.
R_{16}—3300 ohm, ½ w. res.
R_{17}—1 megohm audio taper pot (with switch S_2)
R_{18}—10,000 ohm, 1 w. res.
R_{20}—1 megohm, ½ w. res.
C_1—3.3 μμfd. disc or mica capacitor
C_2, C_{17}—15 μμfd. disc or mica capacitor
C_3, C_4, C_{10}, C_{11}, C_{12}, C_{18}—.001 μfd. disc ceramic capacitor
C_5, C_{15}, C_{16}, C_{23}, C_{24}, C_{28}, C_{29}—.005 μfd. disc ceramic capacitor (C_{28} and C_{29} should be mounted directly at the filament pins of the 6AN8 to ground)
C_6—Gimmick (see text)
C_7, C_{12}—10 μμfd. disc or mica capacitor
C_8—2-8 μμfd. variable capacitor (three plates of E. F. Johnson #157-1 7J12 or equiv.)
C_9—100 μμfd. disc or mica capacitor
C_{14}—4.7 μμfd. disc or mica capacitor
C_{19}-C_{25}-C_{26}-C_{27}—20/20/20/20 μfd., 25/450/450/450 v. elec. capacitor
C_{20}, C_{21}—.01 μfd., 600 v. capacitor
C_{22}—25 μfd., 25 v. tubular elec. capacitor
CH_1—8 hy., 75 ma. filter choke (Stancor C1355)
L_1, L_2, L_3—16 t. #24 en. closewound on ¼" slug-tuned coil form (Miller #4500)
L_4—Same as L_1 but with 2 t. link of #22 plastic covered wire
J_1—Antenna jack (RCA type phono connector)
J_2—Jack to match microphone used
RFC_1—50 t. #36 en. scramble-wound on 10 megohm, ½ w. res.
RFC_2—75 mhy. iron-core choke (Miller #959)
S_1—4-pole d.t. wafer switch (Centralab PA-1011)
S_2—S.p.s.t. switch (part of R_{17})
T_1—Modulation/output trans. 5000 ohms, 6750 ohms, 4 ohms at 10 watts (Triad M4Z)
T_2—Power trans. 250-0-250 v. @ 70 ma.; 5 v. @ 2 amps; 6.3 v. c.t. @ 2.5 amps (Stancor PC-8403)
Xtal.—27.005 mc. third-overtone-type crystal, .005% tolerance (International FA-9)
Spkr.—4", 3.2 ohm voice-coil speaker
1—7" x 9" x 2" chassis
V_1—6AN8 tube
V_2—6AU8 tube
V_3—6AQ5A tube
V_4—12AX7 tube
V_5—5Y3 tube

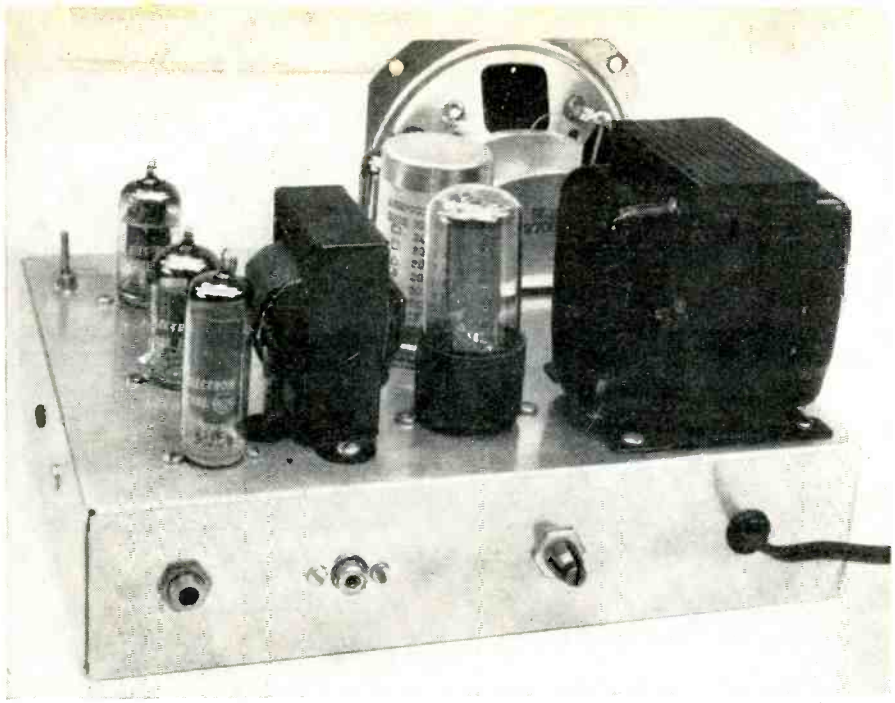
the antenna shall not exceed five watts, except on the radio-control channel of 27.255 mc., where the maximum power limit is 30 watts. The method of checking and determining the power input is explained in the adjustment section.

There is another regulation of which you should be aware. A permanently installed antenna system may not exceed 20 feet in height above any man-made structure (or natural formation) on which it is mounted nor shall the feedline be more than 25 feet long. This precludes the possibility of mounting the antenna high in the air, or placing the transmitter remotely from the operating location.

Construction

Referring to the photographs, you will note that the power-supply components are mounted in the left-rear corner of the chassis, with the exception of the filter choke which is mounted under the chassis and below the speaker. The front-left portion of the chassis has been notched out so that the speaker will set down on the chassis, almost flush with the front apron. The 6AN8, 12AX7, and 6AQ5A are mounted in a line, at the right side of the chassis, and the audio output transformer is located between the 6AQ5A and the 5Y3 rectifier tube. The transmitter circuitry is in the area just forward of the power-supply filter capacitor. The components associated with a particular section are tightly grouped around the tube socket. The close-up views of the equipment should reveal the location of most components.

The filter choke is secured to the side of the chassis with 6/32 hardware. It is necessary to mount the choke first to gain access to the nut, through the speaker cut-out. A five-lug terminal strip is mounted under the centermost transformer mounting bolt and is used for the power transformer primary circuit, filament and high-voltage winding centertaps, and speaker lead tie-point. A four-lug terminal strip is mounted under the front audio output transformer mounting screw. This serves as a tie point for R_3, R_4, C_5, R_{12}, and C_{23}. A third terminal strip is mounted on the side apron just behind RFC_2 and



Rear view of the unit shows regeneration control, antenna, and microphone jacks.

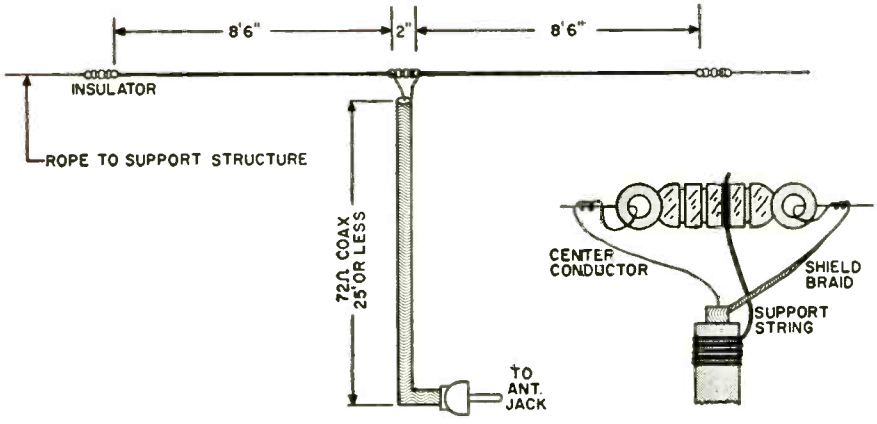


Fig. 3. Shown above are all the construction details on a simple dipole antenna that may be used with the transceiver. Note detailed view of the middle insulator.

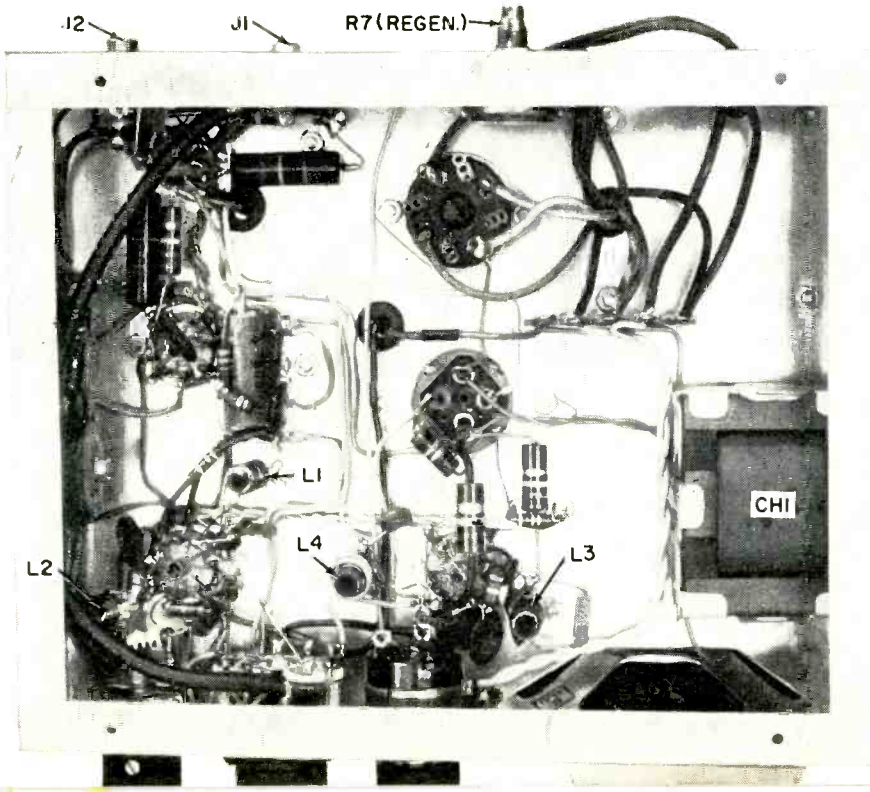
is used to secure R_6 and C_{11}. The rest of the components are self-supporting by their leads or lugs. For convenience in grounding components, sockets with four ground lugs should be used.

The connections to R_7 are important if this control is to work according to the instructions which follow. Looking at the rear of this control, with the lugs up, the left terminal should be grounded while the right terminal is connected to "B+" with a short length of wire. Naturally, the center lug goes to R_6. For proper operation of the volume control (R_{17}) the left terminal should also be ground when observed in the same manner as resistor R_7.

Once the transceiver is wired, testing should be carried out in a logical fashion. Before the unit is plugged in, measure the resistance across the power-line

(Continued on page 148)

Bottom view shows placement of the components. Note positions of the various coils.



By JOHN T. FRYE

NO HANDS, NO HEAD

AS BARNEY entered the front door of Mac's Service Shop he could hear his employer talking back in the service department; but when the youth stepped through the service department door, no one was in sight. Mac was standing at the bench cleaning a TV tuner and saying, "All right, Mrs. Carter, I'll send Barney over right after lunch."

"I knew it had to happen; I knew it, I knew it!" Barney said over his shoulder as he got his shop coat out of the locker. "Sooner or later everyone in this wacky business flips his wig and starts talking to himself. I do it all the time. I'll say this, though: you're different. I always talk to the set that's giving me a hard time, but you talk to imaginary customers. Guess that's because you have business worries while I just have service headaches."

"So who was talking to himself?" Mac grunted. "I was talking on the telephone."

"Yeah-h-h!" Barney snorted derisively, "with the phone five or six feet away and with the handset resting on the cradle?"

"That's right. Take a good long look at the telephone. If you don't notice something different, turn in your Boy Scout badge. You're not observant."

Barney walked over to the telephone resting on the end of the bench.

"Hey, we do have a new phone!" he exclaimed; "and it's a weirdy. What are these 'on' and 'off' buttons down here below the dial for? What's this little knob with the arrow on it? Is this a dial light? What's behind this little chrome hole plug in the base? Has that little plastic box that looks like a housing for a three-inch speaker got anything to do with it?"

"Whoa! Down, boy. Take it easy. This is a Loud-speaking Telephone. It can be used without lifting the handset from the cradle. To make a call or answer the telephone, you just push that 'on' button. The sound comes out of the speaker in this little plastic case. Your voice goes into a dynamic microphone behind that hole plug. The pilot light tells you the phone is on. The little knob in the upper right-hand corner adjusts the volume coming out of the speaker. When the conversation is over, you simply push the 'off' button, and the pilot light goes out. You can pick up the handset at any time and transfer automatically to normal telephone operation."

"How come you had it put in?"

"The telephone installer talked me into it when he was in here the other day to pick up a tape recorder I had repaired for him. He says it will be just the thing when you call in for some information on a set and I have to look it up and give it to you. This 'no-hands' telephone will allow me to talk to you from anywhere in the room while I'm leafing through service literature, checking to see if we have an item in stock, looking through the customer file, and so on. Furthermore, when a customer calls with a description of symptoms, we can both listen while we keep right on working. I agreed to give it a trial for a couple of months and see if it was worth the extra cost."

"Do you know how it works?"

"Sure. I told the installer I wouldn't have any electronic equipment in this room that I didn't savvy; so he let me look at the technical bulletin on it. If you've got any questions, shoot.

"It must have amplifiers in it. Where are they and how are they powered?"

"It has two printed-circuit vacuum-tube amplifiers. Each amplifier consists of a CK-512AX hearing-aid-tube voltage amplifier and a 3V4 output tube. Power for the tubes is taken from the 117-volt line. One amplifier builds up the output of the microphone before putting it on the line. The other amplifier builds up the voice currents from the line so they can drive the speaker."

"Surely all that stuff isn't crammed inside the telephone."

"Nope. There's a small 'control unit' about 4" x 7" x 10" fastened up under the bench. Leads from it go to the telephone, this little speaker, the telephone line, and to the house wiring."

"Why don't you get feedback from the speaker through the microphone?"

"That's a good question and it worried me, too. You actually can get feedback if you turn up the speaker volume too high or if you place the speaker too close to the microphone; but with the speaker three or four feet from the telephone and properly positioned, there's no problem. A hybrid coil inside the control box does the trick. This hybrid coil is a clever gadget that connects microphone signals to the line but not to the loudspeaker amplifier. I haven't time to go into hybrid coil theory now, but you won't be far off if you think of a hybrid coil as a device that represents a sort of bridge circuit forcing one signal to buck itself out while another signal is allowed to pass freely."

"Well, that's the end, the absolute end!" Barney said admiringly as he stroked the telephone.

"Oh no it's not," Mac disagreed with a grin. "Nothing is ever the end in electronics. Someone is always coming up with something a little better. Already they have a Transistor Speaker Phone that has some advantages over this model."

"Such as what?"

"The small power requirements of the transistors are supplied right from the d.c. current in the telephone line itself; so no connection to the house current is needed. Miniaturization afforded by transistors permits all the extra equipment to be housed inside the telephone and the little speaker case, thus doing away with the need for the 'control box.' That means the Transistorized Speaker Phone is portable and can be carried about and plugged in at different locations in the house or office. Transistors, unlike tubes, should last just as long as any other parts of the telephone. Furthermore, they spring into action instantly and do not need the second or so of filament warm-up time required by the tubes."

"Those telephone guys are right on the ball," Barney said.

"They *did* invent the transistor," Mac said quietly. "Don't ever underestimate telephone engineers. Radio engineers have borrowed very freely from them in the past and will continue to do so in the future. The telephone boys have done marvelous research work in the fields of sound, microwave transmission, semiconductors, multiplexing, and many others. When they talk, I listen."

"Suppose you listen to me a bit," Barney said as he picked up the little a.c.-d.c. receiver he had been working on at quitting time the day before. "Ain't it funny how identical troubles come in bunches in service work? This set has exactly the same difficulty as the last one: a dead oscillator. That one I fixed yesterday had an open wind-

(*Continued on page* 88)

PROBLEMS IN TVI LOCALIZATION

The quantity of information on the accompanying chart covering v.h.f. TV and other radio frequencies will be useful in a variety of applications, including some never considered by the compiler. However, it will be most helpful in solving TV interference problems, for which it was designed.

A major difficulty when TVI occurs is that, out of a seemingly infinite set of paths to pursue, one seldom knows where to begin. Such related but quite separate factors may be involved as the frequency of the interfering source, its nature, its location, the frequency on which it enters the receiver, the portion of the set through which it makes its entry, and the techniques best suited to reducing its effects. Often one of these factors is better to start with than another, but it is seldom easy to tell which at the outset, when this information is most needed. Anything that can narrow down the vast range of possibilities is useful.

No single source can provide quick, ready-made answers. However, when properly applied, the INTERFERENCE CHART can save much time by narrowing down possibilities sharply. It will do this in the majority of cases, although it cannot cover every one of them. Conversely, it will highlight important, additional possibilities that are easily overlooked. But the technician will still have to think.

One of its chief functions is that of determining the frequencies on which the interference may be entering the receiver. The "entering frequency" is not necessarily the same as the frequency of origin, or "source frequency," but must usually be determined first. When either of these is already known, the chart may be used to determine what specific service and/or point of origin is involved. This will be covered later.

Where TVI appears to exist on just one channel, or two, it is still not correct to assume that it is simply entering through the antenna in the r.f. bandwidth of that channel. It may be beating against or near the local-oscillator frequency of the set for that channel. It may be an image, as much above the local oscillator as the received signal is below the latter.

The "source frequency" itself may be some sub-multiple of the one on which TVI is actually entering. For example, a nearby industrial plant may have r.f. heating equipment that operates on 33.5 mc. The eighth harmonic, 268 mc., is an image frequency that may disturb a TV receiver with a 41-mc. i.f. strip when the latter is tuned to receive on channel 7 or 8.

In the matter of harmonic interference, it is recognized that requirements for suppressing harmonic radiation are fairly rigid. Even so, harmonic interference is easily produced in the receiver itself. Take the case just mentioned. The heating equipment in the nearby plant may put out a very "clean" 33.5-mc. However, TV tuner circuits are quite non-linear. They can act as excellent harmonic generators for an entering 33.5-mc. or other signal, especially if that signal is strong enough to cause overload. Nevertheless, the cure involves suppression of the fundamental.

The source of interference may be the TV receiver itself, with one circuit providing unwanted signal for another. As a corollary, one TV receiver may be the interference generator for another, especially if they or their antennas are adjacent, or if they are fed by a common signal distribution system.

For example, the video detector (a nonlinear circuit element) has been known to act as a harmonic generator for signals within the i.f. bandwidth that are fed to it. Thus the 4th or higher harmonics of 41-47 mc. i.f. signals can interfere with reception on channels 7 to 13. Also the 13th harmonic (46.54 mc.) of the subcarrier oscillator (3.58 mc.) in some color sets has been known to interfere on all channels of its own or nearby receivers.

Whenever interference appears to exist on many or all channels received, instead of one or two, the probability is that entrance is through the fixed-tuned circuits (video i.f. for picture hash, audio i.f. for garbled sound, 3.58-mc. oscillator for loss of color sync or color). This fact is helpful in determining the portion of the receiver that is affected. While antenna and r.f. circuits are thought of as the most susceptible points of entry, no possibilities should be overlooked. In addition to those already noted, there is always the power line.

How to Use the Chart

To identify probable "source" frequencies of TVI, locate the possible "entrance" frequencies on that portion of the chart marked below as "A" ("Receiver Frequencies"). Using the two "F" scales, align a straight edge so that it intersects the possible entering frequencies, working with one such frequency at a time. (Refer to the note entitled PINPOINTING TVI in the upper portion of the chart.)

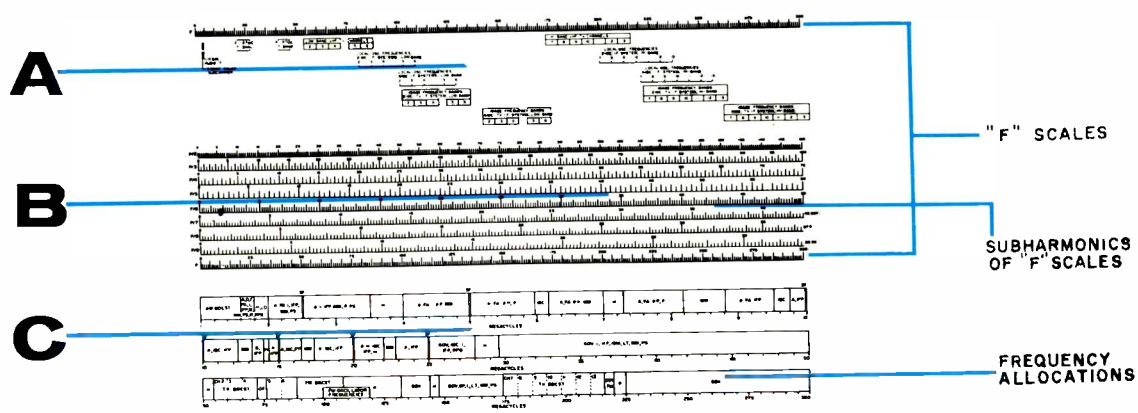
"Source" frequencies whose fundamentals or harmonics may be suspect will be intersected on the intermediate scales (F, F/2, etc., in section "B"). Although harmonics above the 20th have been known to result in TVI, the most likely ones are given by the chart. Subharmonics up to the 10th may be found mentally by moving the decimal point one place to the left on the "F" scale.

The "Allocations" portion of the chart (section "C" below) is then used to see what interfering services may be involved, between 1 and 300 mc., as indicated on the "F" scales. While this may still leave numerous possibilities, common sense and slight effort will provide further, drastic narrowing down. Few of the indicated services are likely to be possibilities in any one area. For example, there is little likelihood of TVI from maritime services in an inland location. Away from airports or airlanes, this source can be ignored. A check with the regional office of the FCC will assist in determining what services are active in a given area and what frequencies they use.

Remembering that the receiver itself or other sets may be implicated, the cautious technician will examine section "A" of the chart for sources at the same time that he uses section "C."

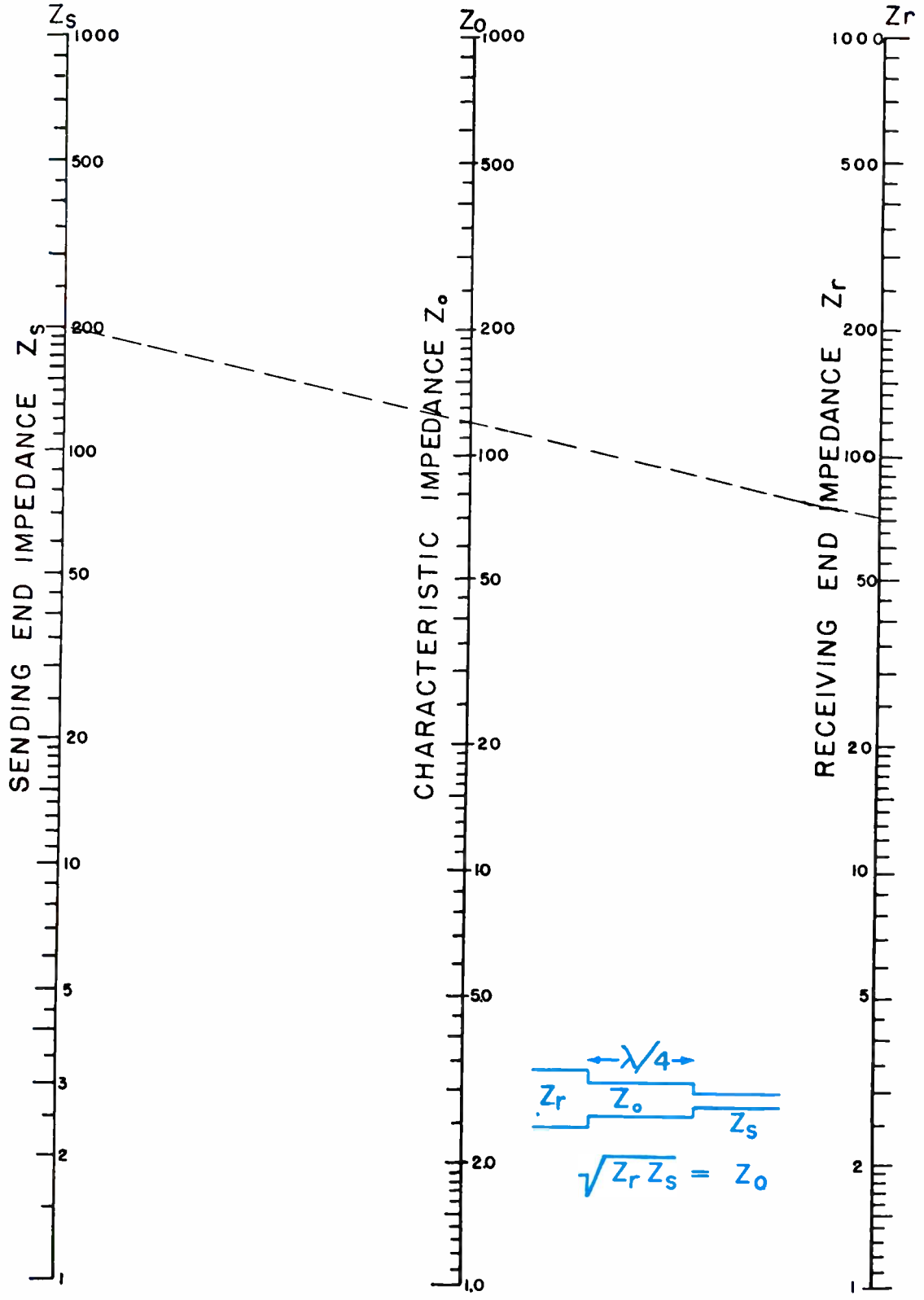
In another application of the locator chart, let us assume that the source and originating frequency are already known. For example, the transmission is readily identifiable as originating from a local airport. To apply proper suppression, we must determine how the interference enters the TV receiver. We now start out with the known frequency, on the "F" and fractional "F" scales in section "B," and determine entering frequencies in section "A."

Since it is not a magic wand, the locator chart is intended to supplement rather than replace other known weapons in the war against TVI. Such devices as interference probes will still be useful. Knowledge of available types of interference filters and their uses, as well as data for fabricating them, is still essential. Also, nothing can replace the ability to think.



QUARTER-WAVE MATCHING SECTION

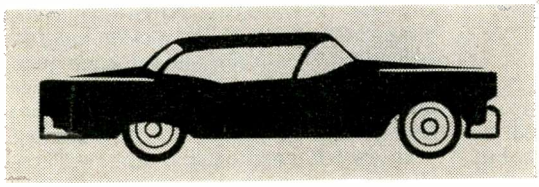
This chart is used to obtain the surge impedance of a 1/4 λ matching section used as an impedance transformer from one real impedance to another.

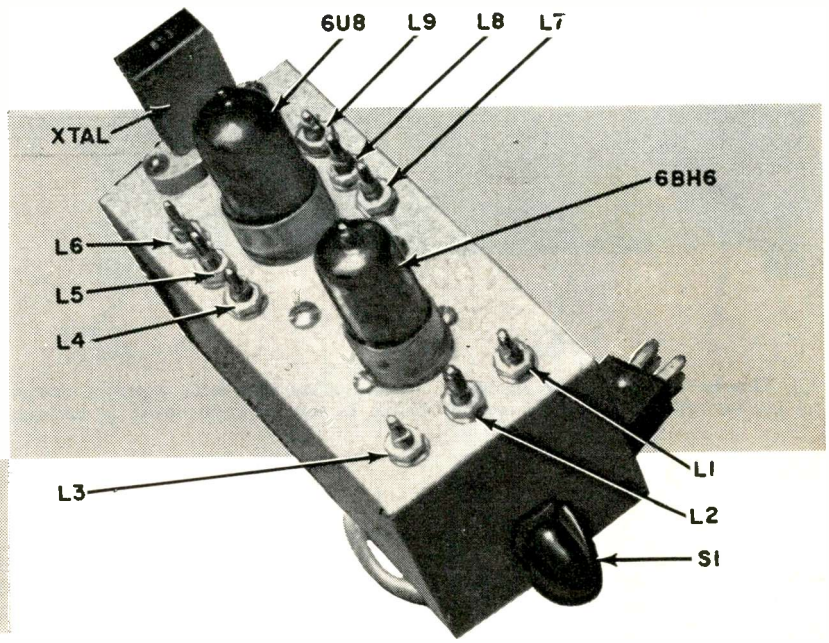


Three-Band Mobile Converter

By JOSEPH L. REIFFIN, W5CWP

Inexpensive to build, small enough to be hidden away in the car, this single-crystal converter unit has more "bring 'em in" power than the mobile ham can employ.





Top view of the crystal-controlled converter is shown here.

YOU certainly don't have to be an Old Timer to remember when operating mobile was strictly a one-band affair. For one thing, the problem of getting an antenna to radiate with at least a semblance of efficiency on more than one band without the use of the rather recently developed "Hi-Q" loading coils and traps, proved to be a big stumbling block. The average mobile installation consisted of a one-band converter, a one-band transmitter, and a single-band antenna to match.

With the advent of efficient multi-band antennas, mobile operation is now conveniently possible on the three most popular bands—10, 15, and 20 meters, without the need for making any adjustments to the antenna and without the need to even leave the front seat of the car. The one-band installation is now just about obsolete and multi-band operation from the family car is becoming as commonplace as multi-band operation from the shack.

Perhaps the greatest obstacle to multi-band operation in the car is the high cost of suitable receiving equipment. There are several very fine all-band receivers designed for mobile installations available, but paying out about $300 for such a receiver is pretty difficult to justify to the XYL, who already holds a dim view of the loss of leg room around the front seat.

The three-band, crystal-controlled converter described here may be the answer to that problem. It is inexpensive to build, small enough to be hidden away practically unnoticed, and has more "bring 'em in" power than you can actually use in your car. In fact, working into a good broadcast receiver, it can make many a full-fledged communications receiver sit up and take notice. It is designed for the 10-, 15-, and 20-meter bands which many hams consider to be the best of our bands for mobile use. This works hand-in-glove with the new mobile antennas that are designed to operate on those three bands without any loading coil tap changes or adjustments of any kind.

Circuit

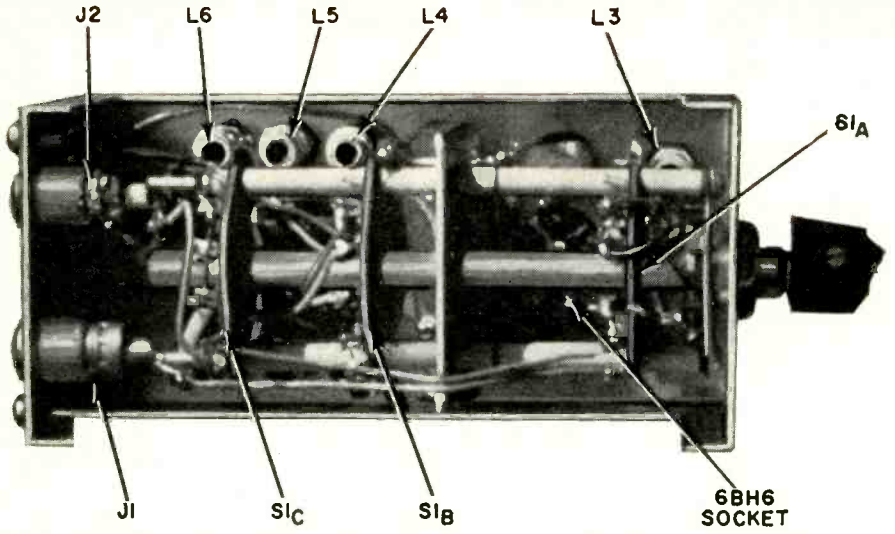
From a circuit standpoint, this converter represents little departure from accepted practices for broadbanded, crystal-controlled converters designed to operate into a tunable broadcast frequency i.f. system. The one new twist is the use of a single crystal for all three bands. By choosing a frequency in the region of 7525 kc. and making use of the 2nd, 3rd, and 4th overtones, this single crystal can perform the oscillator function for all three bands to be covered. The oscillator frequency is on the high side of the signal in all cases. The triode section of a 6U8 tube performs very well as the crystal oscillator. The circuit values are not particularly critical and the values given in the parts list have produced ample output on all overtones, from every crystal tried, for adequate mixing voltage for good i.f. output to the broadcast receiver. All the crystals tested were of the "surplus" type costing approximately 50 cents each.

One problem of band coverage for 10 meters is present here as it is in all converter systems of this type. With the average car receiver tuning 550 kc. to 1600 kc., the coverage of the 10-meter band is limited to about 1050 kc. To cover the entire 10-meter band, a frequency range of 1700 kc. is required. This situation calls for some compromise. By using a crystal frequency of 7525 kc. the portion of the 10-meter band covered will be from 28,500 kc. to 29,550 kc. This clips 150 kc. off the top end of the band and eliminates the entire foreign DX portion from 28,000 kc. to 28,500 kc. It is a simple matter, however to plug in another crystal at 7400 kc. and then the 28,000 kc. to 29,050 kc. portion of the band will be covered. In the same way, the top end of the band could be covered by using a crystal frequency of 7565 kc. A bonus feature of the oscillator circuit is that no re-tuning is necessary when these other crystals are plugged into the mobile converter unit.

Most broadcast receivers do cover a bit more of the frequency range than the absolute broadcast-band edges so that the situation isn't quite as sharply cut-off as indicated. With a 7525 kc. crystal just about all of the American phone band is covered with a little overlap into the DX portion.

Covering the 15- and 20-meter bands presents no problem whatsoever. By using the 7525 kc. crystal that gives the best coverage of the 10-meter band, full coverage of the 15- and 20-meter bands is automatic.

The 6BH6 tube used as the r.f. amplifier is a good choice for this application. It provides good gain, is quite tolerant of physical layout, and shows no sign of instability. There was a strong temptation to use a 6AH6 tube as the r.f. amplifier in order to simplify the operation of this converter when installed in a car with a 12-volt battery system.



This bottom view shows locations of some of the coils with respect to switch. Other coils, not labeled, are not visible in this particular view of the unit.

The 6AH6 tube has the same heater current as the 6U8 tube—.450 amp.—and all that is necessary for 12-volt operation, is to run the heaters in series. The 6BH6 tube draws only .300 amp. of heater current. This makes it necessary to parallel a 42-ohm resistor across the heater terminals of this tube when it is run in series with the 6U8 tube. The 6AH6 tube, due to its exceptionally high G_m, was very unstable and extremely critical of physical layout, shielding, and antenna loading.

Broadbanding is accomplished by using slug-tuned coils with no capacitance across them other than the stray capacity of the wiring and the interelectrode capacity of the tubes. In addition, a low value of plate load resistor is used for the 6BH6 and 6U8 tubes, R_3 and R_6, further degrading the *"Q"* of the tuned circuits, resulting in the broadbanding necessary for this type of circuit.

The opposite is true in the case of the coil used in the plate circuit of the crystal oscillator stage. Here we are interested in a single frequency, the 2nd, 3rd, or 4th overtone of the crystal frequency, and capacitor C_9 is used across the coil in order to aid in increasing the *"Q"* of this circuit. However, the *"Q"* is still not very high as evidenced by the fact that retuning is not necessary when different crystals are used for different band coverage.

No attempt was made to apply the broadcast receiver's a.v.c. voltage to the grid of the 6BH6 tube. This would necessitate digging into the broadcast receiver's innards which many hams do not like to do. The advantages gained by applying a.v.c. to the r.f. stage in the converter are quite marginal. The usual high noise level of a mobile installation would probably keep the a.v.c. bias voltage developed in the broadcast receiver at a continuously high level. If this were applied to the grid of the converter r.f. tube—it would tend to reduce the over-all sensitivity to a marked degree. It will be argued that the weaker signals picked up by the "wide open" 6BH6 r.f. tube will be masked by the high noise level, but there will be many weaker signals that will get through which would have been shut out entirely by the a.v.c. voltage. The only real justification for applying a.v.c. voltage to the r.f. tube is to prevent that tube from being overloaded by a strong incoming signal. Signals that strong *may* be present in your mobile installation, but they will certainly be few and far between.

Should it be desired, a.v.c. voltage can easily be applied to the 6BH6 tube. All that is necessary is to remove the ground from the bottom end of L_1, L_2, and L_3, connect them together and feed the a.v.c. voltage from the broadcast receiver through a 470,000-ohm, ½-watt resistor, bypassed at the coil end with a .002 μfd. capacitor. If this is done, be sure to ground the cold end of the antenna coil winding.

Construction

The converter is built in a 2¼ x 2¼ x 5 inch Mini-Box. This is rather small for a three-band converter but actually there is no overcrowding of the components and wiring is not too much of a problem. By utilizing the layout shown, there is ample room for all the coils, capacitors, resistors, and bandswitch. Wiring is strictly point-to-point and long leads are almost automatically eliminated. The wiring of the chassis should be completed before the bandswitch is mounted. The coils should be wound and mounted in place and short lengths of wire should be soldered to the terminals. When the bandswitch is mounted, it becomes a simple matter to solder the proper leads from the coils to the proper switch terminals.

The bandswitch is made up of three sections of *Centralab* PA-33 miniature switch sections mounted on a PA-301 shaft and index assembly. These switch assemblies are very easy to construct and are extremely flexible in their application. An aluminum partition is used between the first section of the bandswitch and the other two. This serves a dual purpose. It acts as a shield between the 6BH6 r.f. stage and the 6U8 mixer-oscillator stage and also helps to support the bandswitch rigidly. A feedthrough bushing (*National* type TPB) is mounted on the partition to feed the output of the 6BH6 to the 6U8 tube.

The bandswitch is assembled to the following dimensions, using the spacers provided with the PA-301 shaft and index assembly. The first wafer section (section A on the schematic) is spaced ½ inch from the index. The partition is mounted 1¼ inches from the first section. The second wafer section (section B) is mounted ½ inch from the partition and the last wafer section (section C) is mounted 1 inch from section B. The excess length of the long threaded mounting rods should be clipped off. Each wafer section has two poles and five positions for each pole. Only four of these positions are used and the indexing ring supplied allows for this arrangement very conveniently.

In switch position #1, the "off" position, the antenna is switched to the broadcast receiver directly so that it operates normally. In this switch position, the filament voltage is not applied to the converter tubes. In switch positions #2, #3, and #4, the proper coils are switched into the circuit, the antenna is connected to the converter, and the output of the converter is connected to the broadcast receiver antenna input. In these three switch positions, the filament voltage is applied to the tubes in the converter. The "B plus" voltage is not switched since that would require another switch section. In the "off" position, with the filament voltage removed, there is no "B plus" current drain at all and there is actually no need to switch the "B plus" voltage at all.

The power requirements of the converter are 6.3 volts at .750 amp. or 12 volts at .450 amp. for the tube heaters and any "B plus" voltage from 100 volts to 250 volts is satisfactory. The "B plus" current drain varies with the amount of voltage applied. With 180 volts, the total current drain is about 15 ma. Most car receivers can spare that much current so it is a simple matter to obtain the "B plus" voltage from a convenient point. Be sure to take this voltage from a supply point such as the screen voltage of the audio amplifier tube—never from the plate terminal of any tube. The heater voltage should also be taken from the broadcast receiver. In that way you can be sure that everything is turned off when you switch the broadcast receiver off.

This converter can also be used with the newer transistor car radios. In this case you cannot take the "B plus" voltage necessary from the car receiver. It would then be necessary to power the converter from a small vibrator supply or even batteries.

Alignment of the converter is greatly simplified if a signal generator or grid-dipper is available. However, it is not too difficult a job even without the use of either of these instruments. It is also very helpful if an a.c. power supply is available for the initial testing and alignment. Most comunications receivers have an accessory socket that provides suitable external voltages.

Alignment

The first step is to make sure that the crystal oscillator stage is operating properly. If your converter is wired for 6-volt-battery operation, it will only be necessary to have the 6U8 tube in the socket for this test. However, if you are wired for 12-volt-battery operation, you will have to have both tubes in the converter in order to complete the series filament circuit. In any event, the check-out procedure is the same. With a milliammeter— zero to 50 ma. range will do fine—in the "B plus" lead, note the current drawn with the crystal out of the circuit and then note the difference in the current drawn when the crystal is inserted in the socket. There should be a marked reduction in the current with the crystal in if the circuit is operating properly. If a v.t.v.m. is available, oscillation can be checked by reading the voltage present on the grid of the triode section of the 6U8 tube, pin #9. With proper oscillation there will be a negative voltage on the grid and this negative voltage will disappear if the crystal is removed. If the coils are wound according to the specifications given in the parts list, there is very little danger of the wrong overtone being generated in the oscillator. The tuning range of these coils is quite limited and if oscillation is taking place, the frequency of the overtone selected by the bandswitch should be correct. This can be checked, if desired, by tuning a communications receiver to the frequency selected and listening for the oscillator signal. Be sure you are not tuned to an image frequency when making this test. If the receiver has an "S"-meter, it can be used to peak the oscillator plate coils. Just adjust the slugs in these coils for maximum "S"-meter reading.

The converter should now be connected to a broadcast receiver for the final phase of alignment and check-out. A communications receiver with broadcast-band coverage makes an ideal set-up for this operation because the "S"-meter provides a visual means of peaking the coils. A short length of coax cable—RG-59-U or RG-58-U will do very nicely—should be used to connect the output of the converter to the antenna terminals of the broadcast receiver. Coax or shielded wire must be used for this connection to eliminate any leak-through of broadcast-station signals. Length of the cable is not critical but should be kept as short as conveniently possible. When the converter is installed in the car and connected to the car radio, it would be well to use the special type of coax cable that is used for auto antenna lead-in extensions. This is a special low-capacity type of coax and its use prevents the antenna circuit of the car radio being detuned by the high capacity of the standard coax cable. This special cable is inexpensive and usually comes with the proper plugs already attached to each end.

An antenna should now be connected to the converter and the bandswitch set for 20-meter operation. With a 7525 kc. crystal plugged in, the 20-meter amateur band will be found between 700 and 1050 kc. on the broadcast-band dial. If a signal generator is available, it should be set at a frequency of approximately 14,200 kc. This signal should be heard at approximately 800 kc. on the receiver dial. The slugs in the 20-meter coils—L_3 and L_6—should be adjusted for maximum output. If a signal generator is not available, the peaking of these coils can be done on any good signal that will be heard in the 20-meter phone band. Choose a signal that has a minimum of fading on it, preferably a local or one of the "California Kilowatts" that always seem to be present on this band.

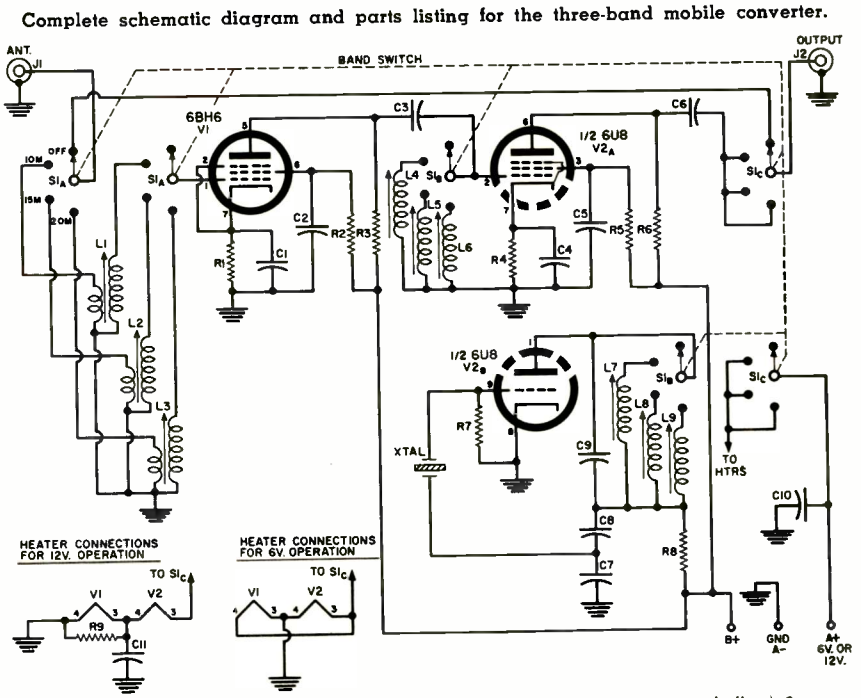
The same procedure should be followed for each band. The 15-meter band will be found between 1125 and 1575 kc. on the broadcast-band dial and the 10-meter band will be found on the entire broadcast-band dial, as explained earlier.

By peaking the coils at approximately the center frequency of each band, the entire band is covered with little or no loss at either end.

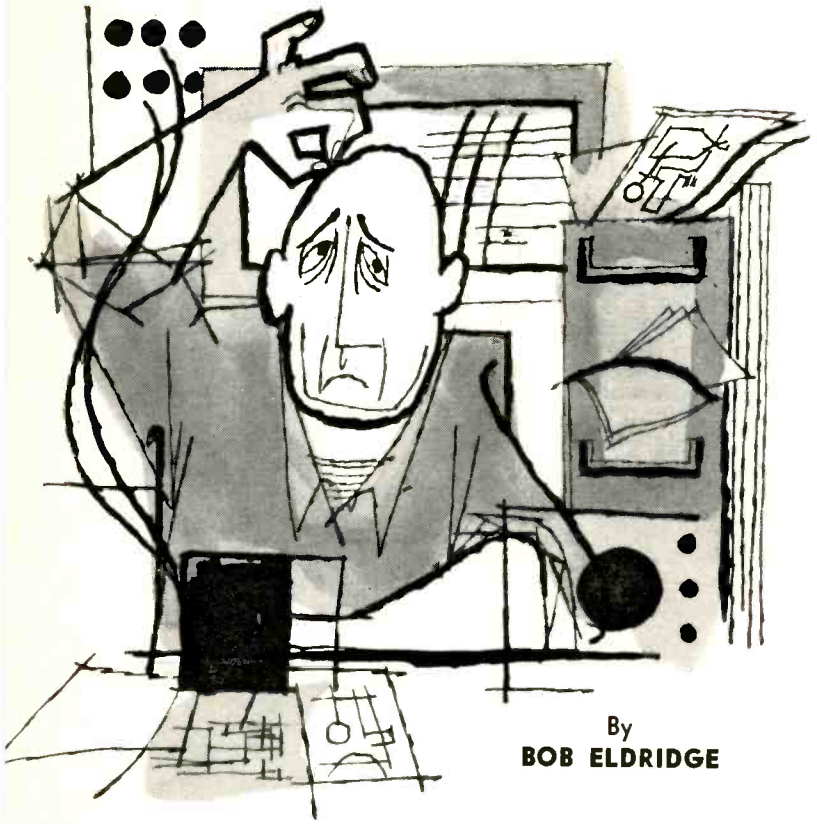
It will be noted that by using the broadcast receiver as a tunable i.f. system, the tuning of the amateur bands is reversed. When the broadcast receiver is tuned to the low end of the broadcast band—around 550 kc.—the high end of the amateur band is located and when the broadcast receiver is tuned to the high end—around 1600 kc. —the low end of the amateur band will be received. This takes a little getting used to—but after a few excursions up and down the bands it becomes an easy thing to put up with a minimum of confusion.

The performance of this little handful is really a revelation. The crystal oscillator provides a measure of stability that is certainly appreciated in a mobile installation, or even at a fixed location for that matter. Naturally, the ability to separate the stations on the bands is a function of the selectivity of the broadcast receiver used. The converter performs its half of the job—that of bringing in the 10-, 15-, and 20-meter bands to the input of the broadcast receiver—with apologies to no one. —30—

Complete schematic diagram and parts listing for the three-band mobile converter.



R_1—220 ohm, ½ w. res.
R_2, R_5—33,000 ohm, ½ w. res.
R_3, R_6—10,000 ohm, ½ w. res.
R_4, R_8—1000 ohm, ½ w. res.
R_7—47,000 ohm, ½ w. res.
R_9—42 ohm, 2 w. res.
C_1, C_4—4700 μμfd. ceramic capacitor
C_2, C_5—.002 μfd. ceramic capacitor
C_3, C_6—50 μμfd. ceramic capacitor
C_7—100 μμfd. ceramic capacitor
C_8—560 μμfd. ceramic capacitor
C_9—10 μμfd. ceramic capacitor
C_{10}, C_{11}—.01 μfd. ceramic capacitor
J_1, J_2—Auto radio antenna chassis-type socket
S_1—Bandswitch (made up of Centralab PA-301 shaft and index assembly with three Centralab PA-33 wafer sections, see text)
Xtal.—7525 kc. crystal (see text)
L_1—18 t. #28 en., (antenna winding) 2 t. at cold end
L_2—25 t. #28 en., (antenna winding) 3 t. at cold end
L_3—42 t. #28 en., (antenna winding) 4 t. at cold end
L_4—16 t. #28 en.
L_5—23 t. #28 en.
L_6—40 t. #28 en.
L_7—15 t. #28 en.
L_8—20 t. #28 en.
L_9—37 t. #28 en.
Note: All coils are wound on ¼" diameter ceramic slug-tuned coil forms (Cambridge Thermionic Co. LS6 forms). All coils are closewound. The antenna windings on L_1, L_2, and L_3 are close-coupled at the cold end of the grid windings.
V_1—6BH6 tube V_2—6U8 tube



By
BOB ELDRIDGE

EDITOR'S NOTE: *For shops that handle only a few locally popular brands of TV, the procedures described here can be invaluable. For others that rely on one of the commercially available service-data services, the job of organizing material is done by experts. Nevertheless, these establishments will find helpful suggestions here.*

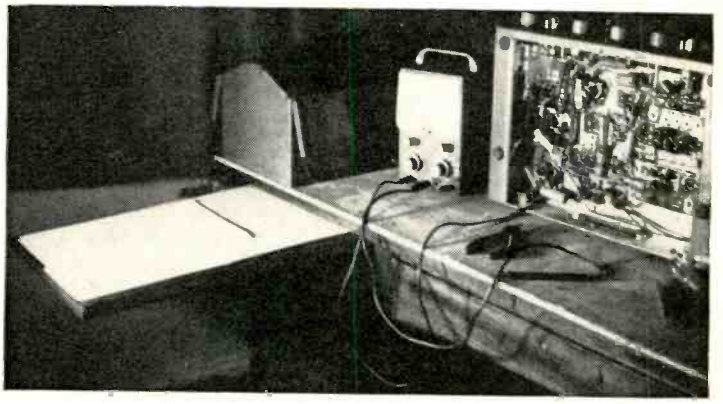


Fig. 1. The use of a sliding shelf keeps your schematics handy, but away from the working surface of the shop bench.

Systematic handling of schematics and other data pays off in faster service.

Get the Most out of Your Service Data

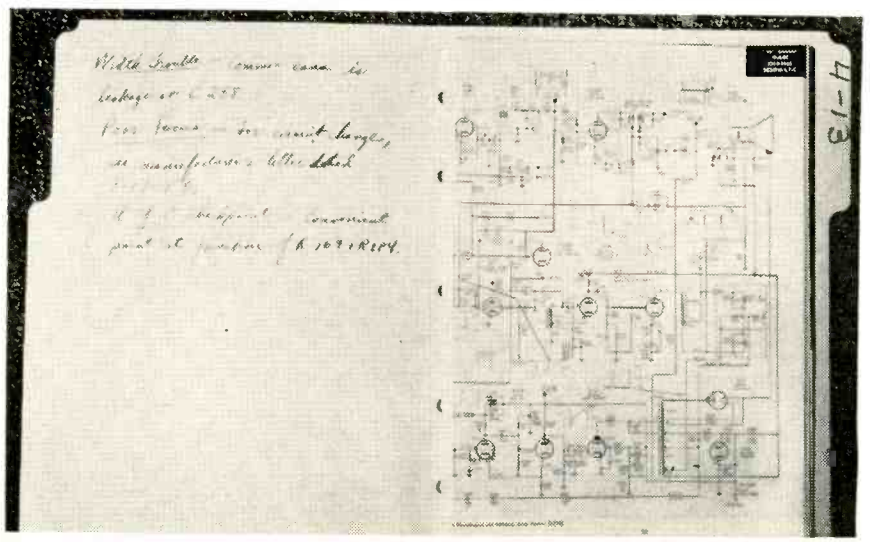
TIME is the most valuable commodity in any service shop, yet few factors waste more of it than the failure to organize and file service information for easy and rapid reference. In the shop that is not well organized, the situation becomes progressively worse as the reference material accumulates; yet, if the technician is reproved on this score, the answer is always, "I want to get it squared up, but I just haven't got the time to do it."

The truth is, he really hasn't the time *not* to do it!

There will be individual preferences as to how the system should be organized, but there are certain features that will be desirable in most systems:

1. It must be easy to determine whether a given, needed schematic is or is not on hand. 2. Data should be easy to find and extract. 3. There must be a quick way of finding such auxiliary information as related manufacturers' letters, factory modifications, service hints, and the like. 4. There should be provision for the addition of special information on a particular model. 5. It must be simple to return the data to its proper place. 6. The schematics must be protected against abuse.

Fig. 2. A typical schematic folder. Helpful notes (left) have been added.



Requirement 1 calls for an index. This should be as large as possible, preferably drawn up on stiff, white paper so that it can be affixed to the wall above or beside the filing cabinet. In drawing up this index, there should be liberal provision for blank spaces under each heading. This takes subsequent additions into account.

Foresight will result in labeling each group of data with a number rather than a manufacturer's name. This helps accommodate the fact that, quite frequently, one schematic will cover sets made under several different trade-names. Under the system described here, the different trade-names listed on the main index refer the searcher to the same single schematic in the actual file. Time is saved, as well as space, because there is no duplication.

For example, part of the *RCA Victor* index might read:

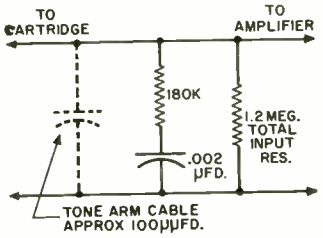
17T200	23-12	(group 23, folder #12)
17T201	23-12	
17T202	23-12	
17T211	23-12	
17T220	23-12	
17T301/U	23-13	
17T302	23-13	
* * * * * *		
* * * * * *		
KCS72	23-12	
KCS78/B	23-13	

If we now want the schematic for Model 17T220, we go straight to section 23 of folder 12—no thumbing over, no

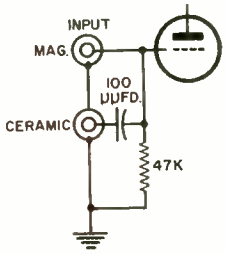
(*Continued on page* 128)

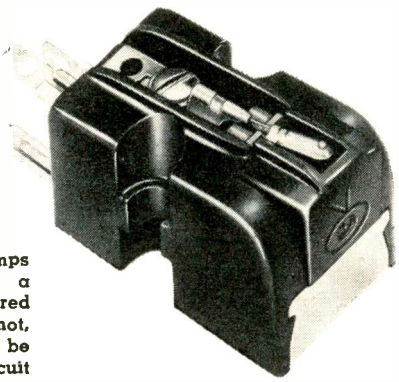
Hi-Fi Product Test Report

RADIO & TV NEWS LAB TESTED



The RIAA equalizing network which is to be used between the cartridge and any high-level preamp input circuit.





There are a few preamps that have provisions for a ceramic input cartridge wired internally as shown. If not, capacitor and resistor must be outboarded or input circuit converted as shown in figure.

CBS-HYTRON STEREO CARTRIDGE

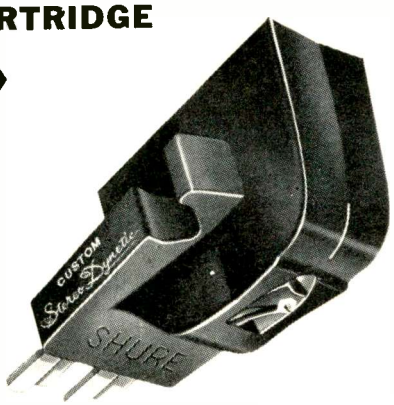
WE HAVE always been of the opinion that if sufficient care were taken in design, a ceramic cartridge could perform as well as magnetic versions. We were pleasantly surprised when we tested the *CBS-Hytron* Model SC-1 to find that it comes close to justifying our contention in this respect.

This cartridge has a diamond stylus .0008" in radius which is to be used at a recommended pressure of 5 to 8 grams. According to the manufacturer, the cartridge frequency response is ± 2.5 db from 30 to 16,000 cps. In our tests we used a pressure of 6 grams and input network recommended by the manufacturer. We obtained an output voltage of .21 volt at 1000 cps (5 cm/sec.). The hum at the output of the network was low. The IM distortion was somewhat lower on the left channel than on the right but both compared favorably with other manufacturers' cartridges we have tested. We were extremely pleased with the relative uniformity of response between the channels; the over-all frequency response that we obtained was within ± 2.4 db from 30 to 15,000 cps with the exception of a dip at 11,500 cps. At this dip response was down 5.2 db. Since most stereo records that are on the market today drop off rapidly above 10,000 cps, the dip should not affect the performance of the cartridge.

When using this cartridge in connection with a high-level input, a special RIAA equalizing network, shown in the diagram, must be used. There is another alternative which may prove somewhat simpler. We found that a 100-μμfd. capacitor with a 47,000-ohm resistor connected as shown in the diagram can give excellent results when used in conjunction with the low-level magnetic input jack of your preamp. In fact we found the frequency response more uniform using this method than with the special RIAA network recommended.

The channel separation for the cartridge measured 20.5 db at 1000 cps. Listening tests certainly proved that a well-designed ceramic cartridge can give excellent performance.

SHURE M7D STEREO CARTRIDGE



THE stereo cartridge industry is moving at an extremely rapid pace. New companies are entering the field and established companies are coming out with new models and improved versions of some of their previous types. In line with this trend *Shure Brothers* has just announced a new addition to its line, the Model M7D. With the exception of a new external housing this cartridge is basically the same as the M3D which was covered in our last month's issue. Since the price of this new cartridge is almost half the cost of the previous one, it seems like a rather odd situation. However, there is a reason for it. The more costly unit, the M3D, is manufactured under laboratory conditions. All the characteristics of this stereo cartridge were held to much closer tolerances, thus assuring uniformity of performance and providing the utmost in high-fidelity reproduction. The M7D is produced under normal controlled production methods. It is possible that one might obtain a lower priced unit whose quality is equal to the higher priced version. However, this is not guaranteed.

The M7D which we tested showed a gradual drop in response of 5 db (± 2.5 db) from 1000 to 6000 cps, then a rise to −3.8 db at 10,000 cps, and then flat out to 15,000 cps, the limit of our test. The amplitude output of the two channels was relatively similar with a maximum difference of 1.0 db. Channel separation at 1000 cps was approximately 21 db. The hum pickup was low and compares with the M3D previously reported. The actual figure is of no specific consequence in that in indicates those conditions that apply with the particular combination of turntable and arm used in our test.

All-in-all, it is a cartridge that will provide truly high-fidelity performance and should be of interest to anyone who is economically minded. For the pro, of course, where cost is no object, the M3D still remains *Shure's* top stereo cartridge.

NEW GS RECORD CHANGER

ANOTHER new addition to the component field is *Glaser Steers'* modernized version of its Model Seventy-Seven stereo record changer. Functionally, it is identical to their previous model which was described in our January 1958 issue but, in addition to conversion to stereo operation and improved over-all design, it has several new features. In the conventional monophonic (*Continued on page* 97)

By ARTHUR A. JANSZEN
Janszen Laboratory, Inc.

Listening tests versus laboratory measurements—what's the right way to assign a figure of merit to a hi-fi speaker?

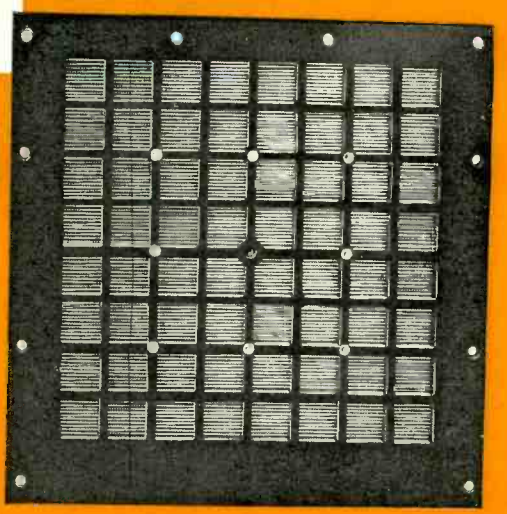


Fig. 1. JansZen Model 130 (above) uses 4 radiators of type shown (right).

Testing Electrostatic Loudspeakers

IT APPARENTLY is still fashionable to refer to loudspeakers as the "weakest links" in the chain of components in high-fidelity systems. The obvious inference to draw from such statements is that in every high-fidelity system, the loudspeaker is the most deficient of all components in the performance of its assigned role. This is not true. There are *some* loudspeakers that introduce less over-all distortion than *some* pickup cartridges, tape playback systems, preamplifiers, power amplifiers, and tuners. Despite the effort that has gone into investigations of the design parameters that make one loudspeaker "good" and another "bad," the problem of loudspeaker evaluation is still with us; for there is no measurement or set of measurements that can be used to predict accurately whether a "typical" listener will prefer speaker *A* over speaker *B*. It may be possible in the future, after extensive bioacoustical experiments have been completed and the data evaluated, to make a prediction of listener preference, based on objective measurements, that will be valid for *most* listeners in *most* situations. At the present time, however, such a statistical prop is not available and there is only one way to find out whether speaker *A* or speaker *B* is to be preferred in a given situation, and that way is to try *A versus B* under the conditions in which listening is to be done.

Listening Tests

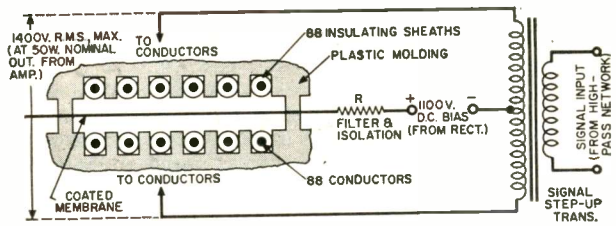
The assignment of a "figure of merit" to a loudspeaker can be valid only under highly specific conditions. This is because one's listening response depends not only on the speaker's actual performance, but also on the acoustical environment in which the listening is done, on the performance of associated equipment, and on subjective factors that defy definition. Judgments of loudspeaker performance based on listening tests can be valid only for one panel of listeners, in the particular listening room, for the particular positions of the listeners and loudspeakers within the room, and for the particular program material used, in conjunction with a particular set of associated equipment. For example, a preference for one loudspeaker over another can sometimes be reversed by simply using a different amplifier.

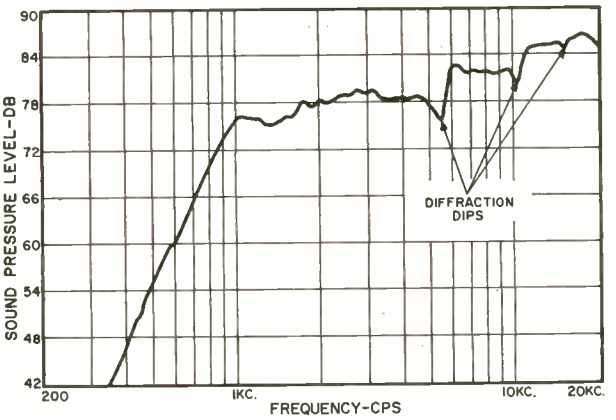
Table 1. Total harmonic distortion in acoustic power output of a single unselected radiator at various frequencies with 5 volts applied to the 8-ohm input.

FREQUENCY (in cps)	% TOTAL HARMONIC DISTORTION
750	0.47
1000	0.4
1500	0.35
2000	0.23
4000	0.16
5000	0.38
6000	0.47
7500	0.5
10,000	0.45

Objective Measurements

Although objective measurements do not permit the assignment of definitive figures of merit to loudspeakers, there *are* several performance factors, which *are* susceptible of objective measurement, that are important in determining critical listener preference, even though they may not represent *all* of the pertinent factors. These are: (1) the range of frequency





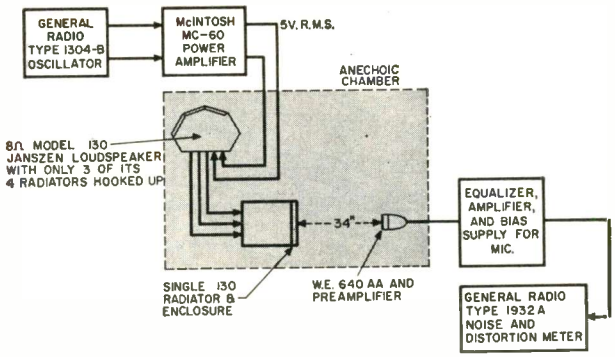


Fig. 2. (Top left) Electrical connections and construction of electrostatic radiator described in text. Circuit for the 1100-volt bias supply (derived from the a.c. line) and the high-pass LRC filter network required is not shown in drawing.

Fig. 3. (Top) Test setup for distortion measurements. The radiator being checked was mounted in a separate enclosure one-quarter the volume of main enclosure. All 4 radiators were connected for proper amplifier loading but radiation from the 3 radiators not under test was prevented by disconnecting bias.

Fig. 4. (Left) Axial pressure response of a single radiator with 2 volts input at 8 ohms. Note slight diffraction dips.

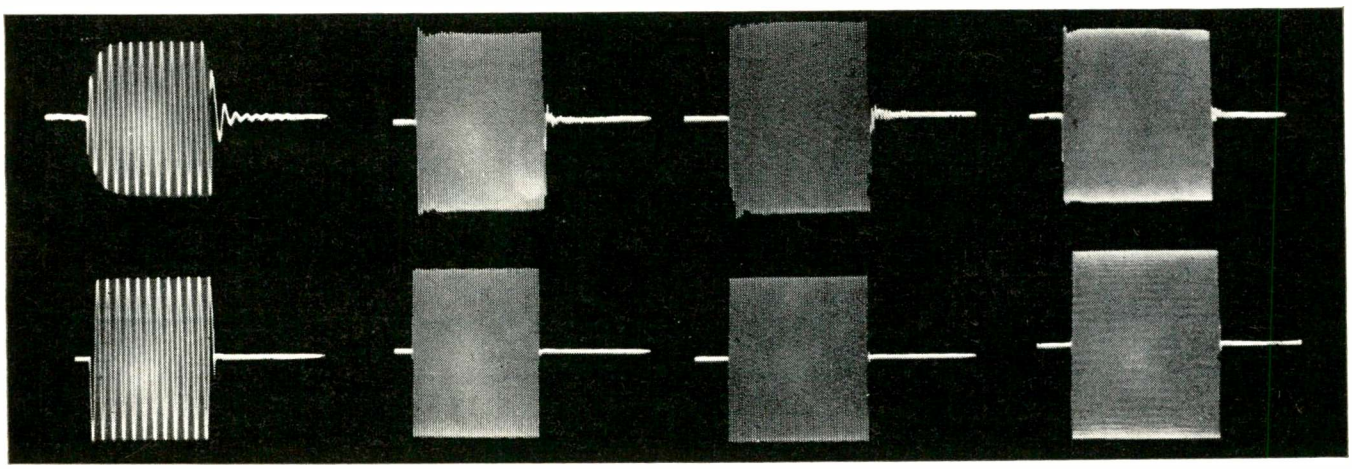
response; (2) the "trend" or shape of the curve of the frequency response curve, *i.e.,* whether some bands of frequencies are emphasized or de-emphasized with respect to other bands; (3) the "smoothness" of the frequency response curve, *i.e.,* the presence or absence of sharp dips and peaks in the curve; (4) the linearity of response, *i.e.,* whether a linear relationship exists between the instantaneous values of input voltage and output pressure over the entire a.c. signal cycle at each frequency within the bandpass, which can be determined by a measurement of total harmonic distortion; (5) the transient response of the system, which can be inferred from the frequency response but which can be more directly investigated by applying "tone bursts" of various carrier frequencies within the passband to the input terminals and photographing the output of a microphone as oscillograms; (6) the distribution of acoustic pressure in both vertical and horizontal planes as a function of the angular position with respect to the axis of the loudspeaker; and (7) the impedance frequency characteristic, which affects the ability of the associated power amplifier to supply the required output voltage frequency characteristic at the required voltage levels.

These then represent the objective measurements that can be made.

It must be stressed that the listener's ability to detect differences in performance between one loudspeaker and another, will depend greatly on the performance of the associated equipment. It is incumbent upon the manufacturer of loudspeakers that are capable of excellent performance to be specific in making recommendations concerning the other components in the system. For example, if another component (or components) is generating a lot of harmonic distortion at 4000 cps, it is likely that a loudspeaker whose response is restricted to frequencies below 8000 cps would be chosen over one whose response extends to 20 kc.

Since a loudspeaker should convert complex electrical waveforms into acoustical counterparts without distortion, it would seem desirable to make this conversion *directly,* without membranes, cones, domes, or horns. Such a system would be of ultimate simplicity. If the acoustic output varied directly with the input voltage, and if the area of the air front at the radiating boundary were large enough to prevent nonlinear response of the air itself, then one would have a loudspeaker free of waveform distortion. If the area were made appropriate to the range of frequencies to be radiated, then the power output could be made independent of frequency (for a constant input voltage), and the electro-acoustical tran-

Fig. 5. Tone bursts at a repetition rate of 30 per second for 1 kc., 3.5 kc., 7 kc., and 20 kc. respectively. In each pair of waveforms the electrical input is shown directly underneath the waveform showing the acoustic output of the speaker.



1 KC. 3.5 KC. 7 KC. 20 KC.

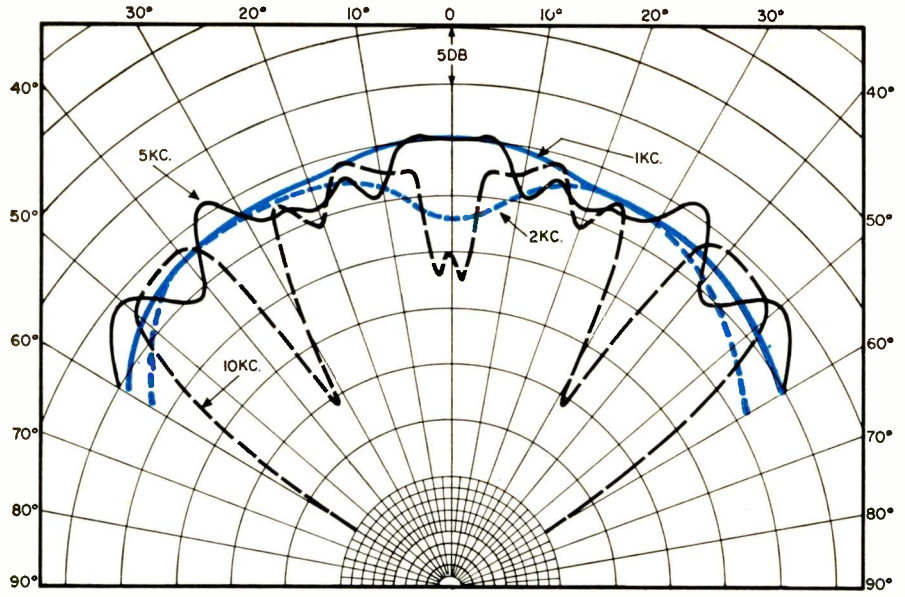


Fig. 6. Polar charts of acoustic pressure at various frequencies with all 4 radiators operating. Measurements were taken in anechoic chamber at distance of 10 ft.

sient response would be without flaw.

Such an ideal loudspeaker is not yet practical and all speakers on the market at present have one or more mechanical and/or acoustical coupling elements which tend to introduce resonances and which, in turn, cause a degradation of transient response. In the radiating elements used in the speaker shown in Fig. 1, an attempt has been made to achieve the greatest degree of simplicity and the nearest approach to the ideal electro-acoustical system. These elements are push-pull, constant-"*q*" electrostatic radiators, in which the vibrating elements are made of plastic membranes so light and thin that over most of their frequency range they operate almost as if the membrane were absent. Through the application of a very high, constant d.c. charge ("*q*") between the membrane and the two stationary electrodes, a high degree of linearity can be achieved with a high per-unit-area acoustic power output.

Test Results

Fig. 2 shows the electrical connections to a segment of a radiator. Signal voltage is applied to the outer electrodes and bias voltage is applied between the conducting coating of the membrane and the outer electrodes by means of a resistor *R*. An analysis of this constant-"*q*" system, in which the electric charge deposited by the bias supply is kept constant during variations in signal voltage by the presence of the high resistance, leads to the conclusion that if perfect symmetry is preserved, there is no harmonic distortion. If *R* is made large enough, electrode asymmetry, within limits that can be maintained in production, causes only very small amounts of distortion. The degree of excellence with respect to distortion that can be achieved in production is shown in Table 1.

Fig. 3 shows a diagram of the test setup used in the measurements. Data gathered in an anechoic chamber on a multiple array of radiators defies interpretation, so measurements were made on a single radiator. The response of the microphone used was equalized by means of a multiple *LRC* network so that the over-all system response was flat to within 1 db up to 20 kc.

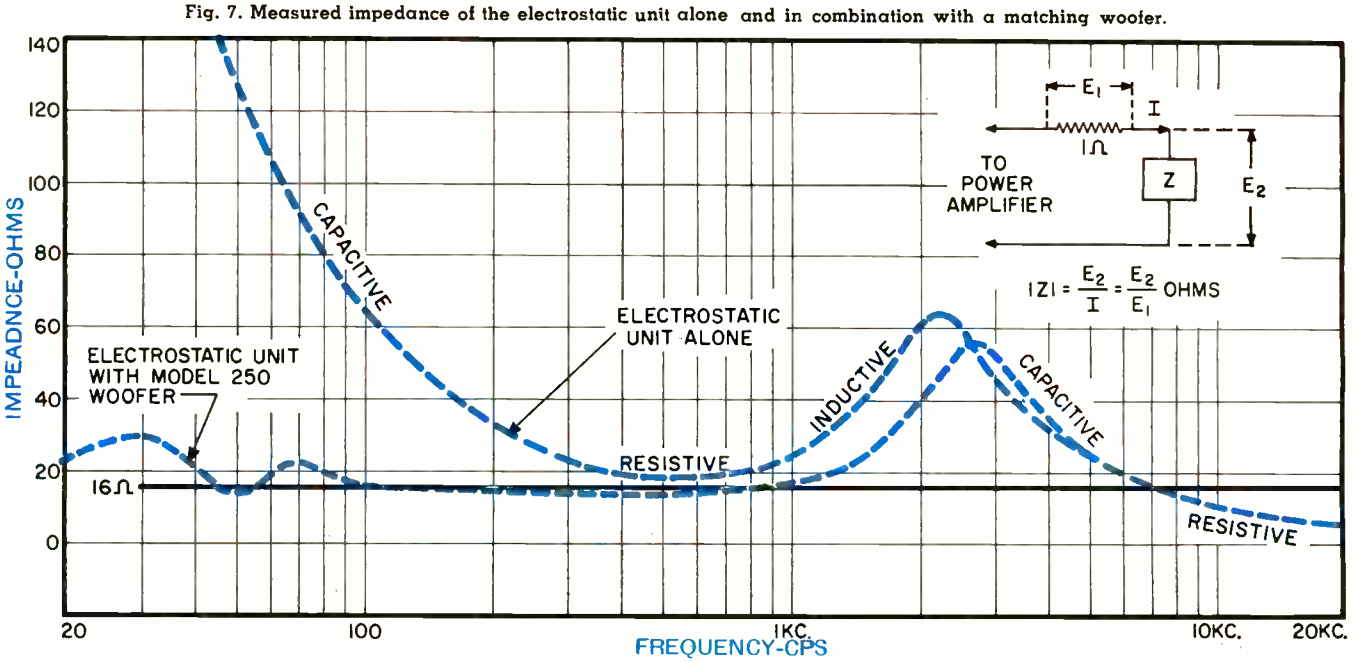
A pressure frequency response curve, taken on axis, is shown in Fig. 4. This was obtained with the test setup of Fig. 3, except that a power level recorder, mechanically linked with the oscillator, was substituted for the distortion meter. The rising pressure response tends to keep the acoustic power output more nearly constant than it would be if the curve were flat. The average reverberant living room translates this rising pressure characteristic, which is accompanied by increased directivity, into a more nearly constant pressure response.

Although the transient response of a loudspeaker can be inferred from its pressure frequency response, tone bursts provide a more direct test. Fig. 5 shows oscillograms of bursts of various carrier frequencies within the passband of the radiator. As one would expect, the 1000 cps bursts, at the lower end of the passband, were not as good replicas of the electrical signal as the remainder of the bursts. The absence of "hangover" is indicative of the effectiveness of a "nearly absent" vibrating element.

Fig. 6 shows the acoustic pressure at various angles off-axis of a Model 130 with all four radiators in operation, at several frequencies. At frequencies below about 8 kc., the response in the horizontal plane is quite uniform over a total angle of about 120°. At 10 kc. and above, there are sharp dips in the

(*Continued on page* 139)

Fig. 7. Measured impedance of the electrostatic unit alone and in combination with a matching woofer.



New TV Projector Makes Giant Color Picture

A new closed-circuit TV projector which is able to produce 12 by 16 foot picture.

A NEW closed-circuit television projector, which produces a bright and sharp 12 by 16 foot color picture, was unveiled recently at the annual session of the American Association for the Advancement of Science in Washington, D. C. *CIBA Pharmaceutical Products Inc.* of Summit, New Jersey, sponsored the live, closed-circuit color telecast and is backing work on the projector. Projecting a large, theater-sized color picture, the demonstration presaged the system's future usefulness in presenting telecasts, live and in color, to large professional audiences in hospitals, universities, and at scientific meetings as a public service. The projector can also be used for black-and-white pictures up to 24 by 32 feet on a metallized screen.

For color reproduction the field sequential system is employed. Utilizing color wheels in the camera and projector, the sequential system adds considerably to the accuracy of the color image produced.

Tradenamed "Eidophor" (a Greek word meaning "image bearer"), the new projector uses a control-layer process to produce the brightly colored pictures. In this process electrical impulses from the camera control an electron beam which bombards, and thus modifies, the surface of a film of oil on a concave mirror. Light passing through the resulting "wrinkles" in the oil film is projected through a special grating onto the screen.

The control layer projection system differs fundamentally from the Schmidt system that is more common in projection television. In this latter system a high-intensity television tube is used. Rather than using the electronic generation of the projection light, the Eidophor system employs an electro-optical control of the light beam from an outside source to produce the picture. It is therefore a relay system, the light output of which is limited mainly by the power of the carbon arc or xenon arc light source.

Special television cameras were made for *CIBA* by *General Electric*. Similar color cameras are now used for monitoring missile sites at Cape Canaveral.

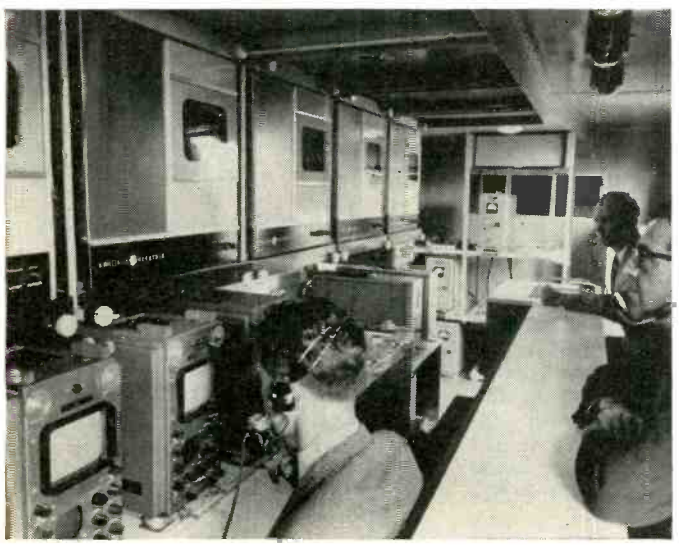
Production models of the color projector are expected to cost about $16,000. The custom-built motor trailer which houses all the other electronic equipment required is the world's largest color television mobile unit, and costs $366,000. A crew of four cameramen, two video operators, one audio engineer, and one projector engineer operate the entire closed-circuit system. —30—

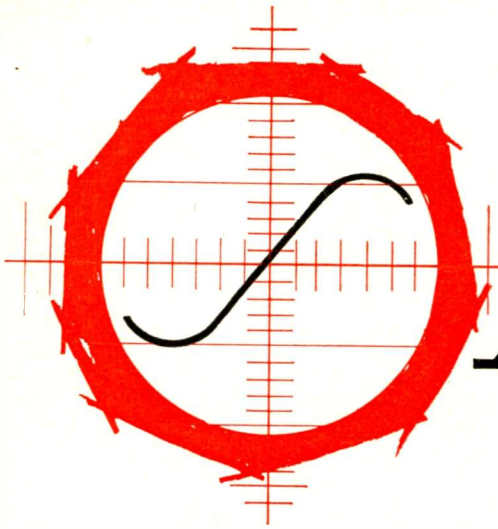
The 5-foot projector weighs 800 pounds; projects a 12 x 16 foot color picture.

This 35-foot-long motor trailer houses all the closed-circuit TV gear needed.

A large professional audience is shown viewing color picture on live telecast.

Interior of the mobile unit, with its 4 TV cameras, 2 projectors, p.a. system, 2 large screens, and control equipment.





By JOHN M. DOYLE

Tips on FM Alignment

Circuits using various types of detectors each have their own bugaboos. Practical techniques.

SINCE MUCH has been written about the alignment of FM receivers, there is not much point in simply reviewing well-known procedures. Therefore, specific problems peculiar to certain types of FM circuits will be our main concern. It will be convenient to concentrate on the various detector circuits, but consideration will be given to related alignment procedures. Considered in order will be discriminator-type detectors, ratio detectors (balanced and unbalanced), locked-in oscillator detectors, and gated-beam detectors.

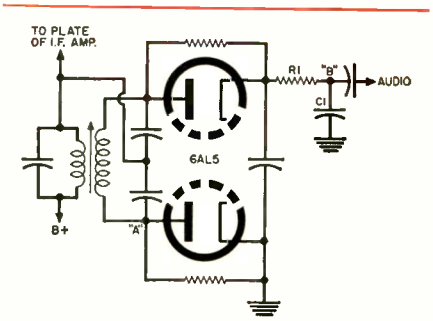
Before any test equipment is connected to the tuner, the latter should be adjusted to a point where no signal is received. This is done because shorting out of the oscillator in an FM receiver cannot usually be accomplished reliably. Since the inductance of the jumper used is likely to approach that of the oscillator coil, oscillator operation tends to continue, although at a different frequency.

For the initial phases of alignment, it is often more practical to forego a sweep generator in favor of a more conventional r.f. generator—one that has been set to the i.f. with 400-cps amplitude modulation. The latter type of signal will be found to provide good accuracy and convenience, especially in indicating exact center frequency during detector alignment. The audio signal also comes in handy for such other purposes as checking AM rejection and detecting oscillation by its effect on the receiver's audio output.

Connection of the signal-generator leads to the receiver chassis in the vicinity of the detector or the final i.f. stage frequently results in the development of standing waves. As a result of these, oscillation may be encountered when i.f. adjustments are attempted. To eliminate this effect, generator leads often have to be re-dressed carefully.

Refer now to Fig. 1, which is the schematic for one version of the discriminator-type detector. The primary of the discriminator transformer is adjusted first, for maximum output. Ordinarily the indicating instrument is connected from the center tap of the secondary to ground, across the load resistor of the secondary. In most versions of the discriminator, this is easy to locate. In this case, the v.t.v.m. is connected from point "A" to ground.

Fig. 1. A version of the discriminator.



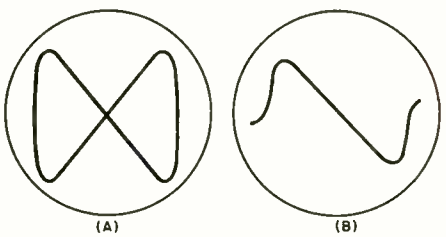


Fig. 2. Swept detector response with scope synced at (A) 120 and (B) 60 cps.

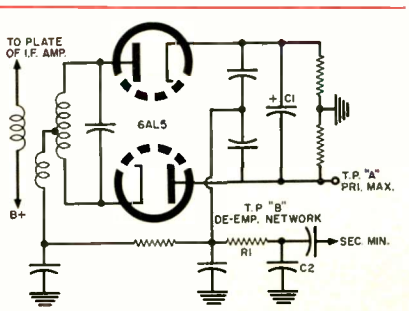
The meter is then transferred to the output of the de-emphasis network (point "B") for the adjustment of the discriminator-transformer secondary. The desired reading here is zero d.c. volts. As the proper setting of the secondary is reached, the meter pointer drops from a definite amount of deflection to zero almost instantaneously. Also the audio modulation from the generator will almost completely disappear at the same point. We therefore have two indicators, one visual and the other aural, for accurately determining the proper point.

If the v.t.v.m. has a zero-center scale, this will be convenient in making the adjustment. A slight movement of the adjustment in one direction will then result in a negative reading, while over-adjustment in the other direction will result in a quick swing through zero to a positive reading.

For final alignment, the sweep generator is brought into play. While a discussion of the conventional setting of generator controls is not intended here, it should certainly be pointed out that sweep width should be increased to the maximum that is consistent with convenient observation of the trace. If sweep is not wide enough, there are several difficulties that can mask the proper alignment point. To mention some, misalignment of the i.f. channel, regeneration, spurious response from the tuner, and standing waves can all obscure the scope pattern to some extent. When the sweep is, for example, 450 kc. wide, the trace on the screen will show the whole response curve and indicate such troubles. If the sweep is too narrow, we may also end up by setting the crossover point on one side of the i.f. response curve.

Occasionally the connection of an oscilloscope to the receiver may result in pickup of external signals, noise, or hum voltages. Internal regeneration or oscillation may also result. These conditions cause modulation or distortion of the observed pattern. To guard against these annoyances, the lead to

Fig. 3. Ratio detector, balanced type.



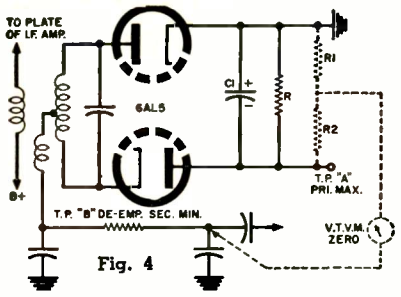


Fig. 4

SHUNT CONNECTION OF MATCHED PAIR RESISTORS AND CONNECTION OF V.T.V.M. INDICATED BY DOTTED LINES

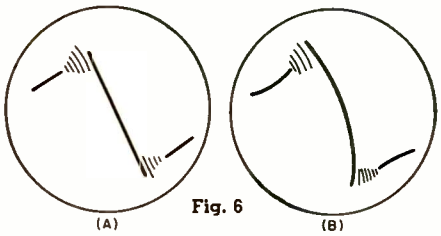


Fig. 6

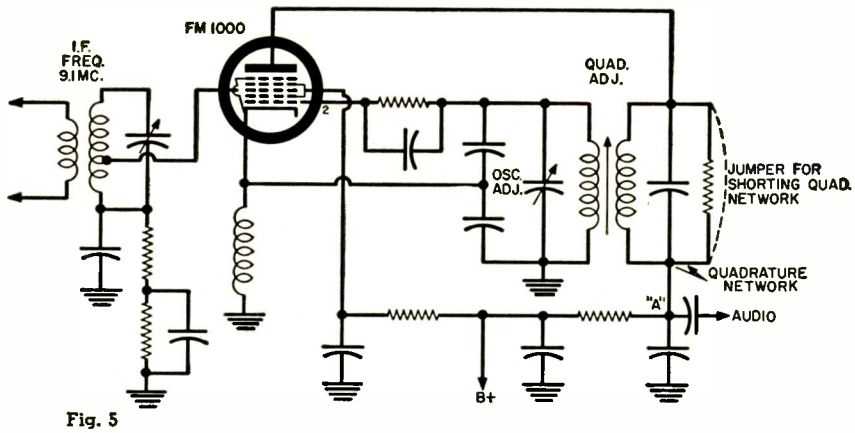


Fig. 5

Fig. 4 (Upper left). One version of the unbalanced ratio detector.

Fig. 5 (Above). Locked-in oscillator-detector found in Philco sets.

Fig. 6. Correct (A) and poor (B) response for oscillator-detector.

the vertical-input terminals should be kept as short as possible and well shielded. If these troubles persist, a resistor in the range between 50,000 and 100,000 ohms may be placed in series with the vertical-input lead of the oscilloscope. In the circuit of Fig. 1, for example, this is necessary to avoid detuning. Keep this resistor as close as possible to the point of contact in the receiver.

A few words are necessary here concerning the final alignment of the i.f. section. When adjusting the frequency setting of the sweep generator, always make certain that the response curve displayed is for the proper intermediate frequency rather than for a harmonic. It is easier to make a mistake of this kind than one might expect, especially if one happens to be working with an instrument that is not completely familiar. However, a simple check eliminates this possibility of error.

With the response curve showing on the screen of the scope, move the receiver tuning control back and forth. If the frequency setting of the generator is correct, the pattern will remain stationary; if not, the pattern will move off the screen as the tuning knob of the receiver is turned.

The reason for this movement lies in the design of those sweep generators where this difficulty is likely to occur. The FM is imposed on an oscillator of fixed frequency, usually in the range between 25 and 60 mc. This signal then beats against another variable r.f. oscillator, providing sweep around the desired frequency by heterodyne action. However, more than one heterodyne output is produced.

For example, assume that the fixed swept oscillator is operating around 45 mc. and that it is beating with a variable oscillator adjusted to 55.7 mc. By adding these two we get 100.7 mc. By subtraction we get 10.7 mc., the desired signal. In addition, the second harmonic of the 45-mc. output is at 90 mc. Thus, there are at least three sweep signals available in this case to which circuits in the receiver may respond, although only one of them is desirable.

If the trace observed on the oscilloscope is the result of either the 90-mc. or the 100.7-mc. signal, it will move off the screen as the receiver's tuning control is rotated because these signals beat with the local oscillator in order to enter the i.f. section. On the other hand, if it is the true 10.7-mc. output, it will stay put. Furthermore, this does not take into account such other adverse effects as image response.

Assuming that i.f. alignment is correct, final oscilloscope alignment of the discriminator is performed by first connecting the scope to point "A" of Fig. 1, as already noted, for the primary adjustment, in which maximum amplitude of the response curve is sought. The scope lead is then moved to the de-emphasis network (point "B") to obtain the crossover pattern, which is adjusted for maximum symmetry, particularly at the crossover point. The sweep frequency of the scope may be set to 120 cps, in which case the pattern should resemble that of Fig. 2A. If the scope is synced at 60 cps, the pattern of Fig. 2B will be obtained.

We will now consider the ratio detector, both balanced and unbalanced types. Information previously given for signal-generator settings and attachment of instrument leads applies equally well here. We first connect the v.t.v.m. across electrolytic capacitor C_1 (point "A" in both Figs. 3 and 4) and ground to adjust the primary of the detector transformer for maximum curve amplitude and to make the i.f. adjustments as well. In the balanced type, we next connect the v.t.v.m. to the de-emphasis network, between point "B" (R_1, C_2 in Fig. 3) and ground, and then adjust the secondary for the rapid zero reading previously described.

To make this adjustment in the unbalanced type, a pair of high-value, matched resistors—100,000 ohms or more—is usually shunted across R in Fig. 4. Connection of the meter is then made between the usual point in the de-emphasis network and the junction of these two temporarily added resistors. To avoid this bothersome procedure, the secondary may be adjusted by ear for minimum audio as previously described, using a conventional r.f. generator with a 400-cycle amplitude-

(*Continued on page* 154)

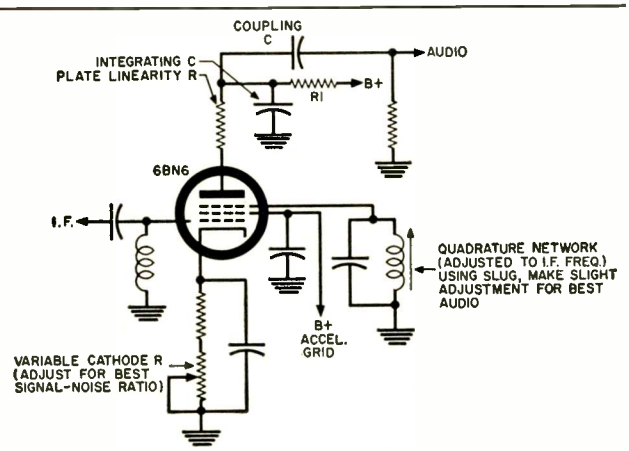
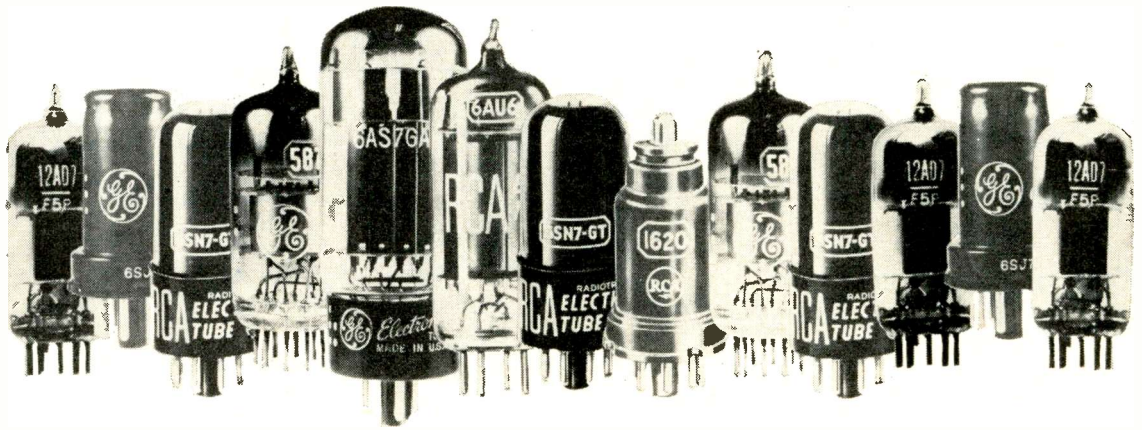


Fig. 7. A gated-beam detector using the 6BN6 tube. The two adjustments in this circuit are the slug in the quadrature tank and the AM rejection control in the 6BN6 cathode.

Test New Tubes on Old Checkers



By JACK DARR

Part 2. Recording developed test settings. How to handle odd-voltage and controlled-warmup types.

TO KEEP a record of the settings found for new tube types, it may be somewhat handier if a small file card is made out for each, rather than trying to keep this information on a single sheet of paper. A small box of appropriate size can be fastened to the top of the tube-tester and the cards filed in numerical order. This makes them easy to find and new cards may be added at any time without disturbing the order.

The gas test of the tester may be used just as it was before. This is merely a resistor switched into the grid circuit of the tube: a button marked "Gas-1" is pushed on the *Hickok* and the "Bias" dial is turned to bring the meter reading down to 100 micromhos. Holding "Gas-1" down, another button, "Gas-2," is pushed, and the meter deflection noted. The second button opens a shunt across the resistor: if there is any gas current flowing in the grid circuit, it will cause the meter to deflect upward. Upward deflection of more than another 100 micromhos indicates that the tube is too gassy for use in critical circuits. This test is especially useful for sync clipper and separator tubes, a.g.c. amplifiers, and oscillators.

Odd-Voltage Tubes

Quite a number of new tubes have been brought out in the last few years with heater voltages which seem very odd to those old-timers accustomed to the familiar 6- and 12-volt types. New tubes may be found with almost any rating from 2.0 volts on up! Some of these may not be found on the voltage selector of the tester; 20 volts, for example, or 19 volts.

The best way to set these up is by a direct measurement. For instance, if a 19-volt tube is to be tested, say a 19AU4, then the selector is set at 25 volts. An a.c. voltmeter is inserted into the filament holes of an unused socket, and the "Line-Adjust" rheostat set to bring the filament voltage down to the correct level. In the case mentioned, the 19AU4 would be plugged into the octal socket: the voltmeter could be inserted into #1 and #8 of the loctal socket for example. This type of compensation may necessitate some extrapolation: the "Line-Adjust" rheostat also raises and lowers the applied plate voltage: however, the results may be interpreted with sufficient accuracy.

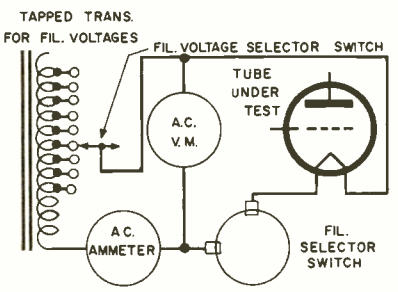
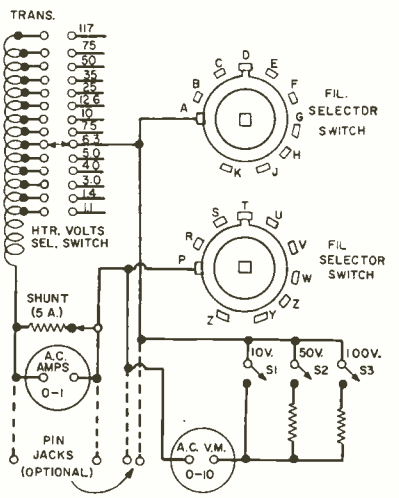


Fig. 4. General arrangement for meters added to filament circuit of a tester.

Fig. 5. Specific wiring for adding meters to Hickok 532. Optional wiring for using external meters also shown.



Controlled-Warmup Tubes

The development of the 600-ma. series of tubes with their controlled-warmup time, for use in TV sets with series heater strings, has also posed a few new problems for tube testers. For an accurate test, these tubes should be set up so that the correct *current* is flowing through their heaters, and then the voltage across them checked. One very elusive trouble in these TV sets is caused by the tube with abnormal filament resistance, causing it to assume more or less than its rightful share of the voltage. To add to the complications, this trouble may be intermittent!

Some late-model testers have provisions for measuring this current, and checking the heater voltage during the test. This provision may be added easily to older testers. A circuit is shown in Fig. 4. A 0-1 a.c. ammeter is connected in series with the heater supply and a suitable a.c. voltmeter is connected across the heater terminals.

The a.c. voltmeter may be connected across the sliders of the heater-selector switches, as shown in Fig. 5. Because of the low heater voltage of many new tubes, a 0-10 voltmeter was chosen. This was raised to an extra range of 0-30 volts by a series multiplier resistor. To avoid accidental damage to the voltmeter, both the basic and extended ranges were selected by a spring-return switch. Other ranges may be added if desired, and a push-button switch used. Although a single s.p.d.t. spring-return switch was used here, any type of switch may be used, depending upon what type of meter and other parts are on hand. As shown

in Fig. 5, a set of pin-jacks may be added instead of this a.c. voltmeter, and the bench v.o.m. may be used, to save the expense of the added meter.

For current measurements, the a.c. ammeter is connected in one leg of the heater supply; it makes no difference which side, of course. The normal 0-1 ampere range is very good for most tubes, especially in the 600-ma. series: the reading falls in the most accurate portion of the scale. For testing rectifier and other high-drain tubes, a very good shunt is needed to protect the meter movement. In the writer's tester, another spring-return switch was used.

A word of caution here: this switch must be of a high quality with *very low contact resistance*. Because of the very small shunting resistance, any contact resistance across the meter will cause it to be overloaded should the switch fail to close cleanly. It might be better to use a d.p.d.t. heavy-duty switch of the type used for portable electric tools, with the contacts in parallel, to avoid this. On the other side of the switch a shunt was worked out by the "cut and try" method, which raised the range of the meter to 0-3 amperes. This is ample for all receiving-type tubes, even the larger rectifiers. The spring normally stays in this position for safety.

The meters shown are mounted on a small piece of thin *Masonite*, but any other thin material may be used. It should be strong enough to hold the switches and brackets, in service. Any suitable wire will serve to connect the meters into the circuit; we used a scrap of 8-conductor "rotator cable," with two conductors paired in the ammeter circuit to avoid voltage drop.

To make the tests mentioned, plug the tube into its socket after setting up the tester. Leave the line switch turned off. Check the time necessary for the tube to warm up, using a sweep-second hand watch, after turning the power on. According to the specifications for these tubes, they should reach almost full operation within 11 seconds after power is applied. More than 10% deviation from this time should be checked carefully. For instance, if a tube required 20 seconds to reach operating temperature, it would probably give trouble in a few weeks and should be replaced.

While running shorts tests, waiting for the tube to warm up, the ammeter should be watched very carefully. Any flickering or variation may mean an intermittent connection inside the heater itself. Probably the best method of evaluating the performance of the filament would be to set the *current* at exactly 600 ma., and then measure the voltage across it; if there is any large variation from normal, the tube should probably be replaced. Fig. 6 shows a test being made on a type 5U8: note the 5 volts indicated on the voltmeter, while the ammeter shows the correct 600 ma. Fig. 7 is a close-up view of the meter mounting and switches. A tube is in the tester, showing 600 ma. on the ammeter, but the voltmeter switch is not being operated.

Another handy test is possible with this set-up. When checking a set of tubes, much time can be wasted waiting for a dead tube to warm up! If you'll glance at the ammeter when a tube is plugged into the socket, it will tell you immediately whether or not the filament is open. Even this small trick can save many minutes of time in a day.

Connecting the Meters

To make the internal connections to the tester, remove the instrument from its case. Check the instruction book and schematic diagram for the location of the various terminals and switches. Locate the filament-voltage selector switches and find the "slider" connections on each: this will generally be the easiest place to make the voltmeter connection. Either of these connections may be opened so that the ammeter leads may be wired in series. Fortunately, most instrument manufacturers are very nice about color-coding the wiring, making it fairly easy to trace.

Low-Voltage Tubes

We inevitably run into a type of tube that cannot be accommodated. These are the ones used in hybrid tube-transistor auto radios using the same potential (12 volts) on both filament and plate. Often identified as the "12K5" type, from one important version in this series, they use a closely spaced "grid" near the cathode that is actually an accelerator rather than a conventional control grid.

While you cannot test the tubes in this family on your old checker, you are no worse off than people buying new testers today, until special circuits are worked out. Tube manufacturers themselves caution against conventional tests for these types. Both *Delco* and *Motorola*, major users of these tubes in their hybrid auto radios, even caution technicians against tapping the tubes for noise or intermittents: a heavy jolt could cause a short between the closely spaced electrodes. The entire chassis should be jarred instead. The only present test for these tubes is direct substitution.

Saving the Sockets

Since replacement of worn-out sockets in a tester gets to be quite annoying, "adapter" sockets should be used in those positions that correspond to the most popular tube types. In many instances, ready-built adapters are available at parts supply houses. They are the types used for in-circuit testing, with terminals brought out at the sides for easy test-equipment connections, but will serve nicely here. Or else, acceptable units can be made up, each consisting of a socket and a tube base wired together "straight through;" that is, with pin 1 connected to pin 1, and so on.

The author began to use such adapters years ago after becoming irritated over the fact that tester sockets "wore out so darn fast." A check of service records and some elementary arithmetic showed the reason: even back in the days of radio, we were testing something like 10,000 tubes a year. With adapters, all the wear is taken by the upper sockets. When these are depleted, they are simply discarded and new ones are plugged in. There is no need to spend time in disassembly and tracing out of wires. —30—

Fig. 6. A 5U8 is in the noval socket (not shown). The ammeter (upper left) indicates the proper 600 ma., while the voltmeter (upper right) correctly shows a 5-volt reading.

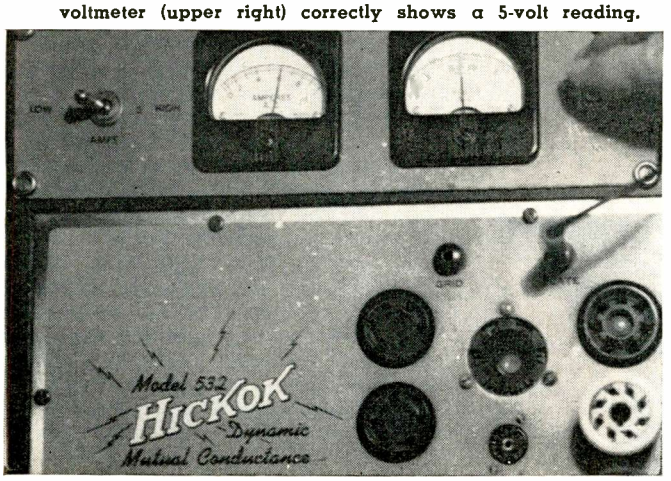
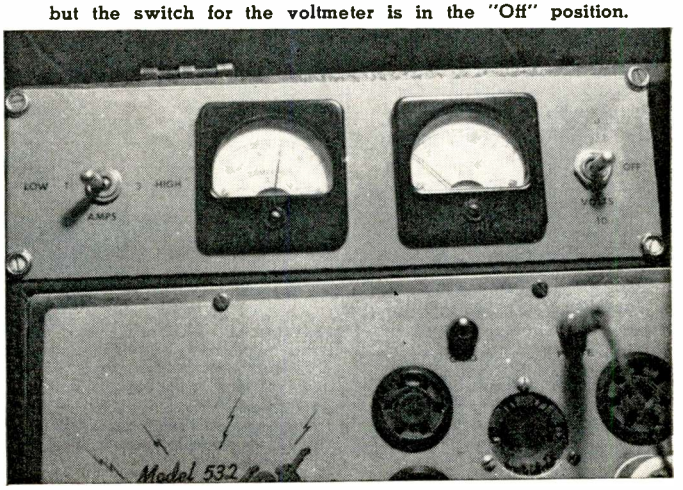


Fig. 7. Close-up of the meter mounting and meter switches. A 600-ma. tube is in the tester (see the ammeter reading), but the switch for the voltmeter is in the "Off" position.



The Case for a Third Channel

By **LEONARD FELDMAN**
President, Madison Fielding Corp.

Results of listening tests when a third channel is added to an already set up stereophonic music system.

AFTER answering consumer questions on stereophonic sound for nearly two years, certain recurring queries served to create a serious doubt as to the validity of some of the accepted axioms of stereophonic reproduction of sound in the home. The problem stems from the nature of the evolution of stereo from its predecessor, binaural sound. Those of us involved in binaural sound, years ago, will always remember dual-headphone listening as a rewarding if somewhat impractical means of achieving spatial realism. We remember, too, that six to eight *inches* between pick-up microphones translated to headphone two-channel listening resulted in virtually perfect spatial visualization on the part of the hearer. The theory advanced then by *Bell Telephone Laboratories* (and there is no reason to believe that human hearing has changed materially in twenty-five years) was that the closely spaced microphones served as individual "extensions" of our two ears, placed in the "best orchestra seat in the house."

There exists even today a hard core of individualists who do the bulk of their two-channel listening *via* headphones. Unfortunately, there is no longer any source material with which to satisfy their binaural craving. Yes, we know that there are nearly a thousand stereo disc titles available (and probably an equal or greater number of stereo tapes), but not one of them was recorded binaurally. The headphone listener is therefore deluding himself—hoping to hear a listening sensation that remains confined to the laboratory.

So much for a few die-hards. The far more alarming question is: are the thousands of newly indoctrinated two-channel stereo listeners equally deluding themselves. Let's examine a typical stereo recording session in detail and see. The first anomaly to strike the observer is the microphone arrangement. If, indeed, the number of channels in the studio pick-up is dictated by the number of ears per person, then the session we are about to witness is intended for outer space consumption, where three-eared Martians dwell. Yes, there are distinctly three microphone channels; a left, a right, and a middle. (There may be more than three actual microphones in a symphonic recording session, but several may be operating to serve only one of the three channels—in effect "compressing" the area of stage-left, stage-right, and center-stage.)

Investigation of this puzzling state of affairs yields two explanations: 1. The recording session is being made monophonically and stereophonically at one and the same time. 2. As long as the center microphone channel is there, why not "blend in" a bit of its output into both the left and right tracks, to eliminate that "hole-in-the-middle" which has so sorely afflicted the listening public? Indeed, why not? Certainly, the "ping-pong" effect originally foisted upon the public to stimulate interest in stereophony is fast disappearing from present-day, sophisticated orchestral recordings. If a fusion or

"wall" of sound is the aim, then it would seem to be justifiable to use any technique available in the studio to create that fusion. But what of the home listener? Equipped with two channels, two speakers, two amplifiers, etc., does it follow that he will derive any benefit from the three-channel recording technique? Or, will speaker placement, maladjustment of controls, and room acoustics create a still more objectionable effect—that of *two* orchestras playing at opposite corners of the room. If the latter results (and we have heard numerous installations which do nothing more), then we are spending vast sums of money on superfluous electronic gear when all we really needed was a second speaker. So prevalent is this particular state of confusion that there is not one of us in the field who has not been asked "Is the only requirement for stereo the addition of a second speaker?"

Somewhere between the "ping-pong" effect and "one-channel" stereo lies a happy compromise, which we set out to find. To subject observers to musical listening alone seemed insufficient in the case of three-channel listening. For one thing, the choice of musical selections would, perforce, be arbitrary. The exact technique used in recording would introduce an even greater variable. Our compromise decision, then, was to combine controlled, single-tone experiments with musical auditioning *via* two and three channels.

The Listening Test

Our population sampling, while small compared with some of the monumental works compiled by pioneers in the field, consisted of ten adult listeners. Six males and four females were chosen. Of the six males, two have had some professional dealings with the reproduction of sound. Two were non-professionals who had heard stereo before and two had never heard any stereo before the tests. All the ladies had heard stereo, but none were professionally involved in hi-fi. All the subjects were tested first for reasonably equal hearing response in both ears.

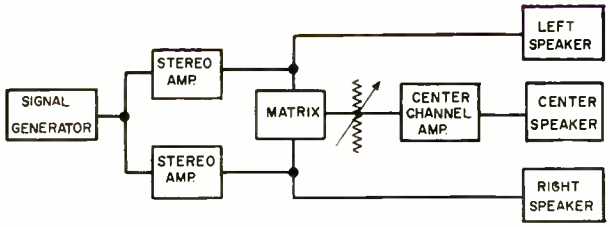


Fig. 1. Block diagram shown here is of the three-channel setup that was employed for the listening tests.

Since our answers were intended to have meaning in terms of home conditions, we elected to conduct the experiments in an average living room rather than in some specially treated sound chamber. In order to eliminate such side effects as "standing waves" and "nulls," each subject was tested from two points in the room. The diagrammatic layout of the test set-up is shown in Fig. 2. In the first series of tests, the same frequency was fed to two loudspeakers and balanced electrically. Unbalance was then introduced, to emphasize either the sound from the left or right speaker. The observer was never told where the emphasis would take place in advance and was asked to indicate when the sound shifted from "center" stage to either the right or the left. This simple objective test was repeated at 10 frequencies, ranging from 50 cycles to 15,000 cycles and at three different levels of intensity. Frankly, after testing the first two observers, we were ready to abandon the project entirely on the basis of such wide divergencies of opinion. As we proceeded with more observers, however, a very definite pattern came into focus. The *average* results of this two-channel test are given in Table 1.

The second series of tests involved the use of a third channel. Much has been written about "three-speaker"

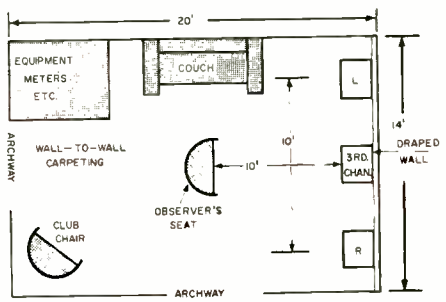


Fig. 2. Room layout in which the two- and three-channel tests were conducted.

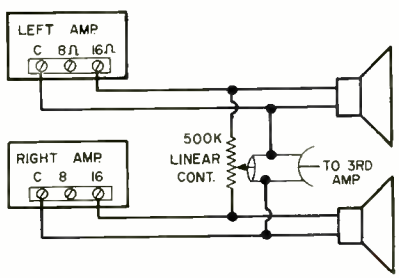


Fig. 3. Matrixing or mixing circuit used.

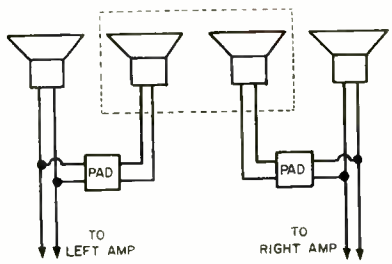


Fig. 4. Creating third channel by paralleling two speakers from left and right channels and positioning them between the outer two. No additional amplifier is needed.

INTENSITY	FREQUENCIES (in cps)									
	50	100	200	400	800	1000	2000	4000	6000	8000 Above
Low	N_T	N_L	5.1 db	3 db	4 db	3 db	3 db	6 db	N_P	N_P N_P
Medium	N_L	7 db	5.3 db	2 db	3.2 db	2 db	3 db	5 db	N_P	N_P N_P
Loud	N_L	5 db	4 db	3 db	3.3 db	2 db	3.5 db	5 db	10 db	N_P N_P

NOTES: Reading of decibels are "average left or right channel emphasis" detected by observers.
N_L = Readings completely random and erroneous, confirming conclusion that low frequencies are essentially non-directional because of long wavelength.
N_P = Readings in these high-frequency ranges, while taken, are deemed inconclusive since errors in judgment of direction were in the majority. At high frequencies, a mere turning of the head will cause the listener to believe that sound has shifted from one side to the other even when sound intensity from one side is as much as 20 db greater than from the other side.

Table 1. Average level differences detected by listeners in two-channel setup.

Table 2. Average level differences detected by listeners in three-channel setup.

INTENSITY	FREQUENCIES (in cps)									
	50	100	200	400	800	1000	2000	4000	6000	8000 Above
Low	N_L	N_L	7 db	8 db	6 db	4 db	6.1 db	7.8 db	8 db	N_P N_P
Medium	N_L	7.3 db	6 db	6.2 db	6 db	4.8 db	7 db	7.3 db	7 db	10 db N_P
Loud	N_L	8 db	6.4 db	6 db	7 db	4.3 db	6 db	8 db	7.7 db	10 db N_P

NOTES: Readings taken in same manner as in Table 1. In addition to increase in one-sided intensity for positive identification of source of sound, it is interesting and somewhat unexpected to note that the range of frequencies over which it becomes possible to determine source of sound is actually extended by the addition of a third channel. It is believed that the center channel serves as a positive "starting point" or mental "anchor point," making phase cancellations less confusing.

stereo, so that perhaps a definition of our "third channel" is in order at this point. We did *not* use a left and right "tweeter" and a center "woofer" channel, for this is still basically two-channel reproduction. We did *not* use one, wide-range center channel and two "end" tweeters or mid-range tweeters. We *did* employ two wide-range systems at the ends and a somewhat less expensive, but nevertheless full-range, system for the center channel. The center channel itself was fed an equal mixture of the left and right channels (the same procedure used in three-channel microphone mixing discussed earlier). The electrical set-up is shown in Fig. 1.

In execution, the second series of tests was identical to the two-channel test, that is, tones of equal intensity and frequency were fed to the left- and right-speaker systems. A mixture of

(*Continued on page* 104)

Replacement Parts—

STANDARD or SPECIAL?

By **WALTER H. BUCHSBAUM**
Television Consultant, RADIO & TV NEWS

Even with many resistors and capacitors, certain characteristics must be considered.

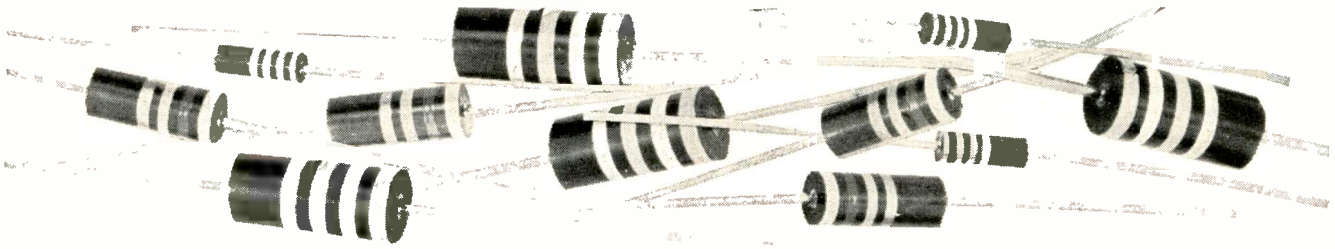


Fig. 1. Standard carbon composition resistors in an assortment of popular ½-, 1-, and 2-watt sizes.

THE PROBLEM of replacing a defective part in a TV receiver often boils down to deciding whether to use a standard component that is on hand or whether to get the manufacturer's exact replacement part. In the case of tubes, diodes, and similar components, an exact replacement is either in the technician's stock or else directly available from the local parts distributor. However, when one section of a multi-section electrolytic goes bad, or if the deflection yoke has a partial short, the difference between using an available replacement off the shelf or ordering the special component from the manufacturer means the difference between a day or weeks of waiting. For both service technicians and customer, the quick repair job possible with a standard part is always preferable to having to wait until the special replacement part arrives, whenever it is possible.

One should know where standard components can be used, where modifications are possible to use a standard component, and where an exact replacement cannot be avoided. In many instances, the local distributor carries parts which could be used provided the technician knows the important characteristics which seem to stamp the defective parts as "specials." Some hints on adapting standard parts to replace a "special" component are also discussed. Only resistors and capacitors are considered here but, in a subsequent article, coils and transformers will be covered.

Composition Resistors

In general, it is a safe assumption that any defective carbon resistor can be replaced by a standard unit. Typical ½-, 1-, and 2-watt resistors are shown in Fig. 1. Resistance values, tolerances, markings and sizes have been sufficiently standardized so that practically all values will be readily available in the technician's own stock or else from the local jobber. It is important to consider the tolerances of the replaced resistor, especially when it is used in such circuits as the horizontal oscillator, a.f.c., or some audio feedback network. It is safe to replace a 10% resistor with a 5% one, but never the other way around.

As concerns the power rating of a resistor, some technicians feel that there can be no harm in using a 1-watt replacement for a ½-watt resistor, but in some circuits this can lead to trouble. In the tuner and i.f. sections, for example, the 1-watt resistor, which has more capacity than its smaller cousin, is likely to cause misalignment. In some other circuit, the ½-watt resistor may have become defective because more than ½-watt of power was handled. Substituting a larger resistor may now obscure the real defect; the excess current continues and, after a while, some other, more expensive component in that circuit may become damaged.

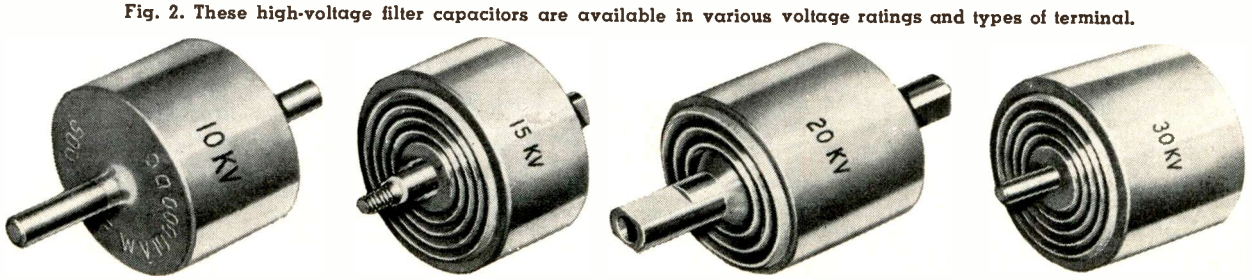
Film Type Resistors

Most film type resistors are used either for high-voltage circuits or else as precision resistors, usually with 1% tolerance. They must be replaced by other film type resistors in either case. Most jobbers carry a line of film types in stock, but the technician has to know the exact resistance, tolerance, and wattage rating in order to get the right replacement. There are some varistors and thermistors which look like film type resistors, but their temperature and current coefficients are quite different.

Potentiometers

Many manufacturers use their own code for marking potentiometer values, and reference to the circuit diagram is therefore often necessary to make sure of the resistance value. Replacing a defective potentiometer may mean a search for the correct replacement part because of the many characteristics that must be considered. Resistance values are standardized and most potentiometers are ½- to 2-watt composition types, unless they are wire-wound units, like the focus and centering controls found in earlier-model TV receivers. What complicates the selection of a standard-replacement potentiometer

Fig. 2. These high-voltage filter capacitors are available in various voltage ratings and types of terminal.



is usually the mechanical arrangement of the defective part with another, concentric potentiometer, or with a switch, and the shaft dimensions. Fig. 3 shows an assortment of typical 2-watt potentiometer combinations.

The taper of a potentiometer is also important to know. This characteristic depends on the rate at which part of the total resistance is tapped off as the potentiometer's shaft is rotated. If the unit has a linear taper, this means that, when the shaft is turned exactly halfway between its two extremes of rotation, exactly half of the total resistance will appear on either side of the tap. When the shaft is turned so that it is a quarter of a turn from one extreme, one quarter of the total resistance will appear on one side of the tap and three quarters of the total will appear on the other.

For audio controls, linear tapers are not usually desirable. Apparent loudness to the human ear does not have a direct linear relationship to increases or decreases in audio voltage. A linear-taper potentiometer would make a volume control appear "bunched up" at one end and spread out at the other. For this reason, a special audio taper is used on all volume controls, and on many tone-control potentiometers as well. This taper "bunches" resistance together at one end of the potentiometer rotation so as to accommodate the logarithmic characteristic of the human ear. There are other types of tapers available, but the most commonly used in radio and TV receivers are the linear taper for TV controls and the audio taper for audio controls.

Another complicating factor in replacing some potentiometers is the location of taps on the fixed resistance. Such taps often are used on the volume, tone, and contrast or gain controls; and the replacement part must have the same taps, at the same resistance points.

The problem of matching the shaft length of the replacement and of making it fit the front-panel knob is usually not severe, since most replacement potentiometers are furnished with an extra-long shaft that can easily be cut down with a hacksaw. Most jobbers stock either a large variety of potentiometers or offer universal replacement kits, which permit the technician to assemble almost any desired combination of resistance, taper, shaft, and concentric combination. Because of their versatility, these kits increase the likelihood of quick availability with low inventory.

While the majority of potentiometers in radio and TV receivers can be replaced by standard parts available from jobbers' stock, there are some potentiometers, especially those using taps, concentric-control arrangements, and possibly special tapers, that must be obtained from the set manufacturer. In some earlier TV sets and in current color sets, special high-voltage insulated potentiometers are used in the h.v. cage. While it is always a good idea to check with the local jobber first, some of these special components may also have to be obtained from the manufacturer.

Power Resistors

Most power resistors used in TV receivers are of the wire-wound type and, since they are made in standard resistance and wattage ratings, they can usually be replaced from the local jobber's stock. In this instance, it is perfectly acceptable to replace a resistor with one of greater power rating provided the replacement fits into the same space. In many TV sets, the power resistors are contained in a single strip assembly, which is often riveted to the chassis. To replace a single section, the new part can simply be wired across the old terminals if an open circuit is the defect. If the defect consists of a short to the chassis, then the replacement will require using different terminal points.

Here, caution is recommended. Power resistors that are bolted to the chassis often use the chassis to dissipate some of their heat. Thus they do not need to have as great a power rating as if they were suspended from their terminals only, thus being required to radiate their dissipated heat into the surrounding air. For this reason, the pigtail type replacement resistor should use the next higher wattage rating than the flat, chassis-mounted resistor it replaces.

Many technicians feel that, instead of getting the correct resistance in the replacement part, it is easier to use a slide-wire type of adjustable resistor and set it to the correct value. This is permissible if the reduction in power dissipation is considered when only a fraction of the entire resistor body is used. It is poor practice to use such a variable resistor at less than half its total resistance setting, unless the power rating is correspondingly increased.

In general, it is a safe assumption that any power resistor can be replaced from jobber's stock, even if the physical appearance is not the same, or if a variable resistor or a combination of several has to be used. The technician should never attempt to replace a wire-wound power resistor by a combination of parallel or series carbon resistors, since their construction may not permit continuous, full, power dissipation without resistance change and eventual deterioration.

Electrolytic Capacitors

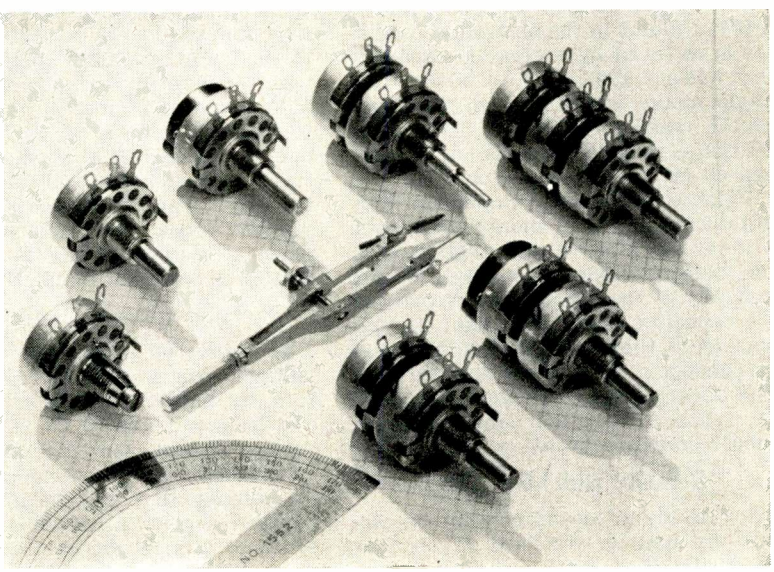
At first glance, the large variety of replacements available at most distributors seems to indicate that any electrolytic capacitor can be replaced by its exact duplicate. This is true for most capacitors. Occasionally some slight differences appear that complicate the replacement problem.

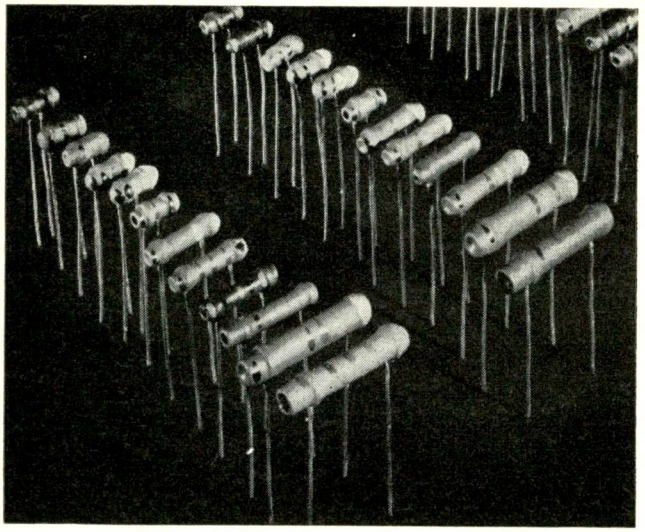
A good example is the instance where the parts distributor has an uninsulated metal-can replacement for a defective electrolytic capacitor that has exactly the same capacitance and voltage ratings, but is insulated by a cardboard tube. The uninsulated capacitor can certainly be used as replacement, provided that its shell is carefully covered with several layers of insulating tape and the capacitance values are clearly marked on the outside.

Another instance is the case where only one section of a multiple-section capacitor is defective. Either because an exact replacement for the entire can is not in stock or because of the difference in cost, the technician may decide to replace only the defective section by a smaller, pigtail-mounted capacitor. Fig. 5 shows typical, cardboard-insulated, electrolytic, single-section capacitors suitable for such replacement work. While the original capacitor can may be mounted above the chassis, the smaller replacement may be mounted underneath, at convenient terminal points. Caution is required here to locate the new part at the coolest, best-ventilated spot, since excessive heat will shorten the capacitor's life.

Ratio detectors use small, low-voltage, electrolytic capacitors. When one of these is replaced, it is important that

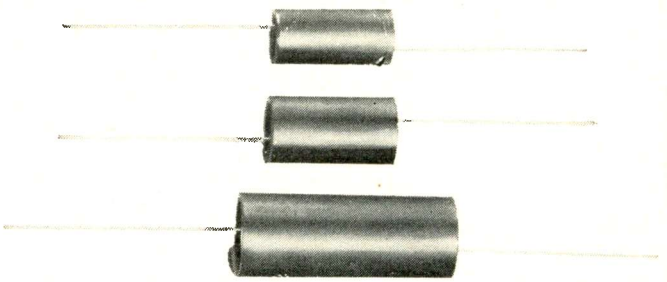
Fig. 3. Some of the many available TV potentiometer combinations.





◀Fig. 4. Ceramic capacitors are available in a variety of types and sizes. Units with controlled temperature characteristics are used to stabilize various circuits.

Fig. 5. Various sizes of cardboard-insulated, pigtail, single-section, electrolytic capacitors. They are useful replacements when part of a multiple unit goes bad. ▼



the correct polarity be observed and that the outer shell be insulated. An exact replacement value is not necessary, but the nominal capacitance of the replacement should not be less than that of the original and not more than 20% higher.

Since capacitances of electrolytics are not usually critical, a somewhat larger unit can usually be used; but when a 40-μfd. filter input capacitor is replaced with an 80-μfd. unit, this may raise the "B+" voltage and the initial current surge sufficiently to shorten the life of other components in the set. In the case of transformerless TV sets, the electrolytics that are part of the doubler and filter-input circuit should be replaced only with very similar capacitors.

Paper Tubular Capacitors

Generally standard items carried in every jobber's stock, paper tubular capacitors are also usually found among the spare parts of the service technician. In most cases, tubular capacitors can be replaced by ceramic disc capacitors or any other type having the same value.

Since many ceramic capacitors have much greater tolerances than the tubular types, it can happen that a ±10% tubular in the horizontal oscillator is replaced by a ceramic capacitor that has a + 100, −20% tolerance. This might make adjustment of the horizontal oscillator difficult. Therefore caution is required in replacing tubular capacitors in such critical circuits.

Voltage ratings are important only in that the new part should never have a lower working voltage than that of the defective part. Although in the majority of the circuits the polarity of the capacitor is not important, the replacement tubular type should always be connected just as the original was. The outer winding terminal, indicated by a line around the capacitor body, should go closest to a.c. ground.

Ceramic and Mica Units

Invariably mica and ceramic capacitors are used in standard values that are available at the distributor. Direct factory replacements of these types is hardly ever needed. The important thing about getting a replacement from a jobber is to make sure that all the characteristics of the capacitor are known. Capacitance, voltage rating, and tolerance are almost always stated either through the color code or else on the circuit diagram or parts list. If voltage rating is not given, it is safe to assume that it should be at least 30% higher than the highest d.c. voltage in the set.

The characteristic that is often overlooked is the variation of capacitance with temperature. Bypass and coupling capacitors in the i.f., video, and deflection circuits are not critical in this respect; but capacitors in the tuner oscillator, the horizontal a.f.c., and the vertical oscillator often have special temperature characteristics. Where mica capacitors are used, the silver-mica type is usually called for to maintain stability over wide ranges of temperature. This is indicated by the color dot in the second row, left, which corresponds to a letter giving temperature characteristics. For example, an orange dot stands for characteristic *D*, which means ± 3% change over a range of ± 100° C.

Ceramic capacitors (Fig. 4) are similarly marked at the color band nearest to the lead. Instead of special stability with temperature, some capacitors also have negative temperature coefficients to compensate for other circuit changes due to heating. If the exact temperature characteristic of the defective capacitor cannot be obtained from jobber's stock, the replacement may have to be gotten from the set manufacturer; but such instances are rare.

High-Voltage Capacitors

In most TV sets, the values and voltage ratings of the h.v. filter capacitors are limited to such values as 500 and 1000 $\mu\mu$fd. and 10, 15, 20 and 30 kv. As Fig. 2 shows, however, the physical arrangement of the terminals varies. To accommodate any terminal combination, some manufacturers offer screw-in kits to enable the technician to make up the terminals as needed. Other parts manufacturers offer a variety of h.v. capacitors designed to replace any type. Generally h.v. capacitors can be replaced from jobber's stock and rarely present any sort of problem.

Variable Capacitors

The trimmer capacitors used in some horizontal-deflection circuits occasionally are made up to manufacturers' specifications and are therefore not directly obtainable from the jobber. Since these capacitors are of the compression type, it is often possible to repair them by taking them apart carefully, clearing the short, and reassembling them. If the ceramic frame is cracked, especially on dual and triple units, it may be necessary to turn to the set manufacturer for a correct replacement part. Trimmer capacitors used on most TV tuners are standard parts and can be had from jobber's stock. Sometimes the exact physical duplicate is not available, and then the technician must determine whether the available part can be fiitted into the space occupied by the defective one. Mechanical work on the tuner must be done with great care, since it is easily possible to damage contacts, switch sections, or coils accidentally.

The variable capacitors that make up the fine-tuning control on the TV tuner almost always must be exact factory replacements. In this connection, it may be mentioned that most jobbers carry an assortment of parts for *Standard Coil*, *RCA* and other widely used tuners.

Conclusion

The point in preparing an article of this type is that many technicians still do not realize *all* the possibilities that can be explored in obtaining replacements for apparently special parts, or *all* of the factors that should be considered in determining just how special a component may be. Some factors have been explored here already. In a subsequent issue, the matter of replacing coils, transformers, deflection yokes and other inductances used in TV receivers will be treated. —30—

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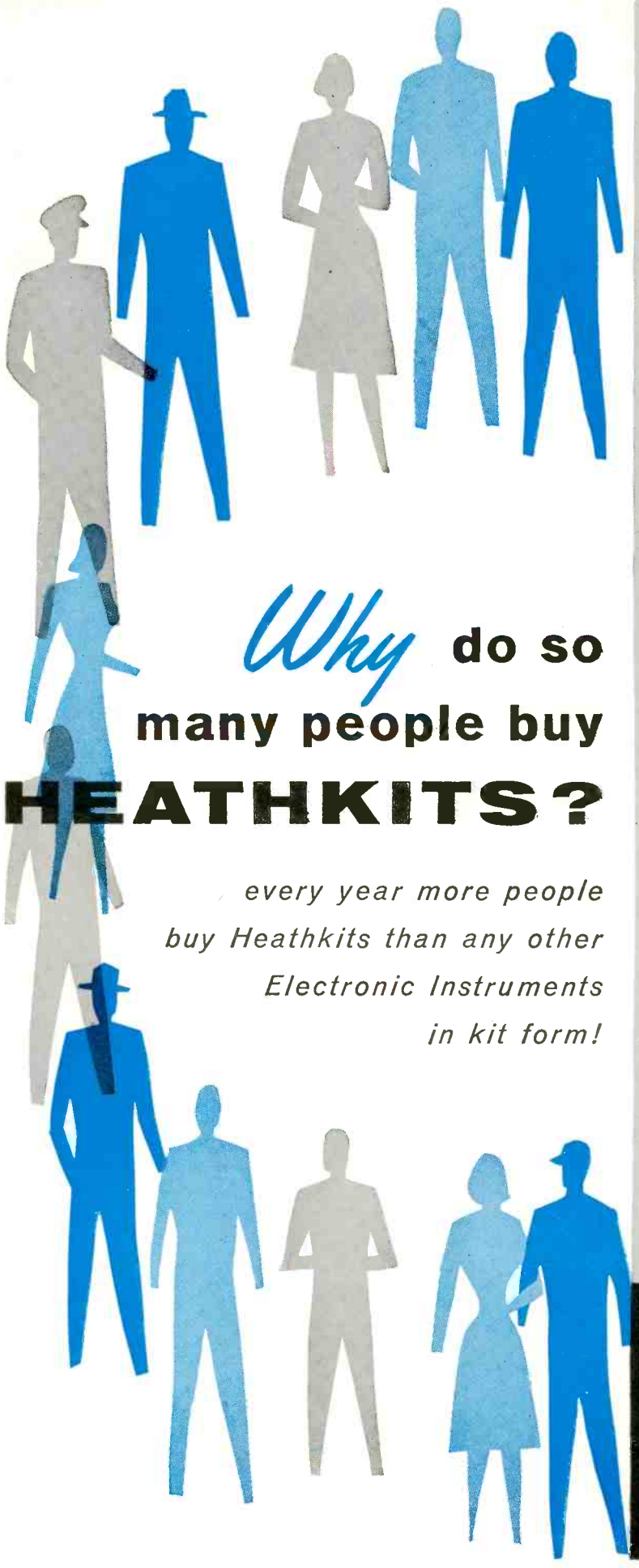

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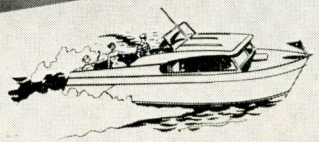

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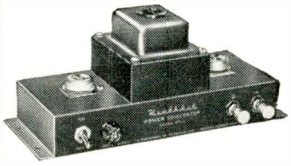

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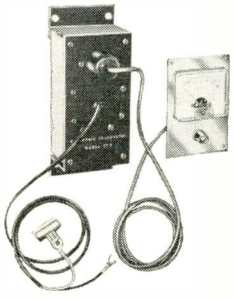

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MODEL AG-9A **$34.50**

AUDIO SIGNAL GENERATOR KIT

This unique generator uses three rotary switches to select two significant figures and a multiplier to determine audio frequency, allowing return to the exact frequency previously measured when making multiple frequency measurements. Covers 10 CPS to 120 kc with less than .1 of 1% distortion between 20 and 20,000 CPS. Shpg. Wt. 10 lbs.

MODEL TS-4A **$49.50**

TV ALIGNMENT GENERATOR KIT

TV service technicians will appreciate the outstanding features found in this sweep generator. Provides essential facilities for aligning FM, monochrome TV or color TV sets. The all-electronic sweep circuit employs a trouble-free controllable inductor which varies frequency by magnetic means. An unusual buy at this low price. Shpg. Wt. 16 lbs.

MODEL CD-1 **$59.95**

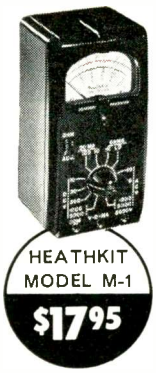
COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color servicing instruments, a color bar and white dot generator in one versatile and portable unit, which has crystal controlled accuracy and stability for steady lock-in patterns. (Requires no external sync leads.) Easy-to-build and easy-to-use. No other generator on the market offers so many features at such a great price saving. Shpg. Wt. 13 lbs.

ETCHED CIRCUIT VTVM KIT

Time proven for dependability, accuracy and overall quality, the V7-A is one of the wisest investments you can make for your electronic workshop or lab. Its multitude of uses will make it one of the most often used instruments in your possession. Use it to measure all operating voltages and potentials such as B+ and AC-DC, or straight AC power supplies, filament voltage, bias voltage, AVC voltage, line voltage, etc. Ideal for measurements in all types of AM, FM and TV circuits. Checks discriminator or detector operation, AVC or AGC performance, while the ohmmeter may be used to measure circuit continuity, circuit resistance, to test out individual components with resistance measurement, or to trace circuit wiring through cables or chassis openings. Front panel controls consist of rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit for high accuracy and an etched circuit board is employed for most of the circuitry. The circuit board not only simplifies assembly but permits levels of circuit stability not possible with ordinary conventional wiring methods. Shpg. Wt. 7 lbs.

HEATHKIT MODEL V7-A **$25.95**



HEATHKIT MODEL M-1 **$17.95**

HANDITESTER KIT

Ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop. The combination function range switch simplifies operation. Measures AC or DC voltage from 0 to 10, 30, 300, 1,000 and 5,000 volts. Direct current ranges are 0 to 10 ma and 0 to 100 ma. Ohmmeter ranges are 0 to 3,000 and 0 to 300,000. Top quality, precision components used throughout. Small and compact, take it with you wherever you go. Very popular with home experimenters and electricians. Test leads and 1½ volt size C battery are included with the kit. Shpg. Wt. 3 lbs.

HEATHKIT MODEL MM-1 **$29.95**

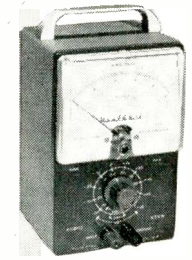
20,000 OHMS/VOLT VOM KIT

Portable and accurate, this kit features a 50 ua 4½" meter and 1% precision multiplier resistors for high accuracy. No external power required. Provides a total of 25 meter ranges on a two-color scale. Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1,500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000. Covers —10 db to +65 db. Housed in an attractive bakelite case with plastic carrying handle. Batteries and test leads included. Shpg. Wt. 6 lbs.

TUBE CHECKER KIT

Brand new in every respect, the TC-3 features outstanding performance and ease of operation. Sockets are provided for 4-pin, 5-pin, 6-pin, 7-pin, large, 7-pin miniature, 7-pin sub-miniature, octal, loctal, and 9-pin miniature tubes. Protection against obsolescence is provided by a blank socket to facilitate modification for checking newly added tube types. A 10-lever switch makes it possible to connect any element to any other element regardless of the pin numbers involved. A neon bulb indicator shows filament circuit continuity and leakage or shorts between elements. A specially designed spring loaded roll chart mechanism permits the roll chart to run freely throughout its entire length without binding. Thumb wheel drive knobs are provided on both sides of the panel to accommodate the left handed operator. Compact and small in size, the TC-3 is ideally suited for portable applications. Both the roll chart and the meter are illuminated to facilitate use in darkened areas. Shpg. Wt. 12 lbs.

HEATHKIT MODEL TC-3 **$39.95**



MODEL AV-3 **$29.95**

AUDIO VTVM KIT

This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of critical AC voltages. Features a large 4½" 200 ua meter with increased damping in the meter circuit for stability in low frequency tests. Measures AC from a low value of 1 millivolt to a maximum of 300 volts AC (RMS). Voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover —52 to +52 db. 1% precision multiplier resistors used for maximum accuracy. Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

MODEL CT-1 **$7.95**

IN-CIRCUIT CAPACI-TESTER KIT

This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mmf, not shunted by an excessive low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). Checks all bypass, blocking and coupling capacitors of the paper, mica or ceramic types. (Does not detect leakage nor check electrolytic condensers.) Electron beam "eye" tube is used for quick indication. A 5-position function switch is featured which controls the power to the instrument and selects the test being made. Easy to build and easy to use. Test leads included Shpg. Wt. 5 lbs.

MODEL BE-5 **$39.95**

LOW RIPPLE BATTERY ELIMINATOR KIT

Completely up to date the BE-5 will power all the newest transistor circuits requiring 0 to 12 volts DC, and the new hybrid automobile radios using both transistors and vacuum tubes. An extra low-ripple filter circuit is employed holding AC ripple down to less than .3%. Doubles as a battery charger or marine converter. Shpg. Wt. 21 lbs.

MODEL T-4 **$19.95**

VISUAL-AURAL SIGNAL TRACER KIT

New in every respect the T-4 features a built-in speaker and electron beam "eye" tube for signal indication, and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 5 lbs.

MODEL C-3 **$19.50**

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately as well as their operating characteristics with this fine instrument. All values are read directly on a calibrated scale. An electron beam "eye" tube indicates balance and leakage. A valuable addition to any service shop or lab. Shpg. Wt. 7 lbs.

"APACHE" HAM TRANSMITTER KIT

HEATHKIT
MODEL TX-1
$234.95

- **Built-in cooling fan**
- **Rotating Slide Rule Dial**
- **Compact, Stable, VFO**
- **Provision for SSB Adapter**

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

This beautifully styled transmitter has just about everything you could ask for in transmitting facilities. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. A completely redesigned, compact and stable VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with full gear drive vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters (11 m with crystal control). This unit also has adjustable low-level speech clipping and a low distortion modulator stage employing two of the new 6CA7 /EL34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. A formed one-piece cabinet with convenient access hatch provides accessibility to tubes and crystal socket. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. A "spotting" push button is provided to allow tuning of the transmitter before switching on the final amplifier. This feature also enables the operator to "zero-beat" an incoming frequency without placing the transmitter on the air. Equip your ham shack now for top transmitting enjoyment with this outstanding unit. Shpg. Wt. 110 lbs.

New Styling... New Features

HEATHKIT

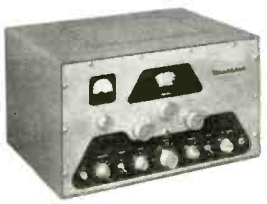
HEATH COMPANY
Benton Harbor 15, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT
MODEL SB-10
$89.95

SINGLE SIDEBAND ADAPTER KIT

Designed as a compatible plug-in adapter for the model TX-1 it can also be used with transmitters similar to the DX-100 or DX-100-B by making a few simple circuit modifications and still retain the normal AM and CW functions. Easy to operate and tune, the adapter employs the phasing method for generating a single sideband signal, allowing operation entirely on fundamental frequencies. The critical audio phase shift network is supplied, completely preassembled and wired in a sealed plug-in unit. Features include single-knob bandswitching for operation on 80, 40, 20, 15 and 10 meters, an easy-to-read panel meter, built-in electronic voice control with anti-trip circuit. Enjoy the advantages of SSB operation by adding this fine kit to your ham shack now. Shpg. Wt. 14 lbs.



MODEL
DX-100-B
$189.50

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

DX-100-B PHONE & CW TRANSMITTER KIT

The same fine performance of the time proven DX-100 is retained in the DX-100-B with improvements in the crystal and loading circuits. The one-piece formed cabinet has convenient access hatch for changing crystals, etc. and the chassis is punched to accept sideband adapter modifications. Features a built-in VFO, modulator and power supply, complete shielding to minimize TVI, and a pi network output coupling to match impedances from 50 to 72 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW. Covers 160 through 10 meters. Single-knob bandswitching and illuminated VFO dial and meter face. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. Designed for easy assembly. Measures 11⅝" H. x 19½" W. x 16" D. Shpg. Wt. 107 lbs.

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

Operates on 80, 40, 20, 15, 11 and 10 meters, using a single 6146 tube in the final for 75 watt plate power input CW, or 60 watts phone. Single-knob bandswitching, pi network output, complete shielding, provision for three crystals and VFO. D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.

MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

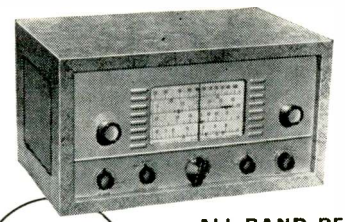
This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6DQ6A tube in the final for 50 watt plate power input, pi network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

"MOHAWK" HAM RECEIVER KIT

Designed for ham band operation and for maximum stability and accuracy, the Heathkit "Mohawk" receiver will let you enjoy ham activities to the utmost. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all the amateur frequencies from 160 through 10 meters on seven bands. An extra band is calibrated to cover 6 and 2 meters using a converter. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely pre-assembled, wired and aligned front end coil/bandswitch assembly assures ease of construction and top performance. Many more important features are provided in this outstanding receiver for dependable and effective amateur communications. Ruggedly constructed with well rated components throughout. Shpg. Wt. 66 lbs. Matching accessory speaker kit; optional extra. Model AK-5. $9.95. Shpg. Wt. 8 lbs.

- **Prewired and Aligned Coil/Bandswitch Assembly**
- **Crystal Controlled Oscillators for Drift-Free Reception**

HEATHKIT MODEL RX-1 **$274.95**



HEATHKIT MODEL AR-3 **$29.95** (LESS CABINET)

ALL-BAND RECEIVER KIT

A fine receiver for the beginning ham or short wave listener. Frequency coverage is from 550 kc to 30 mc in four bands. Features include bandswitch, bandspread tuning, phone-standby-CW switch, antenna trimmer, noise limiter, RF and AF gain controls and headphone jack. Easy to build. Shpg. Wt. 12 lbs.

MODEL QF-1 **$9.95**

"Q" MULTIPLIER KIT

Use with any receiver with IF frequency between 450 and 460 kc to add additional selectivity for separating two signals or to reject one signal and eliminate heterodyne. A great help on crowded phone and CW bands. Not for use with AC-DC type receivers. Simple to connect with cable and plugs supplied. Shpg. Wt. 3 lbs.

MODEL CA-1 **$13.95**

"AUTOMATIC" CONELRAD ALARM KIT

This easy-to-build device gives instant warning and cuts AC power to your transmitter when a monitored station goes "off-the-air". Use with any radio receiver having an AVC circuit. A sensitivity control adjusts to various AVC levels. Incorporates a heavy duty six-ampere relay and manual "reset" button to reactivate the transmitter. Complete instructions provided for connection to receiver. Shpg. Wt. 4 lbs.

"SENECA" VHF TRANSMITTER KIT

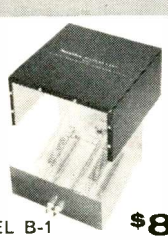
Brand new in every respect, the model VHF-1 "Seneca" is the latest addition to our line of ham transmitters. This self-contained 6 and 2 meter transmitter features built-in VFO, modulator, and dual power supply. A pair of 6146 tubes are employed in the push-pull final amplifier stage and features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Slightly less in the 2 meter band to prolong amplifier tube life. Panel controls allow VFO or crystal control, phone or CW operation on both amateur bands. Four switch-selected crystal positions. Complete RF shielding to minimize TVI. Spotting push-button provided. The VFO slide rule type dial features edge-lighting and vernier tuning. An ideal transmitter for the ham who wants to extend operation into the VHF region. Shpg. Wt. 56 lbs.

HEATHKIT MODEL VHF-1 **$159.95**

MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

Check the match of your antenna transmission system by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1. Handles a peak power of well over 1 kilowatt and may be left in antenna feed line. No external power required. 160 through 6 meters. For 50 or 75 ohm lines. Shpg. Wt. 3 lbs.



MODEL B-1 **$8.95**

BALUN COIL KIT

Unbalanced coax lines can be matched to balance lines of either 75 or 300 ohms by using this balun coil kit. Use without adjustment from 80 through 10 meters at power up to 200 watts. May be located any distance from transmitter or antenna. Protective cover included. Shpg. Wt. 4 lbs.

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

This unique device lets you switch from receiver to transmitter merely by talking into your microphone. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 5 lbs.

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

Far below the cost of crystals to obtain the same frequency coverage this VFO covers 160, 80, 40, 20, 15, 11 and 10 meters with three basic oscillator frequencies. Better than 10 volts RF output on fundamentals. Requires only 250 volts DC at 15 to 20 ma, and 6.3 VAC at 0.45 a. Illuminated dial reads direct. Shpg. Wt. 7 lbs.

Beautifully Styled With Plenty of Room For The Most Complete Stereo System

MODEL SE-1 (center unit) **$149.95** Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39.95** each Shpg. Wt. 42 lbs.

STEREO EQUIPMENT CABINET KIT

This superbly styled cabinet ensemble is designed to hold your complete home stereo hi-fi system, consisting of a "stereo equipment center" flanked by two individual "stereo wing speaker enclosures". The unit has room for all the components required for stereo sound. Although designed to hold Heathkit stereo components, it is not frozen to this arrangement. The kit is supplied with mounting panels precut to accommodate Heathkits, but interchangeable blank panels are also furnished so you can mount any equipment you may already have. The precut panels accommodate the Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2), and record changer (RP-3). Record changer chassis pulls out easily for convenient loading and unloading. Adequate space is provided for record storage and a pair of matching Heathkit power amplifiers (from 12 to 70 watts). The stereo wing speaker enclosures are open backed, cloth grilled cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. The matched grain sliding tape deck access door on top pops-up flush when closed. Entire top features a shaped edge. Hardware and trim of brushed-brass and gold finish. Rich toned grille cloth is flecked in gold and black. No woodworking experience required. All parts precut and predrilled for easy assembly. Maximum overall dimensions (all 3 pieces): 82¾" W. x 36½" H. x 20" D. Center Cabinet: 47½" W. x 36½" H. x 20" D.

CHAIRSIDE ENCLOSURE KIT

Combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit in the space provided. Changer compartment measures 17¾" L. x 16" W. x 9⅝" D. Adequate space is provided in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. Good ventilation is achieved through properly placed slots in the bottom and back of the enclosure. Overall dimensions are 18" W. x 24"H x 35½" D. All parts are precut and predrilled for easy assembly. The Contemporary cabinet is available in either mahogany or birch, and the Traditional cabinet is available in mahogany suitable for the finish of your choice. Beautiful hardware supplied. Shpg. Wt. 46 lbs.

Plan your own Hi-Fi System...

HEATHKIT®

HEATH COMPANY • Benton Harbor 15, Michigan

a subsidiary of Daystrom, Inc.

HIGH FIDELITY RECORD CHANGER KIT

Every outstanding feature you could ask for in a record changer is provided in the Heathkit RP-3, the most advanced changer on the market today. The unique turntable pause during the change cycle saves wear and tear on your records by eliminating the grinding action caused by records dropping on a moving turntable or disk. Record groove and stylus wear are practically eliminated through proper weight distribution and low pivot point friction of the tone arm. Clean mechanical simplicity and precision parts give you turntable performance with the automatic convenience of a record changer. Flutter and wow, a major problem with automatic changers, is held to less than 0.18% RMS. An automatic speed selector position allows intermixing 33⅓ and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33⅓, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The popularity of this modestly priced speaker system attests to its high fidelity performance. The SS-2 provides an ideal basic speaker for your home hi-fi system. Flexibility of design allows it to be used as a table top model or as an attractive consolette with optional legs. May also be used as a supplementary speaker in more advanced systems or as replacement speaker for TV sets, etc. The specially designed tweeter horn rotates 90 degrees allowing you to use the speaker in an upright position if desired, as in the Heathkit stereo wing speaker enclosures. Total frequency range is from 50 to 12,000 cycles-per-second. An 8" mid-range woofer covers from 50 to 1,600 CPS while a compression-type tweeter with flared horn covers 1,600 to 12,000 CPS. Both speakers are by Jensen. A variable balance control allows level adjustment of the high frequency speaker. Power rating is 25 watts. Constructed of ½" veneer-surfaced plywood suitable for light or dark finish. All wood parts are precut and predrilled for simple, quick assembly. An added feature of the SS-2 is that, although an outstanding performer in its own right, it may be combined with the SS-1B "range extending" speaker system later to extend the frequency range at the high and low ends of the audio range. Build in just one evening for many years of listening enjoyment. Shpg. Wt. 26 lbs.

ATTRACTIVE BRASS TIP ACCESSORY LEGS convert SS-2 into handsome consolette. 14" legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26. **$4.95.**

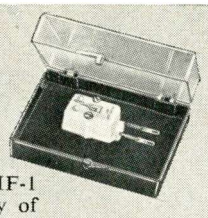
Assemble it in

Just One Evening

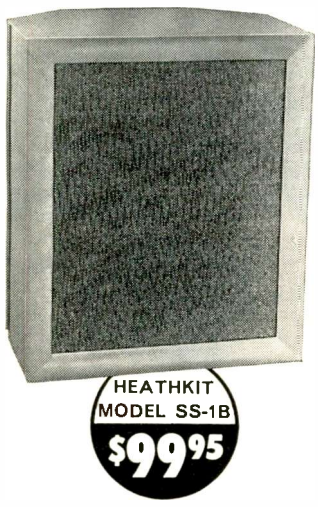
OPTIONAL LEGS
NO. 91-26 **$4.95**

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**



Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.



Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Designed exclusively for use with the SS-2, the SS-1B employs a 15" woofer and a super tweeter horn to extend the range of the SS-2 to an overall response of ±5 db from 35 to 16,000 CPS. When used together the two units form an integrated four-speaker system and are designed to combine into a single piece of attractive furniture. Impedance of the SS-1B is 16 ohms and power rating 35 watts. A control is provided to limit the output of the super tweeter. Constructed of beautiful ¾" veneer-surfaced plywood suitable for light or dark finish of your choice. All parts are precut and predrilled for simple assembly. No woodworking experience required. All hardware included. Shpg. Wt. 80 lbs.

"LEGATO" HI-FI SPEAKER SYSTEM KIT

It is difficult to describe in words the performance of this magnificent speaker system. You may never find absolute perfection in reproduced sound, but the Legato comes as close to achieving it as anything yet devised. Perfect balance, precise phasing, and adequate driver design combine to produce the superb quality of reproduction inherent in this instrument. The crisp, clear high frequencies and rich full bass engulf you in a sea of life-like tone. Two 15" Altec Lansing low frequency drivers cover frequencies from 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. The unique crossover network is built-in making electronic crossovers unnecessary. The legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for light or dark finishes of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

Easy to buy...

Easy to build

Easy to use...

HEATHKIT®

HEATH COMPANY

Benton Harbor 15, Michigan

High Fidelity AM and FM reception in a Single Set

HEATHKIT MODEL PT-1 **$89.95**

Professional Stereo-Monaural AM-FM Tuner Kit

Enjoy stereophonic broadcasts as well as outstanding individual AM and FM radio reception with this deluxe 16-tube AM-FM-stereophonic tuner combination. Features include three etched circuit boards for high stability and ease of construction, prewired and prealigned FM front end, built-in AM rod antenna, tuning meter, FM-AFC (automatic frequency control) with on-off switch, and flywheel tuning. A multiplex jack is also provided. AM and FM circuits are tuned individually making it ideal for stereo applications since both AM and FM can be used at the same time. A switch selected tuning meter functions on either AM or FM. Cathode follower outputs with individual level controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. Anywhere from 1 to 4 limiters or IF's assure smooth, non-flutter reception on weak or strong stations alike. The silicon diode power supply is conservatively rated and is fuse-protected assuring long service life. Flywheel tuning combined with new edge-lighted slide-rule dial provide effortless tuning. Use of three printed circuit boards greatly simplifies construction. Vinyl-clad steel cover is black with inlaid gold design. Shpg. Wt. 20 lbs.

MODEL FM-3A **$26.95**

HIGH FIDELITY FM TUNER KIT

The Heathkit FM-3A Tuner will provide you with years of inexpensive hi-fi enjoyment. Features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures neglible drift after initial warmup. Employs a high gain cascode IF amplifier and has AGC. Power supply is built-in. IF and ratio transformers are prealigned as is the front end tuning unit. Two outputs provided, one fixed, one variable, with extra stage of amplification. Shpg. Wt. 8 lbs.

MODEL BC-1A **$26.95**

HIGH FIDELITY AM TUNER KIT

The BC-1A incorporates many features not usually expected in an AM circuit particularly in this low price range. It features a special detector using crystal diodes and broad band-width IF circuits for low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Covers the complete broadcast band from 550 to 1600 kc. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs and built-in power supply. Shpg. Wt. 9 lbs.

MODEL W-6 **$109.95**

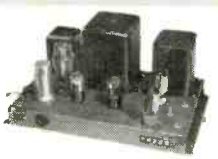
"HEAVY DUTY" 70 WATT HI FI AMPLIFIER KIT

Designed for "rugged duty" called for by advanced hi-fi systems and P.A. networks. Silicon diode rectifiers assure long life and heavy duty transformer provides excellent power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohm or 70 volt output and the correct feedback resistance. Shpg. Wt. 52 lbs.

MODEL W-5 **$59.75**

25 WATT HI FI AMPLIFIER KIT

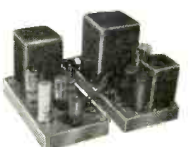
Enjoy the distortion-free high fidelity sound from one of the most outstanding hi-fi amplifiers available today. Features include a specially designed Peerless output transformer and KT66 tubes. Frequency response is ±1 db from 5 to 160,000 CPS at 1 watt and within 2 db 20 to 20,000 CPS at full 25 watts output. Hum and noise are 99 db below 25 watts. Shpg. Wt. 31 lbs.



MODEL W-4AM **$39.75**

SINGLE CHASSIS 20 WATT HI FI AMPLIFIER KIT

A true Williamson-type high fidelity circuit, the W-4AM features 5881 push-pull output tubes and a special Chicago-Standard output transformer to guarantee you full fidelity at minimum cost. Harmonic distortion is 1.5% and IM distortion is below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps for 4, 8 or 16 ohm speakers. Shpg. Wt. 28 lbs.



MODEL W-3AM **$49.75**

DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT

Another famous Williamson-type high fidelity circuit, the W-3AM features the famous Acrosound TO-300 "ultralinear" output transformer and 5881 tubes. The power supply and main amplifier are on separate chassis for installation flexibility. Harmonic distortion is less than 1% and IM distortion is less than 1.2% at 20 watts. Shpg. Wt. 29 lbs.

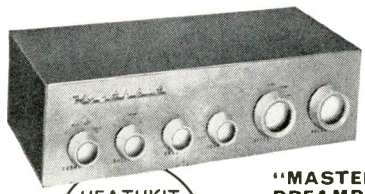
HEATHKIT
MODEL SP-2
(STEREO)
$56.95

MODEL SP-1 (MONAURAL)
$37.95 Shpg. Wt. 13 lbs.

MODEL C-SP-1 (CONVERTS SP-1 TO SP-2)
$21.95 Shpg. Wt. 5 lbs.

Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

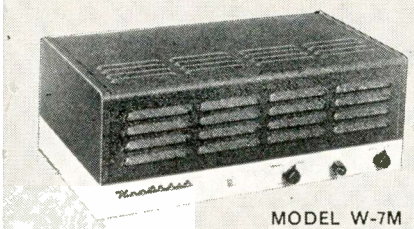
This unique kit allows you to purchase it in the monaural model if desired and then add the second or stereo channel later. The SP-2 features 12 separate inputs, six on each channel, with input level controls. Six dual concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch. A separate on-off switch is provided. The function switch provides settings for stereo, 2-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. NARTB equalization and RIAA, LP, 78 record compensation are provided. A remote balance control is included. Printed circuit boards for easy assembly. Built-in power supply. Shpg. Wt. 15 lbs.



HEATHKIT
MODEL WA-P2
$19.75

"MASTER CONTROL" PREAMPLIFIER KIT

Control your hi-fi system with this compact unit. Features 5 switch-selected inputs to accommodate a record changer, tape recorder, AM tuner, FM tuner, TV receiver, microphone, etc., each with level control. Provision also for a tape recorder output. Equalization for records through separate turnover and rolloff switches for LP, RIAA, AES and early 78's. Shpg. Wt. 7 lbs.



MODEL W-7M
$54.95

"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

Enjoy this high fidelity power amplifier at less than a dollar per watt. Full audio output and maximum damping is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Features famous "bas-bal" circuit, EL-34 output tubes and special 70 volt output. Shpg. Wt. 28 lbs.

MODEL XO-1
$18.95

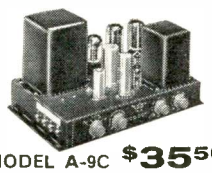
ELECTRONIC CROSSOVER KIT

This unique instrument separates high and low frequencies and feeds them through 2 amplifiers into separate speakers. Located ahead of the main amplifier, it virtually eliminates IM distortion and matching problems. Note: Not for use with Heathkit Legato speaker system. Shpg. Wt. 6 lbs.

MODEL UA-1
$21.95

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

The versatility and economy of this fine kit make it a truly "universal" hi-fi amplifier. An ideal basic amplifier for any hi-fi system or a perfect addition to gear your present hi-fi system to stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range. Shpg. Wt. 13 lbs.



MODEL A-9C **$35.50**

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

Designed for home installation as well as for PA requirements, the A9-C combines a preamplifier, main amplifier and power supply all on one chassis. Four switch-selected inputs are provided as well as separate bass and treble tone controls offering 15 db boost and cut. Detachable front plate allows for custom installation. Shpg. Wt. 23 lbs.

MODEL SW-1 **$24.95**

SPEEDWINDER KIT

A real timesaver, the SW-1 leaves your tape recorder free for operation while rewinding tape at the rate of 1200 feet in 40 seconds. Prevents unnecessary wear to the tape and recorder. Handles up to 10½" tape reels. Handles 800' reels of 8 and 16 millimeter film as well. Automatic shutoff prevents whipping at end of rewind. Shpg. Wt. 12 lbs.

NO. 401-6
$7.50

12" UTILITY SPEAKER KIT

Replace inferior speakers in radio or TV sets to obtain better tone quality or set up an auxiliary speaker for testing purposes with this convenient, high quality speaker. The speaker will handle up to 12 watts with a frequency response of ±5 db from 50 to 9,000 CPS. Speaker impedance is 8 ohms and has a 6.8 oz. magnet. An outstanding dollar value. Shpg. Wt. 7 lbs.

MODEL TK-1 **$9.95**

COMPLETE TOOL SET

These basic tools are all you need to build any Heathkit. The pliers, diagonal side cutters, 2 screwdrivers, and soldering iron are all of top quality case hardened steel for hard duty and long life. Pliers and side cutters are equipped with insulated rubber handles for safety. A good example of just how easy Heathkit building really is. Shpg. Wt. 3 lbs.

HIGH FIDELITY TAPE RECORDER KIT

The model TR-1A tape deck and preamplifier combination provides all the facilities you need for top quality monaural recording/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. Both units may be mounted together or separately affording high flexibility in every application. Features include NARTB playback equalization —separate recording and playback gain controls —cathode follower output and provision for mike or line input. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. A filament balance control allows adjustment for minimum hum level. Complete instructions provided for easy assembly. Overall dimensions of tape deck and preamp is 15½" W. x 13½" H. x 8" D. Shpg. Wt. 24 lbs.

HEATHKIT TR-1A **$99.95**

Includes tape deck assembly, preamplifier and roll of tape.

HEATHKIT TE-1 **$39.95**

Tape preamplifier sold separately if desired. Shpg. Wt. 10 lbs.

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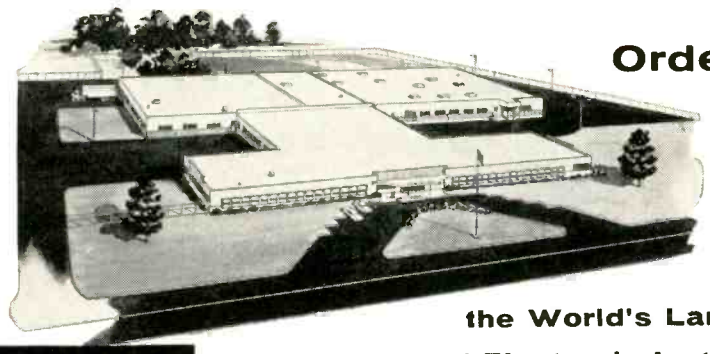
"BOOKSHELF" 12 WATT AMPLIFIER KIT

Here are a few of the reasons why this attractive amplifier is such a tremendous dollar value. You get rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern styling". The many features include full range frequency response 20 to 20,000 CPS ±1 db with less than 2% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs: mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control—and it's easy-to-build. Complete instructions and pictorial diagrams show where ever part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Cabinet measures 12½" W. x 8 3/16" D. x 4⅜" H. Output transformer has taps at 4, 8 and 16 ohms to match the speaker of your choice. An ideal unit to convert your present hi-fi system to stereo sound. Shpg. Wt. 15 lbs.

An Amplifier, Preamplifier all in one!

HEATHKIT EA-2

$28.95



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HEATHKITS are also available at your Dealer see listing on next page

Mac's Service Shop

(*Continued from page 52*)

ing in the oscillator coil and I had to replace the coil. This coil must be bad, too, although the windings show continuity. Guess it must have shorted turns or something.

"What really bugs me though is that the owner said the pilot lamp went out and the set quit playing. That makes sense, for the filament of the output tube was open. But when I put in a new tube the set still wouldn't play and then I found the oscillator wasn't working. It's kind of a coincidence that the coil and the tube should go out at the same time. The owner had been into it, for some of the tubes were in the wrong socket. Maybe he fouled up the oscillator coil by putting the wrong tube in the socket. Anyway, I've put in a new oscillator coil; so let's hear it play."

Barney turned on the receiver, but no sound came from the speaker except a low hum. "What do you know! Guess it wasn't the coil after all," he said in chagrin.

"How about the mixer tube and the oscillator grid capacitor?" Mac asked helpfully.

"Both OK," Barney said promptly. "I checked them before taking out the old coil."

Mac looked down at the receiver on the bench for a minute and then reached over and gently pulled on a wire that ran from the loop antenna on the back of the receiver to the ganged tuning capacitor. The end of the wire flipped loose from the tuning capacitor and the set began to play at once.

"OK, you smart aleck, what did you do?" Barney demanded.

"Just what you asked me to do: I listened to you," Mac said blandly.

"What did I say that gave you a clue?"

"You said the owner had been into the set. I tried to put myself in his place and look at the receiver. I know non-technical people are always looking for a 'loose wire' in a radio. To such a person, the short external antenna lead on the loop would seem to be just such a loose wire. When he looked for the point from which the wire might come, he spied that empty little eyelet connection on one end of the stator of the oscillator section of the tuning capacitor and he thrust the bared end of the wire through the hole. That failed to restore the receiver to operation; so he bundled the set up and brought it to us with the wire still in place."

"And I, like a big dope, never saw it," Barney finished bitterly.

"Don't be too hard on yourself. Your judgment was still fogged by the memory of the recent dead-oscillator set you had repaired and you couldn't think of anything but another bad coil. We all tend to expect recent experiences to repeat themselves in servicing.

Some technicians carry this to an extreme and insist on replacement of certain components in radio and TV sets right off without making sufficient checks to make sure these components are bad. If this fails to restore proper operation, then they go ahead to find what actually is wrong. As a result I have known technicians called 'Resistor Ralph,' 'Picture Tube Paul,' 'Filter Capacitor Frank,' 'Transformer Tom,' and so on. Just make sure I don't have 'Bad Coil Barney' working for me."

"Oakie doakie, Boss," Barney said with a sheepish smile. "I'll watch it. But I'm convinced you do a better job of 'no-hands' telephoning than I do of 'no-head' servicing!" -30-

MARS SCHEDULES FOR MARCH

THE FIRST Army MARS SSB Technical Net, which operates on 4030 kc. upper sideband, Wednesdays at 9 p.m. (EST), has announced the following speakers for March.

March 4—"Frequency Measurements" by Herbert D. Tanzman, Project Engineer, Frequency Control Div., U.S. Army Signal Research and Development Laboratory, Ft. Monmouth.

March 11—"Principles of Radio Direction Finding" by Paul G. Hansel, Engineer-in-Charge, Radio Engineering Dept., Servo Corp. of America.

March 18—"Some Aspects of Grounded Grid Amplifiers" by George Grammer, Technical Director, ARRL.

March 25—"Antennas" by Michael D. Ercolino, President and Chief Engineer, Telrex, Inc.

* * *

THE WESTERN Technical Net of Air Force MARS offers the following program of speakers for March with transmissions on 7832.5 and 3295 kc. and 143.46 mc. Sundays from 2 to 4 p.m. (PST).

March 1—"Environmental Testing of Electronic Equipment and Components" by Eric Edberg, Chief Test Engineer, Varian Associates.

March 8—"Microwave Radiometers" by Don Harris, G-E Microwave Laboratories.

March 15—"Navcom 100 V.H.F. Aircraft Navigation and Communication Radio System" by Kenneth M. Miller, K6BNJ, Chief Engineer, LearCal Div., Lear, Inc.

March 22—"Miniaturization of Amateur Equipment" by W. R. Barstow, Lockheed Aircraft Corp.

March 29—"Equipment Utilization, Conversion Information and Project Reports" by USAF MARS Western Technical Net Members. -30-

ANNUAL RTTY DINNER

THE SIXTH Annual Amateur Radioteletype Dinner will be held in New York City the evening of March 23. Technical discussions and demonstrations of teleprinter equipment are planned.

Reservations must be made in advance. Details are available from Clay Cool, W2EBZ, 443 West 47th St., New York 36, N. Y.

The RTTY dinner is held each year during the IRE National Convention, making it convenient for a maximum number of amateurs to attend.

Last year's event drew hams from as far away as Alaska and New Zealand. -30-

Service Association of the Month

TEA OF SAN ANTONIO, TEXAS

MEMBERS of the electronics service industry in Texas have won themselves a nationwide reputation for "getting things done." The statewide Texas Electronics Association, for example, has gained considerable recognition for its well managed annual electronics fair. One of its member groups, TEA of San Antonio, has run true to the regional flair for successful action.

Shrewdly acknowledging the power of womankind, it chartered a ladies' auxiliary, which is itself no insignificant body. Membership of the auxiliary is about three-quarters that of the association—an impressive figure when one considers that not all of the 28 San Antonio members have "auxiliary ladies!" In any case, this TEA affiliate is not likely to run into the distaff opposition that faces so many active association people in other parts of the country because their efforts take them away from their firesides. In other words, if you can't beat them—let them join you!

Faced with the common, touchy problem of customers who want credit, the group makes up a retail credit report, available to members on a monthly basis. Technicians looking for work and shop owners looking for help find the employment assistance service set up by TEA of San Antonio a valuable function. An investigating committee to facilitate action on any industry problems that may arise keeps the group on a standby basis, ready to act when the situation calls for action. Of great value in establishing confidence with the public is the consumer protection committee, which handles grievances of set owners. Recognition of the difficulties that service people experience everywhere in connection with business and financial matters has led to the formation of a system of group bookkeeping. In addition to these efforts, TEA of San Antonio has done an exhaustive job of recording "fringe" service dealers who operate out of their homes in residential areas and reporting them to the Chief Building Inspector for violation of zoning regulations. This activity has received publicity in the San Antonio newspapers.

Prospective members must have state store licenses. They must also conduct their businesses in areas zoned for commercial use and satisfy the organization as a whole as to their good character and possession of satisfactory shop equipment. TEA of San Antonio takes its code of ethics quite seriously. Members are required to sign a legal form pledging that they will abide by the code and also adhere to the group's by-laws.

Located at 810 E. Commerce St. in San Antonio, this association boasts its own monthly, "SARTA News," which is edited by Kurt Wertheim. It holds two meetings every month, one for business matters and the other of an educational nature. Results of the annual election of officers for 1959 had not yet been reported at the time this was written. Officers for 1958 included C. W. Schertz, president; O. O. Brigman, vice-president; Donald Van Der Brugen, secretary; Tom Boyd, treasurer; and directors Roland Mueller and Ralph McCoy.

As its publication name indicates, the San Antonio organization was initially known as the San Antonio Radio & Television Association. The original seems to stick, although it has chosen to identify itself more closely with the state group with its present name. Organized in 1949, this body has been incorporated. —30—

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When you make your normal service calls, simply inform your customers that you can offer them any and all nationally advertised appliances at substantial discounts. Show your customer the MASTER A.S.P.G. catalog, impressing the point that your professional experience can help her make a wiser decision. (REMEMBER, YOUR SALE IS 90% COMPLETED BEFORE YOU START... YOU ALREADY HAVE THE CUSTOMER'S CONFIDENCE!) Now, give her a chance to sell herself while you proceed with your repair work.

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The MASTER A.S.P.G. CATALOG, which is included with your membership, lists the biggest, most accepted names in the appliance industry. You sell only the best... all nationally advertised, "pre-sold" merchandise that denotes quality and dependability... made by famous manufacturers who make your selling job easier by advertising in newspapers, radio, television and magazines. Such household appliances as refrigerators, ranges, washers, dryers, television receivers, radios, stereophonic hi-fi's, etc., that carry internationally-known brand names like Westinghouse, RCA, G.E., Grundig Majestic, Admiral, Zenith, Hotpoint, Philco, Sunbeam, Motorola, etc., are already known by your customers. YOU SELL MORE CONFIDENTLY BECAUSE THE CUSTOMER HAS MORE CONFIDENCE IN THE PRODUCTS YOU SELL!

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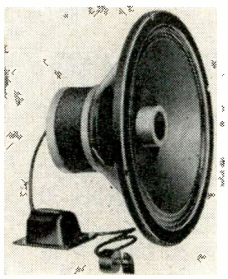
APPLIANCE SERVICEMEN'S PURCHASING GROUP *469 E. Ohio St., Chicago 11, Ill.*

Hi-Fi-Audio Product Review

"KNIGHT" 3-WAY SPEAKERS

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. has added two new deluxe three-way speakers to its "Knight" line of audio gear.



Made in England especially for the company, the new speaker features massive magnet structures, compression-type tweeters, and vacuum-formed woofer cones with high-compliance suspension. The mid-frequency radiator cones are mounted coaxial to the woofers.

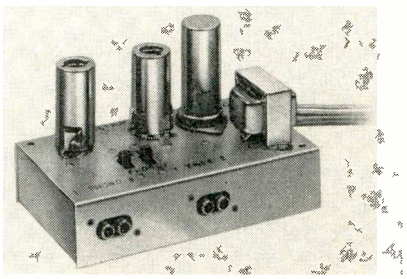
The Model KN-812 is a 12" unit which employs a 3½ pound magnet, has a frequency response of 30 to 20,000 cps, and a power handling capacity of 35 watts. The Model KN-815 is a 15" speaker with a 6¼ pound magnet, a frequency response of 25 to 20,000 cps, and power handling capacity of 50 watts. Both speakers are 7⅜" deep and have 16-ohm impedance. Each speaker has a high-frequency *L*-pad level control on a 30" cable. Frames are of extra heavy die-cast metal.

Write the company direct for prices and further details.

G-E'S DUAL PREAMP

The Speciality Electronic Components Department, *General Electric Company,* West Genesee St., Auburn, N. Y. has announced the development of a new dual stereophonic high-fidelity preamplifier, the "Stereo Classic" Model MF-1.

Featuring high sensitivity, low hum and noise, high channel separation, and individual switching for each channel to select phono or tape input, the new



unit was designed for use primarily with magnetic stereo cartridges, for conversion of existing ceramic cartridge stereo systems where the necessary preamplification is not available in the system.

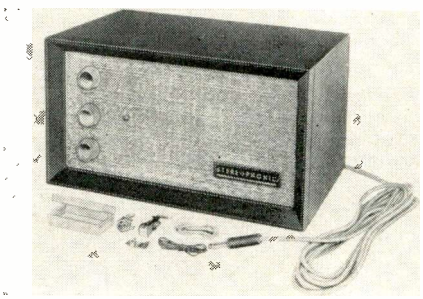
The MF-1 is also equipped for use with stereo tape heads. In addition to providing two stages of preamplification in each channel, it offers proper feedback-type circuit equalization for discs and tape for very low distortion. It may also be used as a stereo headphone amplifier for individual listening and, with a minor circuit modification, as a high gain, monaural or stereo tape recorder microphone preamp. Its low impedance output of less than 10,000 ohms at 100 cps allows the use of an output cable up to 50 feet long.

Complete specifications are available from the manufacturer on request.

STEREO CONVERSION KITS

Fanon Electric Company, Inc., 98 Berriman St., Brooklyn, N. Y. has announced the availability of three new stereo conversion kits which permit the low cost modification of any monaural phonograph to play stereo disc recordings.

Each kit includes a self-contained amplifier and dual speaker system,



stereo turnover cartridge, and the necessary mounting accessories. Each has separate bass, treble, and volume controls.

The lowest priced conversion kit is the STK-4 which has a three-tube amplifier and two matched 4" phased speakers in a two-tone fabric-finished cabinet. A stereo cartridge kit and 15 feet of cable are included. The STK-10 has a 5-tube push-pull amplifier with separate bass, treble, and volume controls and a coax two-speaker system consisting of one 8" woofer and one 3" tweeter. This system comes in a hand-rubbed mahogany, walnut, or blonde cabinet and includes the stereo cartridge, accessories, and extension cable. This same 5-tube system is available in a two-tone fabric covered cabinet as the Model STK-5.

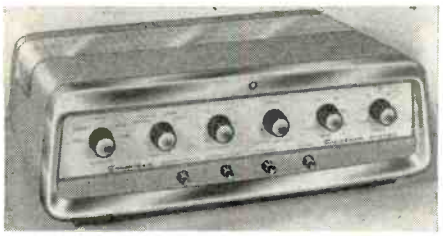
All of the units can be supplied, at reduced cost, without the stereo cartridge and mounting accessories.

GROMMES STEREO LINES

Grommes, Division of *Precision Electronics Inc.,* 9101 King St., Franklin Park, Ill. is now offering two new

stereo series in its high-fidelity equipment line.

The "Premiere" series consists of the Model 40PG stereo amplifier, the Model 209 stereo preamp, the Model 240 basic stereo amplifier, the Model 103GT AM-



FM tuner, and Model 120GAT tuner-amplifier. The 212B preamplifier and 260A 60-watt basic amplifier are also included in the new series.

The "Custom" series consists of the Model 24PG stereo preamp, Model 214 stereo preamp, Model 101GT FM tuner, and Model 102GT FM-AM tuner.

The new lines have been distinctively designed in gold and white in leatherette cases. Modern pedestal styling contributes to the streamlined appearance of the units.

For specifications on any or all of the new units in either line, write the manufacturer direct.

BULK TAPE ERASER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y., is now offering a professional-type bulk eraser for all magnetic recording tape applications.

The ML-120 is a heavy-duty degausser which will handle any reel up to and including 10½" in diameter. The field generator is strong enough to erase any tape without rewinding or flopping the reel.

In operation, the reel is placed over the spindle on the degausser, rotated until each segment of the reel passes over the field area several times, then lifted off slowly to a distance of six or more feet. The demagnetizer is then switched off and the tape is ready for

re-recording. The unit is also recommended for processing new tapes before being used in critical recording applications.

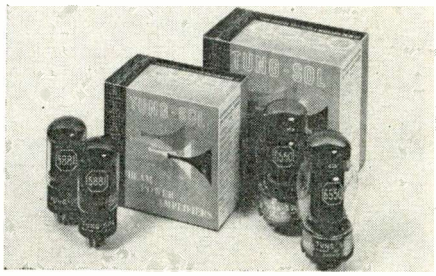
The circuit employs two transformers, drawing 6 amps at 117 volts a.c.; has an "on-off" switch and power-line fuse. The unit measures 6¼ x 7⅞ x 3½". Shipping weight is 14 pounds.

PERFORMANCE-MATCHED TUBES

Tung-Sol Electric Inc., Newark, N. J., is now performance-matching its 6550

and 5881 beam power amplifier tubes and twin-packing them in pairs to eliminate one of the most time-consuming operations encountered by the builder of audio gear.

Matching, which eliminates much of the higher order distortion and makes



possible the best sound reproduction of which the equipment is capable, is a critical criterion with both hi-fi enthusiasts and design engineers.

The 5881's are for service in amplifiers rated at up to 50 watts while the 6550's are used in amplifiers and commercial sound equipment of up to 100 watt power.

NEW MULLARD TUBE

International Electronics Corp., 81 Spring St., New York 12, N. Y., U. S. distributor of *Mullard* tubes, has announced the availability of the ECF80/6BL8, a nine-pin miniature triode-pentode which functions as a high-gain a.f. amplifier and phase inverter.

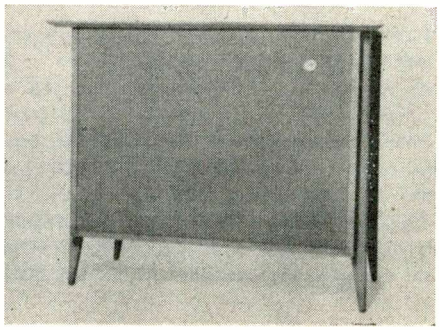
Specially constructed center-tapped heater windings provide unusually low hum characteristics, according to the company. The heater windings may also be grounded for additional balance and hum reduction. The basing and element construction are such that coupling between the two sections is non-existent, making this tube suitable for integrated stereo amplifiers.

Additional engineering data and circuit information will be supplied by the U. S. distributor upon request.

"ISOPHON III"

The *Isophon Speaker Division* of *Arnhold Ceramics, Inc.*, 1 E. 57th St., New York 22, N. Y. has announced the availability of a new four-speaker, three-channel combination unit—the "Isophon III."

Consisting of the firm's P30/37 bass speaker, a mid-range folded-horn com-



pression speaker, and two four-inch high-frequency tweeters, the system includes a multi-matching universal transformer and special divider network.

Designed for either monophonic or stereo applications, the new system is housed in a West Indian mahogany cabinet which is available in a number of finishes as well as in a utility cabinet with non-acoustic baffle board.

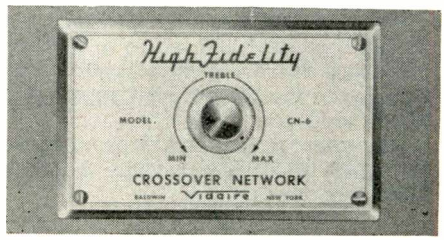
An illustrated catalogue on this and other units in the company's line is available on request.

SPEAKER CROSSOVER NET

Vidaire Electronics Mfg. Corp. of Baldwin, N. Y. is now offering a high-fidelity speaker crossover network, the Model CN-6.

Designed for use with most high-fidelity speakers, the new unit is of the constant-impedance *LCR* type. A treble control is included for varying the treble response of the high-frequency speaker over a range of 9 db. Crossover frequency is 1500 cps with 6 db-per-octave attenuation.

The Model CN-6 may be used with



either 8- or 16-ohm speakers. It comes assembled on a gold-embossed brass plate for mounting on the hi-fi equipment or speaker enclosure.

"TRIMENSIONAL" SPEAKER

University Loudspeakers, Inc., 80 S. Kensico, White Plains, N. Y. has announced the development of an integrated, single-cabinet speaker system for both stereo reproduction and monaural-stereo effect.

The "Trimensional" unit measures 30" wide x 25" high x 12½" deep overall. The system utilizes the reflections from the walls of the listening room to provide broad virtual sound sources with good separation. Compactness is achieved through use of the company's dual-voice-coil woofer which reproduces the bass ranges of both stereo channels. According to the company, full response is obtained down to below 30 cps, for both channels, with an enclosure of only 2 cubic feet for the bass speaker.

The mid-frequency and high-frequency ranges are covered, respectively, by Model C-8W eight-inch direct radiator speakers and Model HF-206 "Hypersonic" tweeters.

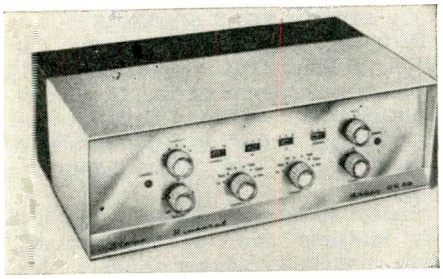
A data sheet giving specifications and recommended operational details will be furnished by the company on request.

STEREO CONTROL CENTER

Arkay, Inc., 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y. has just announced the availability of a new hi-fi stereo control center which incorporates dual 14-watt amplifiers and provides full 28-watt output for monaural use.

Offered in either kit or factory wired

form, the CS-28 has all of its inputs and outputs of the dual variety. In addition the circuit includes a reverse stereo switch for interchanging chan-



nels, a balance control for providing compensation in each channel for the speaker system or room acoustics, and a ganged gain control which governs volume on both channels simultaneously.

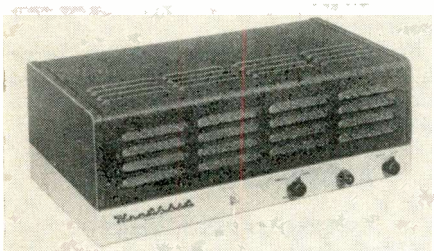
Frequency response is 20 to 20,000 cps; IM distortion 60 and 6000 cps (4:1) is 1% at 14 watts and .5% at 10 watts; harmonic distortion is less than 1% from 30 to 20,000 cps at rated output while hum and noise on the low-level inputs is −70 db and −80 db on high-level inputs. Speaker impedances of 4, 8, 16, and 32 ohms are provided. The circuit uses a total of ten tubes.

For complete details and prices, write the manufacturer direct.

HEATH AMPLIFIER KIT

Heath Company of Benton Harbor, Mich. has just added a 55-watt amplifier to its line of audio equipment in kit form.

The Model W-7M provides frequency coverage from 20 to 20,000 cps at less than 2% total harmonic distortion throughout the entire range. Unique terminal output connections permit instant switch selection of "unity" or "maximum" damping factors for all 4-, 8-, or 16-ohm speakers, with an individually optimized output for each of these impedances. Each output has a separate current feedback circuit for



unity damping. This circuit is entirely shorted out when not in use in order to obtain the highest possible damping factor.

Other features include level control and "on-off" switch right on the chassis plus provisions for remote control for preamps, etc. The company's "bas-bal" circuit conveniently balances the EL-34 output tubes. These heavy duty push-pull tubes operate into a high-quality tapped screen transformer designed especially for this unit by *Chicago Standard Transformer*. A 70-volt output on the transformer provides for p.a. or large music systems.

The unit is housed in a black and

gold case measuring 6" x 8½" x 15". Write the company direct for additional particulars on this medium-power amplifier.

BRITISH COAX SPEAKERS

Ercona Corporation's Electronic Division, 16 West 46th St., New York 36, N. Y. is now handling the U. S. distribution of a new line of British coaxial speakers, made by *Reproducers & Amplifiers, Ltd.* of Wolverhampton, England.

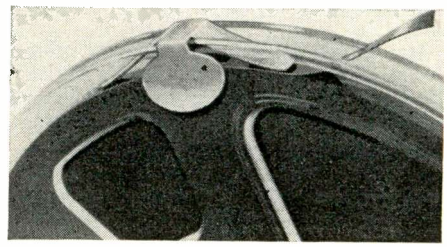
Known as the *R & A* Series 700, the line features coaxial construction, easily removable magnet asembly, plus wide, smooth frequency response up to 10,000 cps. The Model 780 is an 8" unit which will handle 15 watts; the Model 7100 is a 10" version designed for 20-watt applications, while the Model 7120 is a 25-watt, 12" unit. All of the units have voice-coil impedances of 8 ohms. In all instances, the magnet strength is 12,000 gauss.

For full details on price and additional specifications on this new line, write the U. S. distributor direct at the above address.

TAPE REEL CLIPS

Toyco Products' Audio Division, 1712 W. Florence Ave., Los Angeles 47, Calif. is marketing an inexpensive and efficient tape clip under the name "Reel-Neat."

Precision engineered of high-quality polished stainless steel, the clips are



guaranteed to eliminate tape unreeling. The clip snaps on the reel and involves no elaborate or complex operations.

For additional information and price on these new tape-reel clips, write the manufacturer direct at the above address.

AUDIO CATALOGUES

STEREO TAPES & DISCS

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. has just released a new stereophonic record and tape catalogue listing over 200 of the latest stereo disc releases and almost 500 stereo tapes.

Divided into two major sections and sub-divided into categories of music, the catalogue lists classical records and tapes alphabetically by composer. Popular, jazz, and other types of music are listed by performing artists, group, orchestra, and disc or tape title. In almost every case a complete rundown of selections is given.

Dept. PR832 of the company will mail a copy on request. Please specify Stock No. 68 R 566. —30—

Hi-Fi Test Report

(*Continued from page* 61)

record players rumble wasn't as serious a problem in that vertical compliance of monophonic cartridges was considerably damped. However, this is not true for stereo reproduction where high vertical compliance is required. The new model has been redesigned to eliminate this problem in that it has negligible rumble, wow, and flutter. It incorporates an improved motor design and changes were made in the mechanical operation of the changer to allow for smoother performance and operation.

A stereo-monophonic switch has been added which serves an important purpose under certain conditions. When playing monophonic records with a stereo cartridge, it is necessary to connect the left and right channels of the cartridge together. In most hi-fi systems this is done in the preamplifier section and in this case the switch serves no particular function. However, there are many installations that do not provide the paralleling connection, in which case the added switch, which does this job, is important to provide this additional flexibility.

In addition, a dual-channel muting switch and a quick-change cartridge holder have been incorporated. Although designed with stereo in mind, the changer can be used with ordinary monophonic cartridges simply by using only one of the output cartridge cables provided.

There are certainly advantages and disadvantages in using a record changer in place of a manual turntable. If one does not want the inconvenience of changing records then, of course, the changer is the answer. For ultimate quality of sound reproduction the preference is usually in favor of the manual turntable. There are two other factors that must be considered: variation in stylus pressure and the vertical angle of the stylus when playing a record singly or on top of a 10-record stack. The stylus pressure on this unit showed only a 1-gram variation and there was no noticeable change in the sound reproduction with the slight vertical angle stylus variation that occurred in use.

Like its predecessor model, this new changer has four speeds. The turntable comes to rest during the change cycle to eliminate unnecessary record wear. The motor is an improved four-pole, hum-shielded type with balanced rotor for smooth, constant-speed, shock-mounted operation. The turntable also incorporates automatic shut-off after the last record on the spindle has been played.

Regarding the performance of this new changer, we are sure that only the most critical listener would detect any difference between the sound reproduced by this changer and that emanating from some of the better turntables. —30—

How far can you go in electronics without a degree?

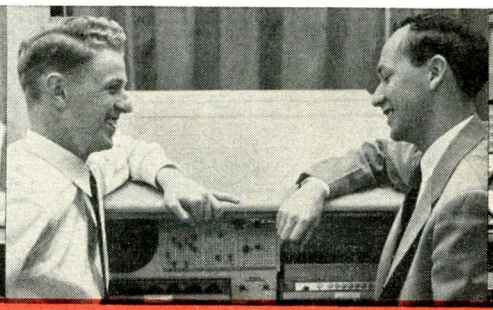
A few years ago, Lincoln E. Kitchin had no formal degree and knew nothing about electronic computers.

He still doesn't have a degree, yet today, he is a Field Engineer on one of America's biggest electronics projects. He helps maintain one of the largest computers in the world. He's doing work ordinarily done by engineers—an opportunity usually denied to men without a degree. This is a story of unusual significance to every technician who feels himself handicapped by lack of a formal degree.

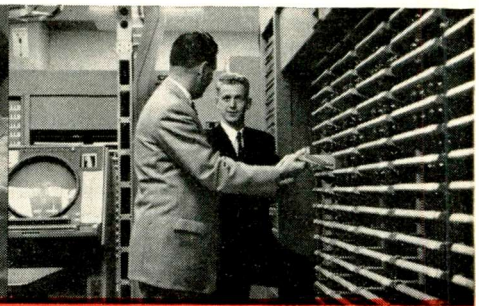
"It all started back at the Base," Link recalls, "about two years ago. We were having lunch. One of my fellow Aircrewmen described an interview he had just had—with IBM.

"It sounded good to me—particularly the field engineering aspects. I wasn't anxious to start my civilian electronics career stuck in a corner of some plant. Here was a chance to work in the field—with all the advantages of a permanent location. I made a note to add IBM to the companies I was considering for civilian work."

Taking notes in IBM Field Engineering class



Discussing a SAGE display console



Front view of computer frame

Interviewed by IBM

A month later, Link sat across the desk from an IBM interviewer. "Frankly," confesses Link, "I was scared at the thought of this interview. I didn't know the difference between an analog and a digital computer. I didn't expect to get the job."

The interviewer put Link quickly at his ease. A check of his background revealed Link's Service training—28 weeks of Class "A" aviation electronics plus Class "C" schooling in LORAN, RADAR and SONAR. He took a test, which indicated excellent aptitude for computer work.

Then Link learned how IBM would train him in electronics—for five months at full salary—to become a Field Engineer on the SAGE Program. He learned about SAGE, part of our nation's radar defense net, which is built around giant IBM computers—each containing 50,000 vacuum tubes plus 170,000 diodes. He heard about IBM's excellent company benefits, especially interesting to Link who had a wife and child. By the time the interview was over, Link had decided that IBM and the SAGE Program were what he was looking for. He decided then and there that he wanted to come with IBM.

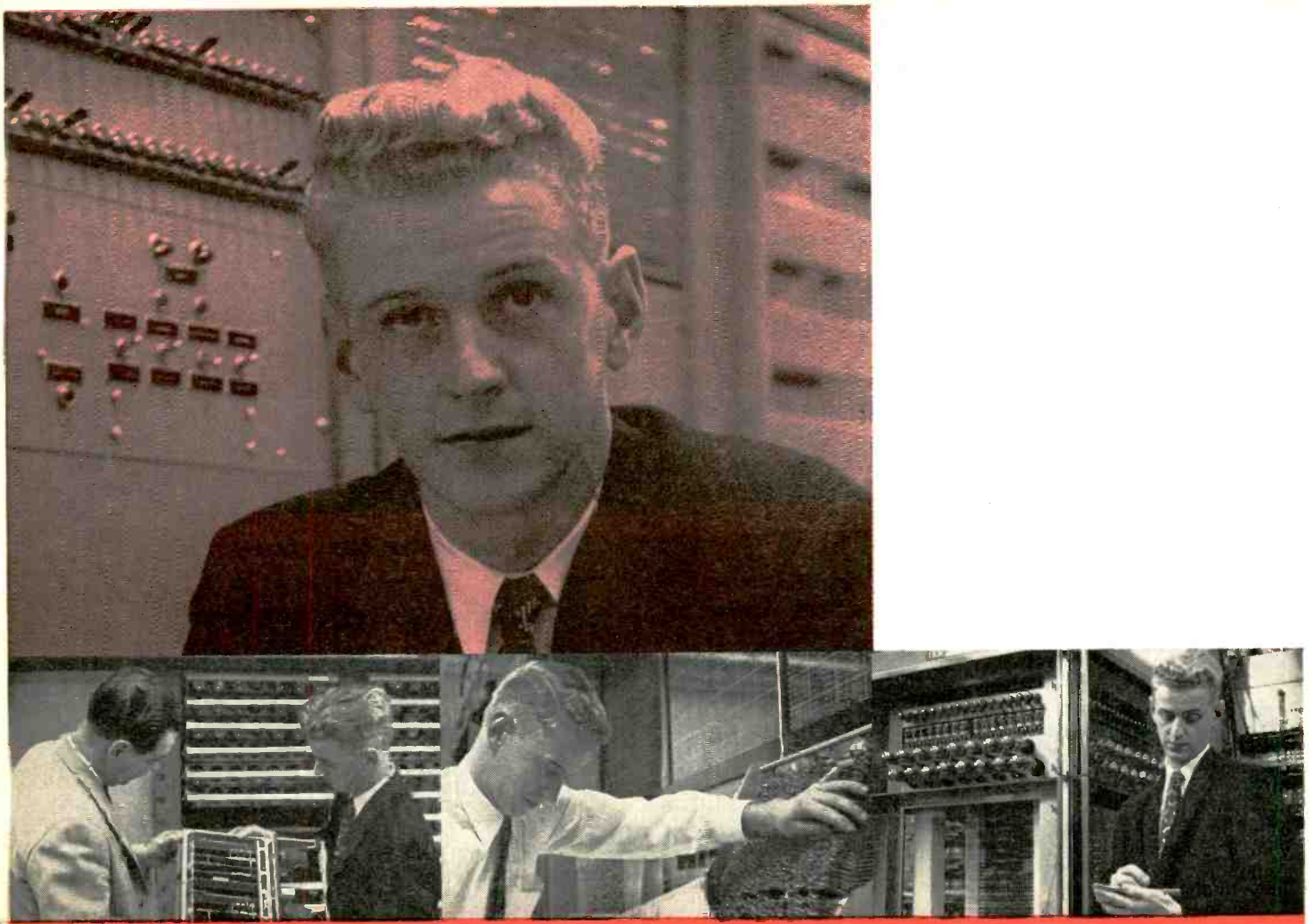
Receives 20 weeks' training

Link reported to Kingston, N. Y., for training. In the IBM "school," he studied basic computer circuits, computer logic and programming, card punch machines—all part of the twenty-week course a Computer Units Field Engineer takes. "The instruction was excellent," he recalls. "Our teachers, experienced field men, often made points not in the textbooks." Formal classroom lectures accounted for half his time, the other half being spent in the laboratories, where he worked on actual computer equipment for SAGE. During his training period, Link received a living allowance in addition to his salary.

Assigned to site in home state

His twenty weeks' training completed, Link was assigned to the SAGE site at Topsham, Maine. "IBM makes every effort to assign you to a location of your choice wherever possible," Link, who is a native State-o'-Mainer, points out.

At Topsham, Link has completed the installation phase of the computer. Now, his work consists of preventive maintenance and "keeping the customer happy"—the customer, in this case, being the Air Force personnel who man and operate the computer. "Installing this giant computer was a significant engineering feat," Link recalls. "First we ran 2,509 cables from 4 to 300 feet long. Then we bolted the computer sections together and hooked up the cables. Next came the testing phase in anticipation of Air Force acceptance tests.



A problem in pluggable units | Working on manual input board of SAGE computer | Recording data on main core memory unit

"I'm in the Display Group," Link continues, "which has responsibility for over one hundred display consoles. Each of these has a 19-inch and a 5-inch cathode ray tube (similar to a TV tube) plus associated circuits. The knowledge of complex circuitry which we learned in the IBM school is essential for this work. We also maintain our own test equipment—oscilloscopes, meters, signal generators and specially designed pluggable unit test equipment."

What does the future hold?

Link looks forward to a rewarding career as a Computer Units Field Engineer. Promotion-wise, he could become, with further training, a Computer Systems Field Engineer, a Group Supervisor or Group Manager. Most important, however, he believes, is the excellent electronics background he's acquiring for the years ahead. "I've had a new engineering dimension added to my career—thanks to IBM's willingness to spend time and money training technicians to assume engineering responsibilities."

A career for you with IBM?

Since Link Kitchin joined IBM and the SAGE Program, opportunities are more promising than ever. This long-range program is destined for increasing national importance and IBM will invest thousands of dollars in the right men to insure its success.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 5 months as a Computer Units Field Engineer. While training, you receive full pay plus living allowance before assignment to a permanent location. You are paid a salary, not hourly wages, plus overtime.

From then on, you can go as far as your abilities and ambition will take you. IBM is the leader in a field that offers you unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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Military Products Division
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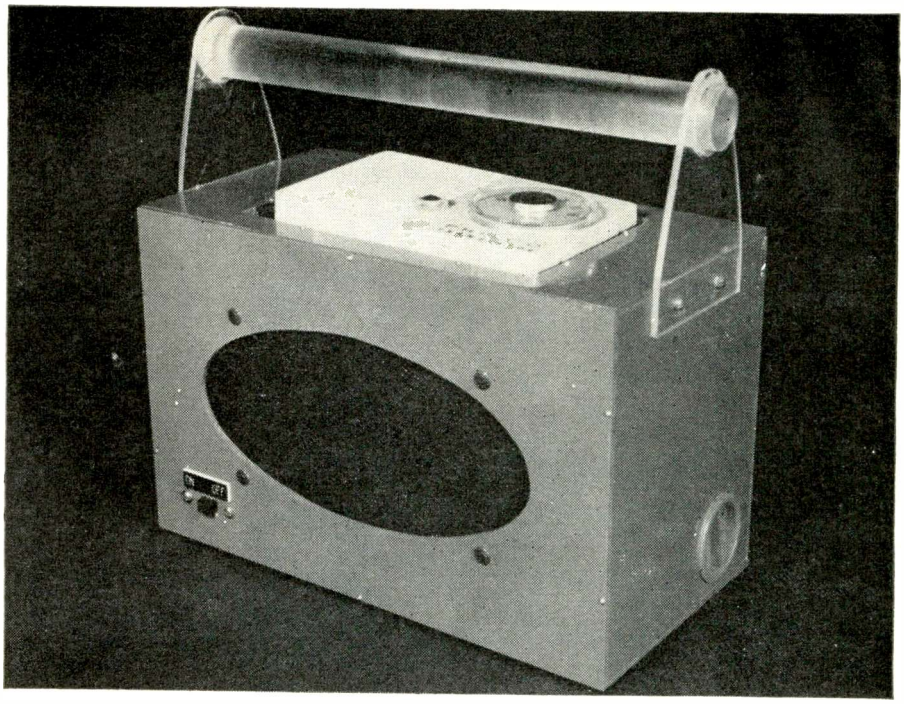


The personal portable fits neatly into a recessed opening in the carrying case housing the added amplifier and loudspeaker.

Outboard Amplifier for Transistor Portable

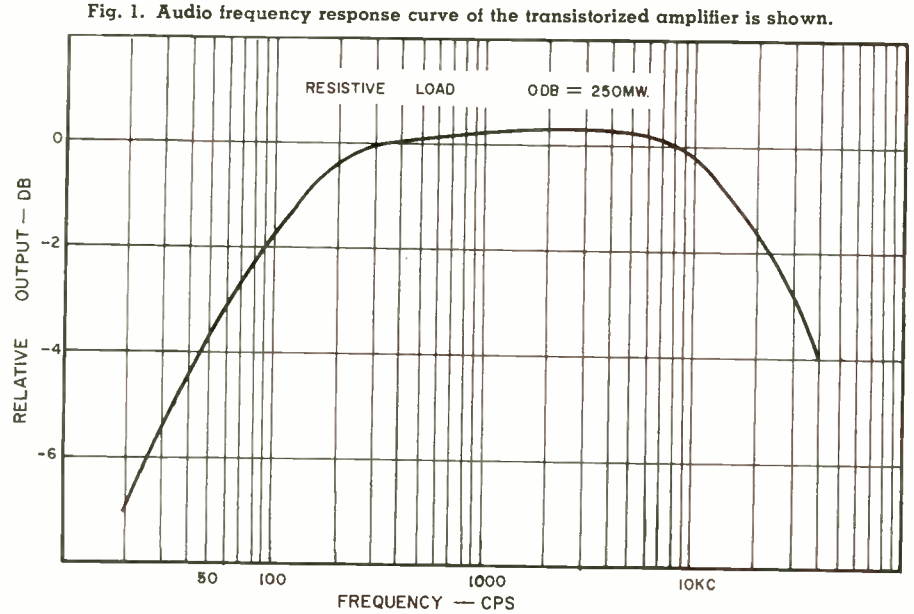
By **T. C. LAWSON**
Applications Engineer, Philco Corporation

Convert your personal set to a "Big Little Portable" with this detachable transistor amplifier and larger speaker.

IN this transistor age, the small, personal portable radio has become a reality. In these receivers some compromises in audio reproduction and output level became necessary due to the small speakers and battery supplies available.

There are times when it would be desirable to be able to increase the power output and to improve the fidelity of such receivers, as when on a crowded beach or at home. By incorporating an amplifier and a larger speaker in a cabinet, the tiny personal radio can become a 1-watt output receiver of improved fidelity.

Fig. 1. Audio frequency response curve of the transistorized amplifier is shown.



In order to build an amplifier of relatively high output while retaining its "portable" feature, a class B push-pull circuit was used. In class B operation, power consumption is minimum and distortion is quite low. The power consumption is low enough so that four size "D" flashlight batteries are adequate for the power supply.

The amplifier, shown schematically in Fig. 3, uses a conventional push-pull, transformer-coupled circuit. Base bias is developed by the voltage divider R_1 and R_2. By making R_1 small, the base bias circuit may be left unbypassed with only negligible loss in gain. The audio response of amplifiers of this type is usually determined mainly by the quality of transformers used. The typical cut-off frequency of the transistors used (*Philco* 2N353) is 16 kc., but the degeneration introduced by the unbypassed emitter resistor raises this cut-off frequency considerably. (The cut-off frequency is defined as the frequency at which the current gain of the transistor falls off 3 db.)

Fig. 1 shows that the response is down only 3 db at 30 kc. with the low frequency response beginning to fall off between 100 and 200 cps and down

3 db at 60 cps. The curve was taken with a resistive load connected in place of the speaker. When the speaker is connected, its resonant frequency, usually close to 100 cps, will bring the low end up. Tone control could be added to the circuit but if the amplifier alone is fairly flat, then the response of the receiver will be reproduced. The gain of the amplifier is 23 db at 400 cps. This means that any receiver which will supply at least 5 mw. of output power will be able to drive the amplifier to its full output capabilities.

The maximum power which can be delivered to a resistive load was measured at 1.5 watts. Clipping sufficient to give 10 per-cent distortion occurred at an output of 915 milliwatts. The distortion at 250 milliwatts was 2.4%.

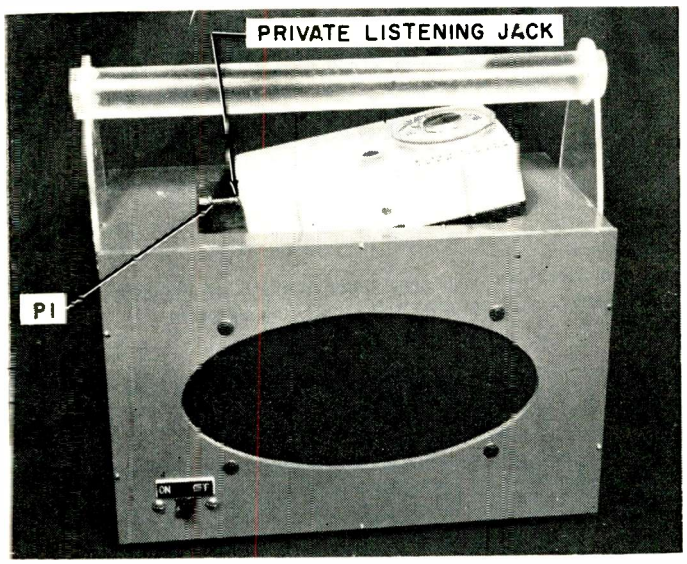
Battery life will depend on the manner in which the amplifier is used. Since it is a class B stage, the power required from the battery depends on the listening level. At full output, the total battery current is 335 ma. while at 250 milliwatt output, which is still a good listening level, the current is 150 ma. The "no signal" current is 16 ma. For the average listener, battery life expectancy should be 100 to 200 hours. With supply voltages as low as 4 volts the output will fall off, but the amplifier will still perform well at low listening levels.

Although temperature usually has an important role in the design of transistor circuitry, the use of power transistors at these output levels requires no special consideration. Heat sinks are not needed. The amplifier performs very well at 55 degrees C (131 degrees F) where the "no signal" current rises to about 30 ma. At this temperature the maximum power output falls off slightly.

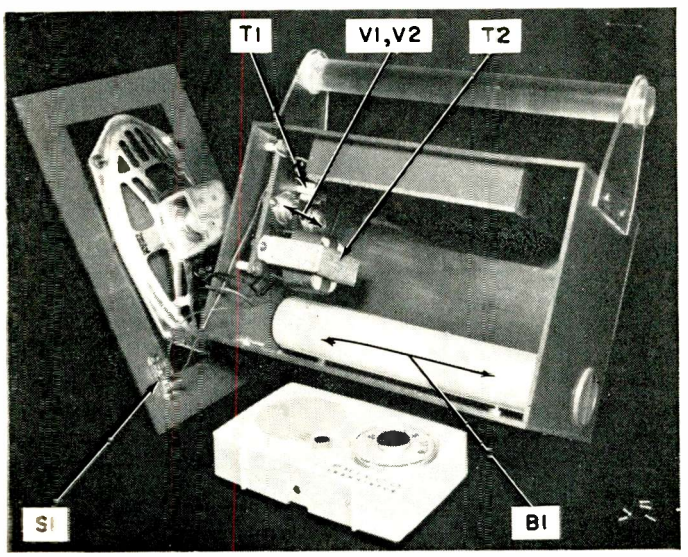
The amplifier and speaker are enclosed in a cabinet which measures 10½" x 6½" x 5½". The top is recessed to hold the personal receiver. The size of the recess will of course depend upon the receiver used. In the author's unit, the receiver was a *Philco* Model T-4. Electrical connection of the receiver to the amplifier is made through the "private listening" jack which is provided on most receivers. If the particular radio being considered does not have one, it is a simple matter to install one. Fig. 2 shows how this can be done by a simple wiring change.

The male plug is spring-mounted in the side of the recess to permit the receiver to slide into place. The amplifier case is constructed of ⅛" Polyvinyl Chloride board *(Colonial Plastics Mfg. Co.*, 8007 Grand Ave., Cleveland, Ohio), commonly called "Van-Cor". This board is very easily worked and its softness adds to the audio response. The handle is made from 1" polystyrene rod. The photographs show the parts layout used by the author. The tube in the bottom of the set is the battery holder. This type of holder makes it possible to change batteries without opening the amplifier case. Also, the danger of destruction of the amplifier due to leaky batteries is eliminated. The holder is polarized so that it is impossible to insert the batteries in the wrong direction.

The "Big Little Portable" described has been used both at home and on Florida beaches in the blazing sun. Performance was very good and many hours of entertainment have been enjoyed in situations where the small portable alone would have been unusable. —30—



The interior view of the carrying case clearly shows the mounting of parts as well as placement of four flashlight cells.



◀ **As the personal portable is placed into the recessed opening, the spring-mounted plug in the side of the opening is fitted into the set's private listening jack. Refer to text.**

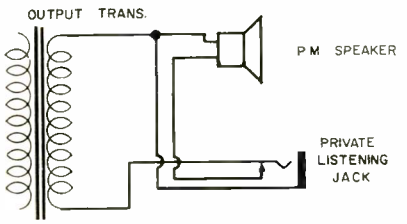
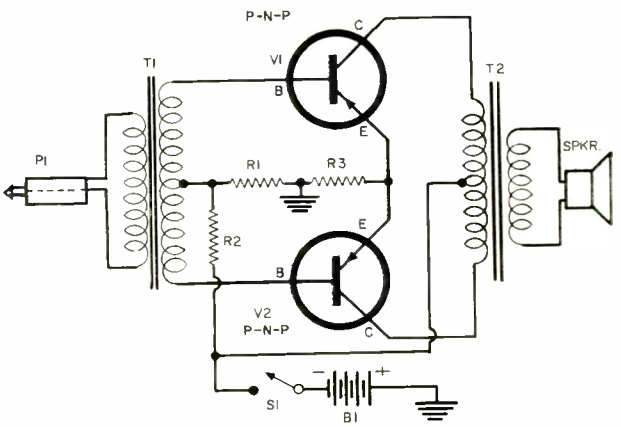


Fig. 2. Method that can be employed to add private listening jack to set.

Fig. 3. Schematic of the added amplifier.



R_1—56 ohm, ½ w. res.
R_2—2200 ohm, ½ w. res.
R_3—1 ohm, ½ w. res.
P_1—Subminiature phone plug
S_1—S.p.s.t. slide switch
B_1—6-volt battery (four "D" flashlight cells)
T_1—Input trans., 12 ohms to 100 ohms center-tapped (Chicago Standard TA-39)
T_2—Output trans., 48 ohms to 16 ohms (Chicago Standard TA-11)
Spkr.—16-ohm speaker, 3½" x 7½"
Battery Holder—Mayfair Molded Products #624-L
V_1, V_2—"p-n-p" transistor (Philco 2N353)

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- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

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

OUTSTANDING FEATURES

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

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

IN-CIRCUIT RECTIFIER TESTER Model SRT-1

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

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

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

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

OUTSTANDING FEATURES

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

SIMPLE TO OPERATE

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

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

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

TRANSISTOR TESTER Model TT-2

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors go bad the need for TRANSISTOR TESTER is great. They can develop excessive leakage, poor gain, shorts or opens.

The TT-2 is an inexpensive quality instrument designed for accurate and dependable tests of all transistors and diodes — quickly and accurately.

OUTSTANDING FEATURES

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

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

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

EASY TO BUY IF SATISFIED
see order form on facing page

FOR 10 DAY *FREE* TRIAL

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

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

STILL THE BEST SELLING TUBE TESTER IN THE FIELD

FAST-CHECK TUBE TESTER

Model FC-2

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

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

SIZE: W: 14⅝" H: 11¼" D: 4⅜"

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

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

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

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

RANGE OF OPERATION

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

IMPORTANT FEATURES

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

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

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

MINI-CHECK TUBE TESTER

Model MC-1

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

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

SIZE: W: 9" H: 8½" D: 2¾"

OUTSTANDING FEATURES

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

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

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

CONVENIENT TIME PAYMENT PLAN — NO INTEREST OR FINANCING CHARGES

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

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Case for a Third Channel

(*Continued from page 71*)

the left and right outputs was fed to the center speaker at a voltage level equal to one of the end speakers (or, in other words, 3 db lower than the total power of both end speakers). The sound of one channel was increased in intensity until the observer could state with certainty that the sound seemed to be coming from a particular direction. The average results of this second series is shown in Table 2. By comparing equivalent average measurements between the two series of tests, one immediate conclusion can be drawn with respect to three channel. It takes *more* change of emphasis of either left or right channels before the listener can definitely "fix" the source of sound. For example, at medium sound level of 1000-cycle tones, the listener felt a shift from center to either left or right with a change of only 2 db. In the three-channel set-up, a change of 4 db was required before the observer detected the "shift" of location. The conclusion is that it is *far* more difficult to achieve true balance in a two-channel stereo set-up than in three channel. In fact, we seriously doubt if balance can be maintained or adjusted for a given point in the room without instruments. This does not mean that under musical conditions stereo illusion is lost. It does mean, though, that in two-channel stereo the vocalist or soloist originally at center stage may alternately appear to be at stage-right or stage-left by a mere shifting of the listener in his chair. This did, in fact, take place in the musical tests which followed.

Musical Corroboration

To translate the tabulations into further meaningful conclusions, we selected vocal and instrumental discs and tapes and subjected the listeners to them. In all ten cases, the listeners preferred having the third channel in use in this form of musical presentation. (Of course, the listeners were never told whether the third channel was in or out and *over-all* sound level at the listener's seat was maintained constant. As the third channel was faded in, end channels were reduced proportionately, to maintain equal *total* sound at all times.) In the case of solo or vocal music surrounded by an orchestral background, the reason given for the preference of third channel was essentially "I find that I don't have to concentrate on *where* the soloist is standing." In purely orchestral music, only six out of ten preferred a third channel. Two experienced no perceptible difference between two and three channels and two actually preferred the two-channel arrangement. It is interesting to note that these latter two were the two gentlemen who work professionally in the audio field. It is possible that the extensive stereo listening these men have done recently

may be partly responsible for their subjective answers as to preference.

Whence the Third Channel?

If your interest is aroused at this point, and if you would like to draw your own conclusions, it is not difficult to duplicate the set-up we used. The third channel was derived right at the speaker terminals of the left and right channels. The "hot" lead to each of the end speakers was fed to a 500,000-ohm potentiometer (one lead to an end terminal of the potentiometer, the other speaker lead to the other end terminal of the potentiometer). The arm of the pot was then used to feed a third basic power amplifier and speaker. By rotating the shaft of the potentiometer (which had a linear resistance element) half way, equal amounts of left and right signal were picked off at the arm of the pot. A schematic of the arrangement is shown in Fig. 3. All grounds (from left and right speakers and shield of cable going to third amplifier) were tied together. It is extremely important that the third speaker be phased properly with respect to the other two. If increasing the level control on the third amplifier seems to *reduce* the total level of sound in the room, you can be certain the third speaker is phased incorrectly and a simple reversal of the leads to that speaker will correct the situation. It goes without saying that the left and right speakers should also be phased properly.

Several preamplifiers currently available for stereo set-ups feature provisions for a third power amplifier connection. These include *Madison Fielding* Model 340, *Scott* Model 130, and *Lafayette* Model KT-600. In these preamplifiers, the necessary "blending" is accomplished electronically, providing the user with a "mixed" left and right signal for just this application. Undoubtedly, others will be marketed.

Still a third method of achieving three channels suggests itself. In this last method, no third amplifier is required, but two more wide-range speakers are involved. The set-up is shown in Fig. 4. Here, a third wide-range speaker is paralleled across the left speaker and a fourth speaker is paralleled across the right speaker. Physically, however, the two extra speakers are mounted in one enclosure, which is positioned between the other two enclosures. If you have a pair of speakers currently doing stereo duty in another room, this might be the most inexpensive way to perform the three-channel experiment without additional expenditure until you decide whether or not you like the effect.

As for our own situation, there will be no rest until I replace the speaker system I "temporarily" stole from our bedroom and am unwilling to return—I happen to have decided in favor of three-channel stereo in the living room. For the time being, our bedroom TV set will have to subsist on its own 4" low-fi unbaffled "squeaker." —30—

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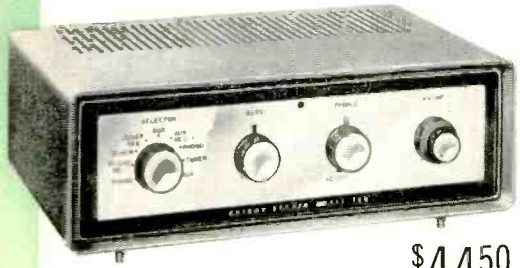

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Newest complete Stereo high-fidelity amplifier at an amazing low $44.50. Includes built-in magnetic cartridge preamps. Tandem controls for simplified operation. Single switch selects phono, tuner or auxiliary stereo inputs, plus stereo reverse on each; also switches monaural input to both amplifier channels. Bass and treble controls boost and attenuate. Special clutch-type concentric volume control permits adjusting balance on each channel, then controls overall volume. Total output is 20 watts (10 watts per channel at less than 1½% distortion). Response, 20-20,000 cps, ± 1.5 db. Four pairs of stereo inputs: magnetic cartridge, ceramic cartridge, tuner, auxiliary. Hum-free (DC on preamp tube filaments). Custom case, 4¼ x 13¼ x 9". Shpg. wt., 27 lbs.

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In a class by itself—a control center that will do **anything** and **everything** you want. Features complete input flexibility—5 Stereo inputs (including tape heads), additional 4 inputs for monaural. Six record equalizations for monaural; RIAA for Stereo. Volume, bass and treble controls on concentric shafts with special clutch for both individual channel and overall control. Single switch selects straight Stereo; Stereo Reverse, either channel separately, or either channel into monaural output. Continuously variable loudness control; hum-free (DC on all tube filaments); cathode follower output and special recorder output. Exclusive printed-circuit switches and boards. Custom styled case, 4¼ x 13 x 8". Shpg. wt., 17½ lbs.

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Absolutely the finest dual amplifier you can build—equal to highest-priced factory-built units. Ideal for use with the KNIGHT-KIT preamp, either as two 30-watt stereo amplifiers or 60-watt monaural amplifier. Exceptional response from 10 cps to 42,000 cps. Phenomenal 0.08% distortion at full 60 watts. Includes static plate current balancing adjustments for each channel; absolute stability under all operating conditions; custom-quality transformers. Also has special built-in circuitry, with easy external adjustment, for precise balance of gain on each channel to achieve perfect monaural performance. Two printed-circuit boards for easy assembly. Beautiful black and chrome; 9 x 14 x 8¼". (Cover extra, $6.50.) 36 lbs.

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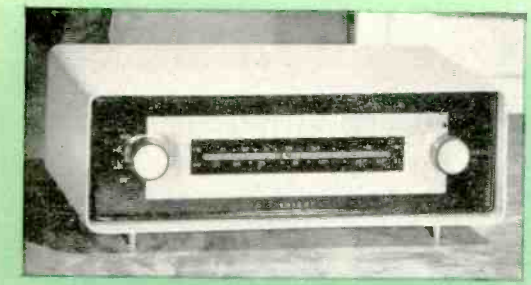

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The best-looking, best-performing FM-AM tuner kit for the money. You'll enjoy building and owning it. FM sensitivity is a remarkable **2.5 microvolts for 20 db of quieting.** AM is **3 microvolts for 10 db signal-to-noise ratio.** Outstanding features include: single large printed-circuit board with most critical wiring already done; AFC (with disabling feature); flywheel tuning; precisely pre-aligned RF and IF coils—no further alignment needed; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; rotatable built-in AM antenna. Beautiful French-gray case, 4¼ x 13¼ x 8". Shpg. wt., 12 lbs.

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Never before has there been so much solid hi-fi value and quality performance at such low cost. Features smooth, clean output for truly rich reproduction. **Guaranteed specifications:** frequency response, 30-15,000 cps ± 1½ db at half power; less than 1% distortion at full power. **Has 15 db of inverse feedback.** Has preamp stage equalized for magnetic cartridges; inputs for phono and tuner; separate bass and treble controls with both boost and attenuation, push-pull EL84 output tubes; virtually hum-free performance. Size with cover, 5 x 9¾ x 7". (Cover extra, $3.95.) 7½ lbs.

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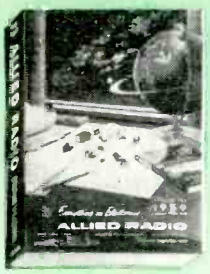

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Provides full centralized stereo control (volume, balance and channel selection) for use with any two amplifiers. Handles up to 20 watts program material. Unit simply connects between speakers and output terminals of amplifiers (no amplifier rewiring needed). Lets you balance speaker system volume; provides master gain control for overall volume (can be used remotely); lets you play either channel monaurally through one or both speakers; provides channel reversal; phase reversal switch for best overall performance. 4½ x 7¾ x 4". 3½ lbs.

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Quality audio control center. 16 combinations of equalization; 8 inputs including tape head; DC on all tube filaments; printed-circuit switches and boards. Custom-styled. 12½ lbs.

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Williamson-type circuit. Response, ±0.5 db, 9-70,000 cps at half power. Includes balance control; calibrated damping control; potted output transformer. Shpg. wt., 25 lbs.

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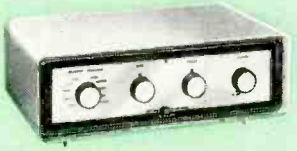

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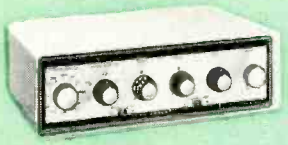

30-Watt Hi-Fi Amplifier Kit

Linear-deluxe Williamson-type circuit. Clear, rich 30 watts output; full equalization; 8 inputs; level and loudness controls; DC on filaments of preamp tubes; rumble filter; variable damping. Exclusive printed-circuit switches and boards. Custom-styled. 32 lbs.

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Pre-finished enclosure; easy to assemble. Hi-fi response, 45-14,000 cps. Includes 12" woofer and horn-type tweeter. Available in mahogany, blonde or walnut (specify finish). 26 x 29 x 14". Shpg. wt., 33 lbs.

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Has all the selectivity, sensitivity and features of high-priced commercial units. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator; built-in Q-multiplier; delayed AVC; provision for Y-256 crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection for SSB. Controls: Main tuning, bandspread, band selector, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, ant. trim.—plus Q mult. controls: null-off-peak, selectivity, tune. Phone jack on front panel. Exclusive printed-circuit bandswitch; printed-circuit boards. Handsome metal cabinet, 10 x 10 x 16½". (Less speaker and S-meter.) 23 lbs. **$104.50**

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Y-728. 4" speaker in matching cabinet. 3½ lbs. Net . . . **$7.50**

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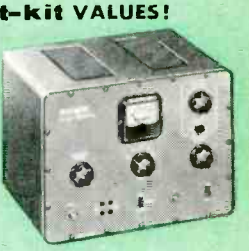

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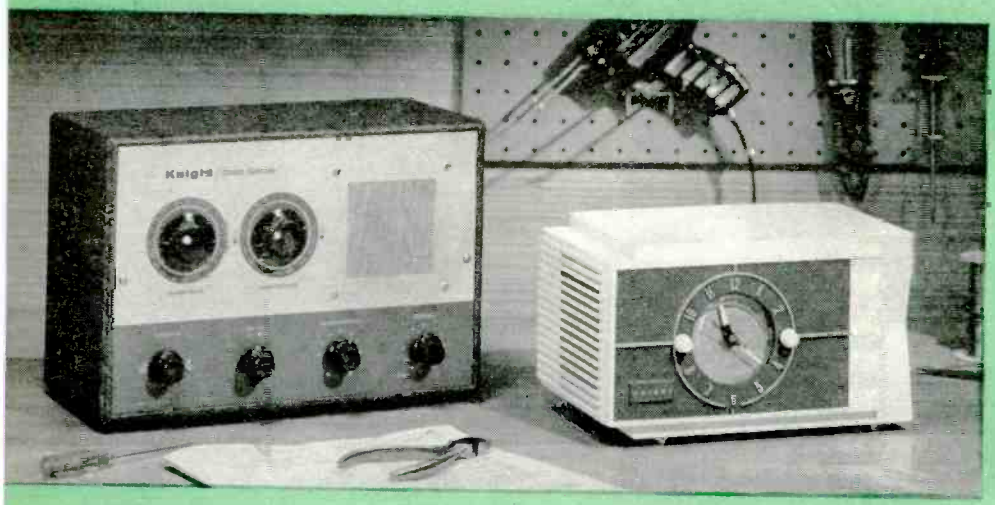

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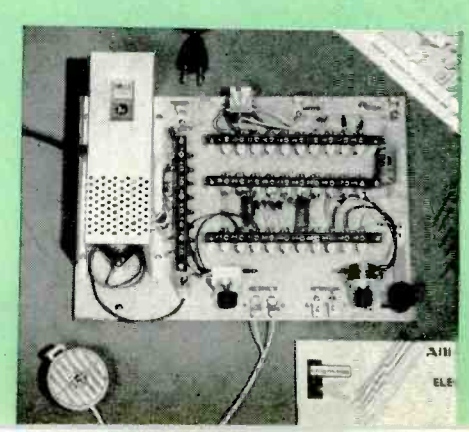
Fascinating way to learn electronics—build any one of 12 practical circuits! Change circuits just by relocating a few wires. Safety-designed, no voltage exceeds 25v. Makes any one of the following: AM radio, amplifier, code oscillator; home "broadcaster"; electronic timer, switch or flasher; voice-operated, capacity-operated or photoelectronic relay; CW "transmitter"; light control oscillator. With all parts, mike, phototube, instructions for each project. For 110-125v. AC. Shpg. wt., 3½ lbs.

Model Y-272. Net only..... $14.95



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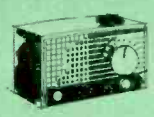
"Ranger III" AC-DC Radio Kit



Superhet broadcast band receiver. Built-in antenna; AVC; Alnico V speaker. Black plastic cabinet. AC or DC. Shpg. wt., 4½ lbs.

Model Y-736. Net only....$16.95

"Ocean Hopper" Receiver Kit

Regenerative receiver for broadcast, long wave and short wave reception from 155 kc to 35 mc. With coil for broadcast band. For AC or DC. Shpg. wt., 7 lbs.

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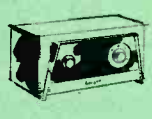
Y-748. Set of plug-in long wave and short wave coils. Net...$2.95

"Ranger III-PC" AC-DC Radio Kit



Printed-circuit broadcast band superhet. Easy to assemble. Has AVC, built-in loop antenna, Alnico V speaker. Ivory plastic cabinet. AC or DC. Shpg. wt., 4 lbs.

Model Y-738. Net only....$18.95

"Ranger" Radio-Intercom Kit

It's a broadcast band radio—it's an efficient 2-way intercom—both in one! Ivory plastic case for Master station/Radio; smartly styled Remote station. With 50-ft. cable. AC or DC. Shpg. wt., 8 lbs.

Model Y-739. Net only....$27.50

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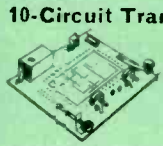
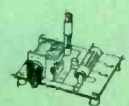


Builds any of 10 favorite projects. Entire kit on a printed circuit board. Just plug in leads to change from project to project. 3 lbs.

Model Y-299. Net only....$15.75

1-Transistor Radio Kit



Offers fine local broadcast headphone reception. Printed circuit board for easy assembly. Works for months from penlight cell supplied. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-765. Net only.....$3.95

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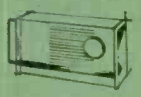

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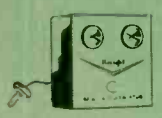

Excellent for local broadcast reception. Newest printed-circuit board for easy assembly. Built-in antenna; miniature dynamic earphone; plays for months from single battery. In handsome carrying case; only 4 x 3¾ x 1¾". Less battery ($1.25). 1½ lbs.

Model Y-263. Net only **$11.50**

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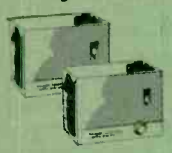

Complete 2-station system; low-cost, easy to assemble. High gain, clear toned, sensitive. Has 2-stage amplifier and 4" PM speakers. Handsome metal cabinets. Includes master, remote and 50-ft. cable. AC or DC. 8 lbs.

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Gives clear headphone reception of local broadcast stations. Sensitive crystal diode; efficient "Hi-Q" coil. (Antenna and headphone required.) Shpg. wt., 1 lb.

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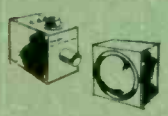

Ultra-sensitive relay at very low cost. Fine for automatic control of lights, door openers, as a burglar alarm, etc. Shpg. wt., 3½ lbs.

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A really tremendous value in a quality tube checker. Checks over 400 tubes. Features "Flip-Card" charts with tube settings in loss-proof pull-out storage drawer. Has sockets for 7-pin miniature, 9-pin miniature, octal and loctal base tubes. Checks for cathode emission, filament continuity, shorted elements. Meter has "Replace-Good" scale and special scale for checking diodes. With quick-setting, universal-type selector slide switches. Includes "Hi-Lo" line-voltage regulator switch. Compact and light—use anywhere. With tube charts. 5½ lbs.

Model Y-707. Net only . . . **$19.95**

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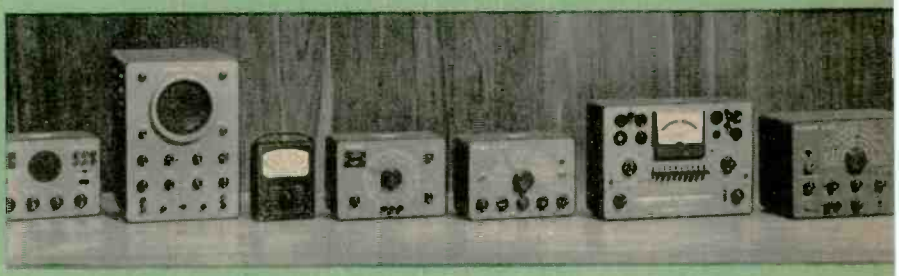

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Technical Books

"NEW SIDEBAND HANDBOOK" by Don Stoner, W6TNS. Published by *Cowan Publishing Corp.*, 300 W. 43rd Street, New York 36, N. Y. 215 pages plus catalogue section. Price $3.00. Paper bound.

This is a "how-to" book for the radio amateur who operates SSB and those who have been "thinking it over" and are as yet undecided as to whether to hop on the bandwagon or not. The author, a dyed in the wool "sidewinder," is a mighty persuasive salesman so be forewarned!

The book is divided into eight informal and chatty chapters covering a definition of sideband, balanced modulators, the filter system, phasing system, double sideband, linear amplifiers, how to receive sideband, and accessories for sideband shacks.

Parts of the text are humorous but this treatment is incidental to a sound and thorough discussion of the subject. The author "knows his stuff" and is happy to share his knowledge with his audience. Line drawings, photographs of commercial equipment, schematics, and graphs are lavishly used to amplify the text material. A bibliography at the end of each chapter is provided for those who wish to delve deeper into some particular phase of the subject although this volume is complete in itself.

Hams seeking greater operating convenience and pleasure will undoubtedly want to investigate the possibilities of SSB while those already a member of the "fraternity" will be interested in sharpening their operating practices.

* * *

"INTERNATIONAL RADIO TUBE ENCYCLOPAEDIA" by Bernard B. Babani. Published by *Bernards (Publishers) Limited, London*. Available in the U. S. from *Joseph Plasencia, Inc.*, 401 Broadway, New York 13, N. Y. Price $15.00 postage prepaid in the U. S., its possessions, and territories. Third Edition.

Listings of over 27,500 tubes of all types are included in the newest edition of this well-known reference volume. Since the appearance of the second edition in 1954 more than 9000 tubes have been added by electronic manufacturers throughout the world.

The Encyclopaedia is divided into ten sections covering radio receiving tubes, triode transmitting tubes, tetrode and pentode transmitting tubes, rectifiers, thyratrons, regulator and control tubes, tuning indicators, cathode-ray tubes, photo tubes, and rare tubes and their equivalents.

Instructions for using the charts and tables are printed in 14 languages in addition to English, fully justifying the "International" in the title. Tubes made in Great Britain, U. S., France, Germany, Italy, Holland, Switzerland, Poland, Czechoslovakia, Belgium, Japan, South American countries, Australia, Spain, Canada, and the U.S.S.R. appear along with comprehensive data on each type. Of particular interest to those who have purchased various items of surplus military gear is the section on tube types used in the equipment of the British, U. S., Russian, and European Armed Forces.

There are completely cross-indexed equivalents tables covering every receiving tube produced in the world, enabling the user to substitute tubes where required. A numerical-alphabetical index, a section showing the various types of tube bases, a listing by tube purpose, and a manufacturer's index with trade-names and complete addresses are all "plus" features which will be warmly appreciated by those who have occasion to consult such a reference source.

* * *

"MOST-OFTEN-NEEDED 1959 TELEVISION SERVICING INFORMATION" compiled by M. N. Beitman. Published by *Supreme Publications*, Highland Park, Ill. 192 pages. Price $3.00. Soft binding. Vol. TV-15.

This is the fifteenth in this publisher's series of servicing data books and follows the same pattern of presentation as the earlier volumes.

Sets made by *Admiral, Emerson, General Electric, Hotpoint, Montgomery Ward, Motorola, Packard-Bell, Philco, RCA, Sylvania, Westinghouse,* and *Zenith* are covered. All of the essential material needed for a quick servicing job has been included. Double-page diagrams, alignment tips, waveforms, voltage values, parts location diagrams, factory revisions, and service hints are provided.

An index which lists the receivers by maker and chassis and model numbers is included to facilitate location of the required material.

* * *

"FUNDAMENTALS OF TRANSISTORS" by Leonard Krugman. Published by *John F. Rider Publisher, Inc.*, New York, 164 pages. Price $3.50. Paper bound. Second Edition.

The progress of the transistor art has been so rapid that a second edition of this volume (originally published in 1954) was warranted. Large portions of the original text have been rewritten and additional material included to bring the reader up to date on technological developments.

New material includes the theory, construction, and operation of semi-

conductor devices such as surface barrier, intrinsic, drift, avalanche, and spacitor types. Illustrative circuits and design theory applicable to amplifiers, oscillators, and high-frequency usage indicate the current state of the art.

To make this volume suitable for home-study and classroom use, each chapter carries review questions plus a bibliography for further study. Those seeking a compact, up-to-date reference on transistors would do well to consider this volume. A practical working knowledge of mathematical processes would be helpful.

* * *

"LAYMAN'S GUIDE TO HI-FI" by Byron Wels. Published by *American Electronics Co.,* 1203 Bryant Ave., New York 59, N. Y. 72 pages. Price $1.25. Paper bound.

In this non-technical discussion of high-fidelity equipment, the author covers turntables, record changers, tone arms, and pickups; FM and AM tuners; amplifiers; speakers, cabinets, and enclosures; the assembling of kits; and the installation of a hi-fi system using pre-assembled components.

Additional chapters present an introduction to high-fidelity, a discussion of the components comprising a high-fidelity system; how to listen to high-fidelity program material; and the future of hi-fi. A glossary and index complete the volume.

The language is simple and schematics and graphs have been eliminated in favor of block diagrams. Each type of component discussed is illustrated with a photograph of a commercial unit.

For the technically inclined or the "old hand," the author's treatment is overly simplified but for the real tyro this text should prove helpful.

* * *

"GUIDE TO MOBILE RADIO" by Leo G. Sands. Published by *Gernsback Library, Inc.,* New York. 160 pages. Price $2.85. Paper bound.

Despite the fact that mobile radio has become a 79-95 million-dollar-a-year-business, there is surprisingly little information in print about available equipment, how to install it, and troubleshooting procedures.

While this book isn't the complete answer to the lack of literature on the subject it is a step in the right direction. Obviously a subject this comprehensive and covering so many different types of equipment cannot be exhaustively treated in a book this size but it helps.

The twelve chapters cover mobile radio in general, the mobile unit and base station, receivers, transmitters, power supplies, antenna systems, remote control, portable equipment, selective calling, maintenance, licensing, and conducting a field survey. Graphs, schematics, polar patterns, and photographs of commercial units all help to amplify the text.

The book will be of interest to radio technicians, mobile equipment sales personnel as well as those who buy and operate such gear. —30—

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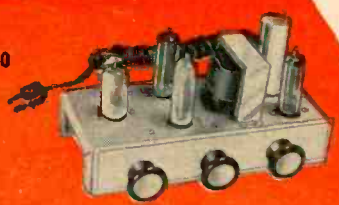

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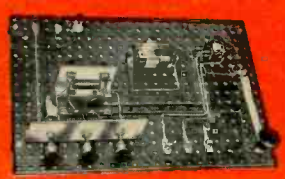

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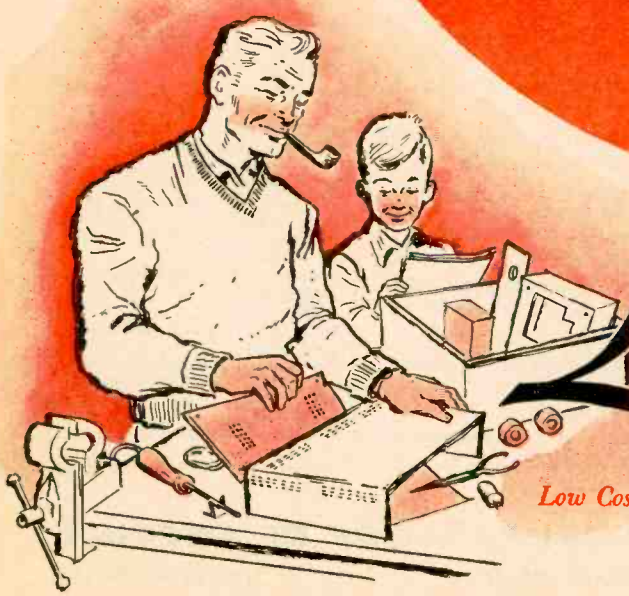

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Simple "Tune-Operate" Switching for the Ham Transmitter

By **HOWARD S. PYLE, W7OE**

Provides protection for transmitting tubes and components while tuning up and permits reduced power operation of the rig for local contacts.

PRACTICALLY all radio transmitters built for military and commercial services are provided with what is designated a "tune-operate" switch which permits reduction of the power input during tuning adjustments thereby protecting tubes, meters, and other components from dangerous overloads.

Seldom does such a simple and practical safeguard appear in *amateur* radio transmitting equipment whether of commercial manufacture or of the "home-brewed" type. In addition to the protective feature provided for the components, a "tune-operate" switch, such as described here, permits instant switching from "high" to "low" power for those short contacts within your local area, reducing the interference problem and earning you the gratitude of other nearby hams!

Installation of such an arrangement is simple in existing rigs; more simple still to incorporate in one you may be planning or building. The cost is small and the circuit uses standard, readily obtainable parts. If these parts are purchased new your cost will run less than five dollars. Your own station junk box will no doubt produce most or all of the required components.

Such an arrangement as described and illustrated here is adaptable to any amateur station of any legal power, with one exception; those using a common filament and plate supply transformer in the final stage. These latter appear only in the "low power" category . . . below 100 watts . . . where such a protective device is less essential. Combination plate and filament transformers are rarely available in secondary voltages greater than 600-0-600 a.c., producing a d.c. voltage in the neighborhood of 500. For the higher-powered rigs requiring 750 to 1000 volts and more, separate plate and filament transformers are invariably used.

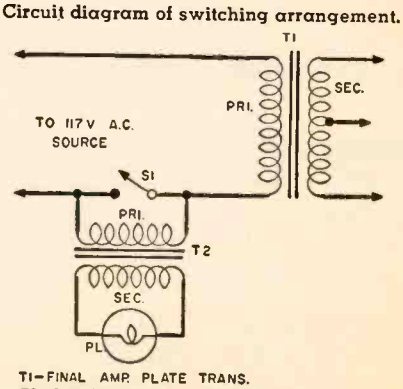
To lower the a.c. output voltage of the final amplifier plate transformer, which drops the d.c. voltage proportionately, it is merely necessary to decrease the a.c. *input* voltage at the primary terminals. The most satisfactory method of accomplishing this is to insert the *primary* of an additional small transformer of the same input voltage (usually 117 volts) in *series* with the primary of the *plate* transformer, with provision for switching this second primary in or out of the circuit. This is readily accomplished by wiring a single-pole, single-throw toggle switch of appropriate carrying capacity directly across the second primary.

The second transformer can well be an ordinary filament type with a 117-volt primary winding. The secondary voltage is immaterial although we shall use it, whether it is 2.5, 5.0, or 6.3 volts. For what? Merely connect a pilot light of appropriate voltage across it, behind a panel jewel of whatever color you select (the author used amber) and when the pilot light is illuminated you are on "low power" . . . when it is extinguished by throwing the "tune-operate" toggle switch to "operate" or "high" position, you are back on normal power! Approximately fifty percent reduction in power input and consequent r.f. output will result with the switch in the "tune" or "low" position.

It should be possible to find sufficient chassis space in any rig on which to mount the second transformer. Any panel will most certainly accommodate a small toggle switch and a pilot light bracket and jewel. Appropriate labelling with neat little decals will add a suitable "professional" touch.

This simple and positive little protective feature is shown schematically in the accompanying diagram. —30—

Circuit diagram of switching arrangement.



T1—FINAL AMP. PLATE TRANS.
T2—CONVENTIONAL FIL. TRANS.
PL—PILOT LAMP (VOLTAGE TO MATCH SEC. VOLTAGE OF T2)

NOT USED, NOT PULLED OUT OF OLD SETS

Brand New TUBES

BETTER THAN 70% OFF!

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and RAD-TEL'S FIRST QUALITY!

REMEMBER . . . ALL RAD-TEL TUBES GUARANTEED ONE FULL YEAR

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BRAND NEW

Guaranteed 1 Full Year!

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
1AX2	.62	5BQ7	.97	6BC5	.54	6CU6	1.08	12AF6	.49	12V6GT	.53
1B3GT	.79	5CG8	.76	6BD6	.51	6CY7	.71	12AQ5	.52	12W6	.69
1S5	.51	5CL8	.76	6BE6	.55	6DE6	.58	12AT6	.43	17AX4	.67
1U4	.57	5J6	.68	6BF6	.44	6DG6GT	.59	12AT7	.76	17BQ6	1.09
1U5	.50	5T8	.81	6BG6G	1.66	6DQ6	1.10	12AU6	.50	19AU4	.83
1X2B	.82	5U4GB	.60	6BH8	.87	6DT6	.53	12AU7	.60	19BG6	1.39
2AF4	.96	5U8	.81	6BK7	.85	6J5GT	.51	12AV6	.41	19T8	.80
2BN4	.60	5V6	.56	6BN4	.57	6J6	.67	12AV7	.75	25BQ6GT	1.11
3AL5	.42	5X8	.78	6BN6	.74	6K6GT	.58	12AX7	.63	25C5	.53
3AU6	.51	5Y3GT	.46	6BQ/		6L6	.84	12AZ7	.86	25CD6	1.44
3AV6	.41	6AB4	.46	CU6	1.25	6S4	.48	12B4	.63	25CU6	1.11
3BZ6	.55	6AC7M	.96	6BQ5	.65	6SK7GT	.74	12BD6	.50	25L6	.57
3BY6	.55	6AF4	.97	6BQ6GT	1.05	6SN7GT	.65	12BE6	.53	35C5	.51
3CB6	.54	6AG5	.65	6BQ7	.95	6T4	.99	12BH7	.73	35Z5GT	.60
3CF6	.60	6AH6	.99	6BR8	.78	6T8	.80	12BQ6GT		50B5	.60
3DT6	.50	6AK5	.95	6BY6	.54	6U8	.78		1.06	50C5	.53
3V4	.58	6AL5	.47	6BZ6	.54	6V6GT	.54	12BY7	.74	50L6GT	.61
4BN6	.75	6AM8	.78	6BZ7	.97	6W4GT	.57	12C5	.56		
4BQ7	.96	6AN8	.85	6C4	.43	6W6GT	.69	12CU5	.58		
4DT6	.55	6AQ5	.50	6CB6	.54	6X4	.39	12CU6	1.06		
4BZ7	.96	6AT6	.43	6CD6	1.42	6X8	.77	12DQ6	1.04		
4CB6	.59	6AT8	.79	6CF6	.64	6Y6G	.65	12F8	.66		
5AM8	.79	6AU4GT	.82	6CG7	.60	8AU8	.83	12K5	.65		
5AN8	.86	6AU6	.50	6CG8	.77	8AW8	.93	12L6	.58		
5AQ5	.52	6AU8	.87	6CM7	.66	11CY7	.75	12SA7M	.86		
5AT8	.80	6AV6	.40	6CN7	.65	12A4	.60	12SK7GT	.74		
5BK7A	.82	6BA6	.49	6CS6	.57	12AD6	.57	12SN7GT	.64		

All Tube Prices Subject To Change Without Notice!

NOT AFFILIATED WITH ANY OTHER MAIL ORDER TUBE CO.

RAD-TEL TUBE CO.

Est. 1945

55 Chambers Street
Newark 5, N. J.
Mitchell 2-3147

TERMS: A 25% deposit must accompany all orders—balance C.O.D. All shipments F.O.B. Newark warehouse. Orders under $5—50c Handling Charge. Subject to prior sale. No C.O.D.'s outside continental U.S.A.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS (Peak to Peak)** — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77—VACUUM TUBE VOLTMETER . . . Total Price $42.50—Terms: $12 50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only .....

$42.50 NET

SUPERIOR'S NEW MODEL 79

SUPER-METER — WITH NEW 6" FULL-VIEW METER

A Combination VOLT-OHM MILLIAMMETER.

Plus CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.

Also Tests SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: 001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: −6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. **All Germanium Diodes.**
All Silicon Rectifiers. **All Silicon Diodes.**

Model 79—SUPER-METER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months if satisfactory. Otherwise return, no explanation necessary!

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads.....Only

$38.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER — NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See page 119 for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

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

SUPERIOR'S NEW MODEL 76

ALL PURPOSE BRIDGE

Model 76 Bridge...Total Price $26.95—Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months if satisfactory. Otherwise return, no explanation necessary!

IT'S A
CONDENSER BRIDGE
with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

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

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

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

SPECIFICATIONS:

CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megahms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

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

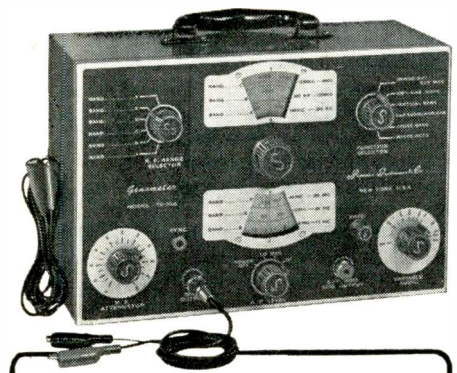
RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 5 megahms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

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

$26.95 NET

SUPERIOR'S NEW MODEL TV-50A



Model TV-50A GENOMETER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

GENOMETER
7 Signal Generators in One!

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

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:
A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

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

$47.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See page 119 for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

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

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

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

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

$47.50 NET

SUPERIOR'S NEW MODEL 83

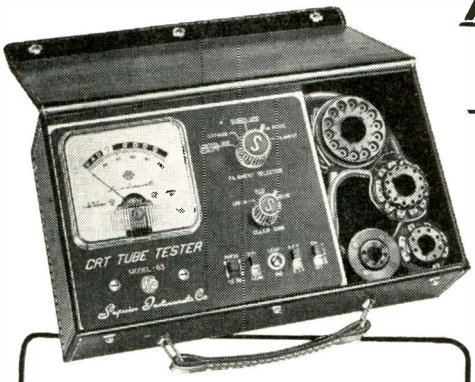
C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES



Model 83—C.R.T. TUBE TESTER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 is *not* simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

SHIPPED ON APPROVAL

NO MONEY WITH ORDER—NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment *after* trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

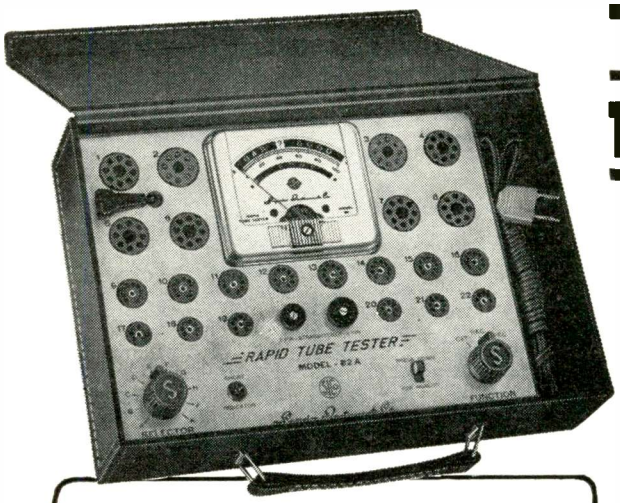
See following page for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!



Model 82A — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

1. **Turn the filament selector switch to position specified.**
2. **Insert tube into a numbered socket as designated on our chart (over 600 types included).**
3. **Press down the quality button —**

THAT'S ALL!

Read emission quality direct on "BAD-GOOD" meter scale.

Specifications

- Tests over 600 tube types
- Tests 0Z4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only.....

$36.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER — NO C.O.D.

MOSS ELECTRONIC, INC.
Dept. D-583 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

Name .....

Address .....

City ..... Zone..... State.....

All prices net, F.O.B., N. Y. C.

- ☐ Model 77 ..... Total Price $42.50
  $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 79 ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 76 ..... Total Price $26.95
  $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TV-50A ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TW-11 ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 83 ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 82A ..... Total Price $36.50
  $6.50 within 10 days. Balance $6.00 monthly for 5 months.

Synthetic Quartz Produced in Pilot Plant

Large crystals are being grown for use in communication equipment of the Bell System.

The crystals shown are all synthetic quartz which has been grown at Western Electric's Merrimack Valley Works in No. Andover, Mass. Such crystals will replace natural quartz crystals, obtained mainly from Brazil, in communication equipment.

DETAILS of pilot plant production of synthetic quartz crystals for telephone communication purposes were disclosed recently. Large crystals are now being grown in limited quantities at *Western Electric's* Merrimack Valley Works in North Andover, Mass. The process being used is an outgrowth of one that had been employed experimentally at the *Bell Telephone Laboratories.*

Synthetic quartz provides a number of advantages over natural quartz in addition to its availability in any quantity and size. Seeds can be cut to provide grown crystals which can be sawed in the most efficient manner. Also, synthetic quartz has natural crystal faces, which allow easier orientation of the stock for cutting into crystal units. It has none of the foreign inclusions which usually occur in natural quartz and it can be produced without either optical or electrical twinning.

The crystals are grown in a long, narrow autoclave mounted vertically and filled with a solution of sodium hydroxide. Small pieces of readily available natural quartz are then placed in the bottom of the vessel to provide the nutrient. Future production will use even less costly and more readily available material such as high-quality sand as the nutrient. Seed plates cut from either natural quartz or synthetic crystals, are hung from a rack in the upper section of the vessel. After sealing, the autoclave is heated to the required temperature and maintained under a constant temperature differential from bottom to top for the required processing time. This period has varied from a week to several weeks.

Economical growth rate much in excess of 60 thousandths of an inch per day has been achieved. During the process the nutrient dissolves in the hotter lower region and is carried by convection currents to the cooler upper region. The lower temperature here leads to a supersaturated condition in the nutrient solution, which causes the dissolved quartz to redeposit onto the seed plates in single crystal form. The high temperature and pressure requirements are among the most severe encountered in any process industry.

—30—

R. A. Sullivan (left) and R. A. Laudise are shown behind the top of a high-pressure autoclave used in growing synthetic quartz. Sullivan holds large crystal grown in large autoclave, while Laudise holds smaller crystal and experimental vessel that was used in early research.

RADIO SHACK STUNS THE HI-FI WORLD!

REALISTIC STEREO-36

ONLY 36-WATT HI-FI AMPLIFIER UNDER $100!!!

Hi-Fi Monaural 36-Watts / *Hi-Fi Stereo 18-Watts*

Never before has there been a 36-watt amplifier within a mile of this REALISTIC low $69.50 price! And it performs with the finest! Yes, this new REALISTIC "STEREO-36" is the ideal choice whether you're "stereo" or "monaurally" inclined. It delivers a full 36 watts (72 watts peak!) when used in a monaural system . . . yet, just a twist of the Channel Mode Selector turns it into a full-fledged dual 18-watt (36 watts peak!) stereo amplifier and dual pre-amp Stereo Control Center! It's Exclusive at Radio Shack, because cost-conscious Radio Shack knows how to use its 36 years of experience to produce the finest in high fidelity at the lowest possible cost! It's not done with mirrors . . . it's done with enormous purchases and the manufacturing "know-how" of Radio Shack's staff of design and production engineers. The new REALISTIC "STEREO-36" is one of the finest stereo monaural amplifiers on the market today! We guarantee it to be equal or superior, in specifications, performance and appearance to any similar amplifier costing up to $130.00 or your money back!

RADIO SHACK EXCLUSIVE!
by the makers of the famous REALISTIC
Electrostat-3 Electrostatic Super-Tweeter

REGULAR VALUE ~~$129.95~~

$69.50 INCLUDING CABINET

$7 Down
$7 Monthly

Technically Minded? Read These Specs!

Laboratory-verified specifications! Power Output: 18 watts per channel (36 watts peak!). Freq. Response: 20-20,000 cps ±0.5 db. Hum and Noise: 80 db down. Distortion: less than 1% at full rated output! Separate wide-range (±12 db) bass and treble controls: Twin-section, single-action master volume control with loudness off-on switch. Channel balance control: Variable equalization control: Channel mode selector with indicator lights and rumble reduction setting for use on monaural records; 4-position input selector. Has 4, 8 and 16 ohm outputs for each channel. 10 tubes. 140 watts, 115-volts AC. Measures only 5¼" h. x 14⅝" w. x 11½" d. Order No. R-33CX505Y Ship. wt. 18 lbs.

BUY IT AT EITHER STORE OR BY MAIL — ONLY 10% DOWN!

SALE! RADIO SHACK 36-WATT STEREO SYSTEMS AT TERRIFIC SAVINGS!

	Reg. Value
Realistic Stereo-36 Hi-Fi Amplifier	$129.95
British Monarch Hi-Fi Changer	54.50
G-E Diamond Stereo GC-7 Cartridge	23.47
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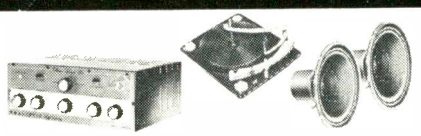

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By BERT WHYTE

AS I have said before in these pages, the stereo disc, even at this early stage of development, has become a generally reliable proposition. In other words, one can purchase a stereo disc with a reasonable degree of assurance as far as quality is concerned. Of course, as with monophonic discs, there is great variation among record companies and, in fact, there is often variation in quality among discs from a single company. Now don't get me wrong . . . I'm not looking at the stereo disc through rose-colored glasses . . . in fact let me hasten to add that I still feel that even the very best stereo disc cannot equal the best of 7½ ips stereo tape. In terms of frequency response and dynamic range, at least, the best monaural discs surpass the best stereo discs. But . . . and this a *big but* . . . neither is the stereo disc as poor as many people would have you believe.

The stereo disc is often maligned unjustly, for the real culprit, it is becoming more and more apparent, is the stereo disc playback equipment. There are many things that can go wrong and contribute to general dissatisfaction with the quality of the stereo disc. The biggest offender is the stereo playback cartridge. Some of these are so poor that if stereo discs were twice as good as they are the results would still be ghastly. There are many types and brands on the market now and of these there are few that can honestly qualify as acceptable for hi-fi use. Nor is price the ultimate criterion in this field. The old adage of "you get what you pay for," operates to a certain degree, but it is by no means a guarantee of high quality. I strongly urge any of you who have been dissatisfied with the results obtained from the stereo disc to investigate the pickup field. If you can, go to a reputable hi-fi component dealer and, armed with a record that has had favorable reviews from a number of critics in responsible journals, listen to it with the various stereo cartridges. Listen particularly for the degree of instrumental separation, and how effective are the directional characteristics. As reproduced through the better quality preamps which have volume controls fairly accurately calibrated, notice if one channel or the other seems to require an inordinate amount of boost or cut in order to balance to stereo. Generally if large amounts of boost are required in one channel, this is usually the effect of a cartridge with extremely poor vertical compliance. Listen also for general over-all smoothness of response and note particularly on recordings of concertos if the solo instrument "stays put" in a given place between the speakers or appears to "jump" suddenly from one channel to the other. Sometimes this is an inherent fault in the recording itself, but more often than not it is a sign of a cartridge with a very limited degree of interchannel separation.

For optimum results, once you have found a cartridge that seems to perform properly, close attention must be paid to the arm in which it is mounted and also to the type and quality of turntable which will be used. You must remember that the stylus of a stereo cartridge is only 0.7 mil and if this smaller area is subjected to stylus pressures on the same order of magnitude as the monophonic types, the result will be rapidly ruinous wear to your stereo discs. An arm should be chosen that is so carefully balanced that stylus pressures are at a maximum of 2 to 4 grams for perfect tracking. Since good stereo pickups have excellent vertical compliance any turntable or changer that has poor rumble characteristics will have this factor accentuated.

Finally in the quest for good stereo disc reproduction, once the proper cartridge, arm, and turntable have been secured, they must be mounted most carefully. First make sure that the turntable is perfectly level by means of a small spirit level. Then follow to the split millimeter the manufacturer's arm mounting instructions especially in regard to distance between turntable center pin and the center of the arm pivot and degree of stylus overhang. Lastly, and of absolutely vital importance . . . the stylus must be positively perpendicular to the plane of the record. This means neither left nor right oriented as viewed from the front, nor canted forwards or backwards as viewed from the side . . . perfectly vertical is what we want! Having accomplished this, and carefully examining the records you purchase for eccentric spindle holes and warpage, you will find that most of the odd "swish-swash" and other types of spurious modulations will have disappeared and with any reasonably well cut "45-45" vertical-lateral stereo disc you should enjoy the beauty of stereo music.

This triumvirate of good stereo cartridge, arm, and turntable is quite the most important part of any stereo disc system and if I were starting from scratch to build a system . . . this consideration would take precedence over fancy amplifiers and fancy speakers. Those can always come in due time, but at least with a good pickup, arm, and turntable at the very beginning, you won't ruin your precious stereo discs and you will be able to enjoy them when you move up to the better speakers, etc.

SIBELIUS
SONGS
Kirsten Flagstad, soprano, with London Symphony Orchestra conducted by Oivin Fjeldstad. London Stereo OS-25005. Price $4.98.

Those who feel that stereo is wasted on a solo voice, even if accompanied by an orchestra, are directed to this *London* recording.

The opinions expressed in this column are those of the reviewer and do not necessarily reflect the views or opinions of the editors or the publishers of this magazine.

This was a fine monophonic recording but now hearing Madame Flagstad's glorious voice in the rounded fullness and beauty of stereo, there just isn't any comparison. True, the glaring spotlight of stereo also throws into relief some of the faults that the inroads of age have made on this great voice, but there is still so much that is pure gold, that the faults are ignored.

The Sibelius songs fit her voice like a glove and *London* has thoughtfully provided a text so we can follow them. Countryman Fjeldstad affords sympathetic accompaniment from the London Symphony. For the most part Flagstad is heard *via* the center "ghost channel" and the stereo effects of the orchestral background add to the superb realism.

CHADWICK
SYMPHONIC SKETCHES
Eastman Rochester Symphony Orchestra conducted by Howard Hanson. Mercury Stereo SR90018. Price $4.98.

Outstanding as a monophonic disc and as a stereo tape, we now have Chadwick's delightful score on stereo disc and it is one of the major successes in this field. For one thing there is no diminution of level, nor is this level accomplished at the expense of bass response, as is so often the case. Rather percussion here is as solid, especially in the big bass drum wallops, as one could desire. The over-all sound is very clean with no tendency for the bright brass to "splatter." The stereo virtues are bountifully exhibited . . . fine directionality, good instrumental separation, excellent ghost channel "fill."

This comes off in comparison to the stereo tape very respectably . . . there is wider frequency range and dynamic scope on the tape, while on the other hand the disc is actually a bit quieter than the tape. Given a choice I'd still vote for the tape, but this is certainly a step in the right direction.

FALLA
THREE CORNERED HAT, SUITES #1 AND #2
TURINA
SINFONIA SEVILLANA
Orquesta Nacional de Espana conducted by Ataulfo Argenta. London Stereo CS6050. Price $4.98.

I gave rave notices to the monophonic version and now plaudits are equally deserved by this stereo edition. Argenta is completely masterful with this music and with the blandishments of stereo, this music is positively irresistible. The colorful orchestration is particularly suitable for stereo and is much benefited by the increase in clarity and realism. Nice clean strings here, bright brass in the Spanish manner and sharply accented, beautifully articulate percussion. Good directionality and excellent depth from the astutely handled acoustics. Don't miss this!

BEAT TROPICALE
Jose Bethancourt and his orchestra with Harry Coons and Richard Campbell on drums. Concert-Disc Stereo CS-33. Price $4.98.

Here is an innocuous appearing item which is a real stereo sizzler. Side one of the disc is devoted to Jose Bethancourt and his orchestra in some tasty Spanish-inspired bonbons. Among these are "Inspiracion," "La Cumparsa," and a wild piece entitled "Cha-cha Flamenco." There is much use of xylophone here and it comes through with brilliant clarity. Anyone who thinks that stereo discs can't reproduce sharp transients should listen to this.

The other side is really fantastic. The two above-named skin-beaters take on a wild session with quasi-African rhythms, replete with a huge variety of modern and primitive

percussion instruments. Their fast and furious drumming is breathtaking and so are the fabulous sounds they evoke from their instruments. At several places some oversized tom-toms are used and if your speaker system is capable enough you'll hear some mighty low frequency whumps, which at the same time effectively refute the argument that you can't get real lows in a stereo disc. Later on there is some trick sound-on-sound overdubbing which is ear-popping in stereo.

Contrary to what you might expect, the stereo effect here is not all "left and right" but intelligent use is made of the "ghost channel" and there is even some "panning" between the speakers that is quite effective. A sleeper this record and an item worthy of hi-fi fanciers.

GRIEG
PEER GYNT (INCIDENTAL MUSIC)
London Symphony Orchestra conducted by Oivin Fjelstad. London Stereo CS-6049. Price $4.98.

Another stereo winner from *London,* whose consistency in this field is amazing. This time the ever popular music from "Peer Gynt," here given a crisp assured performance, that doesn't quite match the mastery of Beecham, but which need bow to none other. The stereo is splendid throughout and adds greatly to this score, revealing many details which are not apparent in the monophonic versions. Depth effect here is superb.

MOZART
SERENADE FOR WIND INSTRUMENTS IN B FLAT MAJOR, #10
Eastman Wind Ensemble conducted by Frederick Fennell. Mercury MG50176. Price $3.98.

Mozart on a monophonic disc of surpassing excellence. There is still great work being done *via* the single channel, and although one awaits eagerly the stereo disc that is sure to follow, it will be reassuring to those who are not stereo equipped that high standards are being maintained. This is something of a "first" for the versatile Fennell, who heretofore has made our living rooms tremble to the mighty Sousa and the thunder of drums and fife. In this beautiful "Serenade," which calls for the utmost virtuosity from every player, Fennell demonstrates he knows how to turn a Mozartean phrase with the best of them. The performance is superbly modeled . . . a just right blend of ebullience and erudition that puts this near the top of the list in company with some formidable Mozarteans.

In terms of sound, it is "no contest" as *Mercury* has lavished on this recording the same clarity and brilliance, the same fine balance and acoustic perspective afforded Mr. Fennell in his more athletic recordings. Highly recommended.

BLAST OFF!
The Gus Bivona Band. Warner Bros. W1219. Price $3.98.

As noted in a recent column, *Warner Bros.* has entered the record business with a bang and is releasing prodigious quantities of material, mostly of the pop variety. What I have received so far is mostly monaural and a sprinkling of stereo. As might be expected from a company whose name is so closely linked with the beginnings of sound movies, they are doing a fair job of recording. I don't think they have reached their full potential yet, but this big-band recording gives evidence that they are getting there. In such items as "C-Jam Blues," "Fugue for Tinhorns," and "Where Are You," this proves to be an easy swinging yet solidly rounded outfit that has a fine sax section and a first-rate rhythm section.

Throughout the sound was very clean, wide in range, and recorded with spacious but not overdone acoustic perspective. Of its type, a pleasant recording.

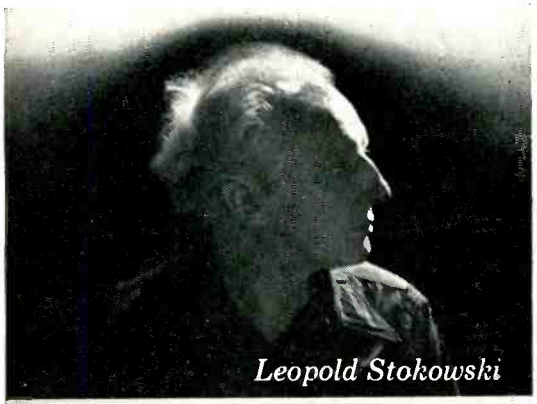
VIVALDI
CONCERTO GROSSO IN D MINOR
MOZART
EINE KLEINE NACHTMUSIK
BACH
PRELUDE IN E MAJOR
Musical Arts Symphony Orchestra conducted by Leonard Sorkin. Concert Disc Stereo CS-31. Price $4.98.

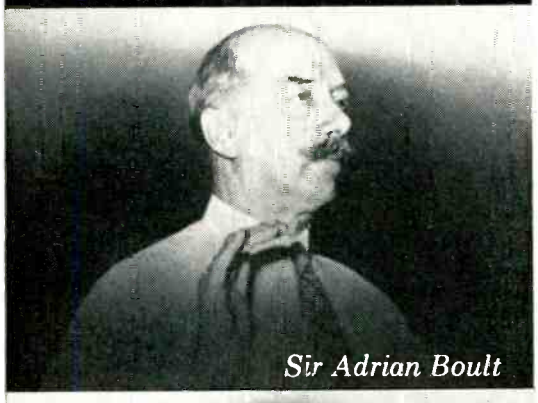
Not unexpectedly, with the advent of the stereo disc, most of the bigger companies have concentrated on the more spectacular symphonic repertoire. For those whose taste runs more conservatively, there has been very little issued on stereo disc. Thus this fine coupling of Vivaldi, Mozart, and Bach should be eagerly welcomed by people in that group.

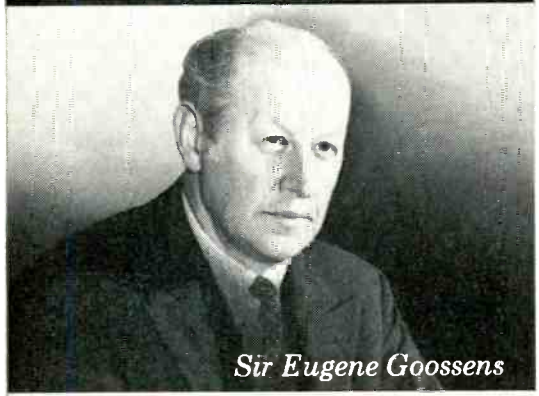
This is exemplary music-making on all points. The performances are all first rate. done with taste and with considerable verve and *brio.* The playing of the orchestra is most expert and I rather suspect the personnel is recruited from the Chicago Symphony. Leonard Sorkin is, of course, the same gentleman whose Stradivarius heads up the well-known Fine Arts Quartet.

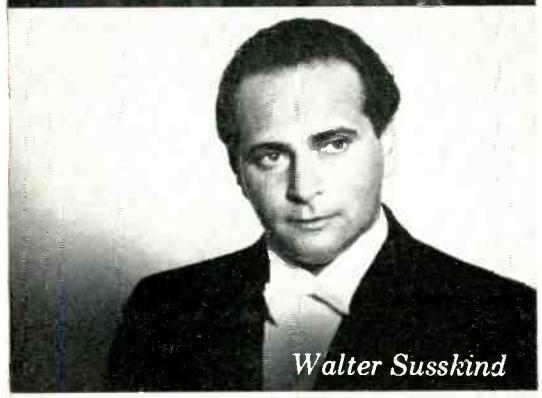
The sound is exceptionally bright and clean. and yet there is never any "wiriness" to the strings. Directionality was excellent as was instrumental separation and an acoustic perspective was chosen which lends smoothness and roundness to the sound without loss of detail. —30—

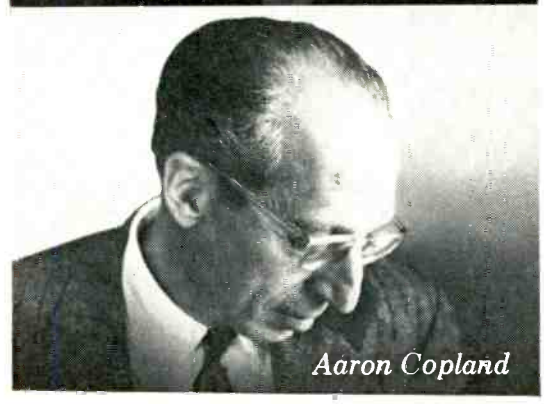
New Shure "Ten-Four" mobile communications microphones are dragged behind auto for more than three miles during series of "torture tests" to determine ruggedness of new lightweight plastic "Armo-Dur" housing. This housing is a high-impact thermoplastic resin of uniform molecular structure. Similar substances are used in football helmets, roller skate wheels, and artillery shell casings. An estimated 35,000 separate shock-impacts did not affect microphones' frequency response or mechanical functioning. The housing proved more rugged than conventional metal housings in experiments that included exposure to high temperatures and corrosive fumes.











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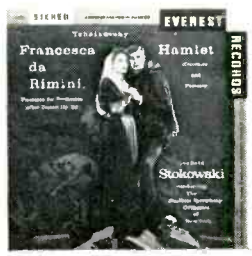

Tchaikovsky: Francesca da Rimini; Hamlet Overture. Leopold Stokowski, the Stadium Symphony of New York.
LPBR-6011 SDBR-3011†

Mahler: Symphony No. 1 in D Major—Sir Adrian Boult conducting the London Philharmonic Orchestra.
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Respighi: Feste Romane; **Rachmaninoff:** Symphonic Dances, Op. 45—Sir Eugene Goossens, the London Symphony Orch.**
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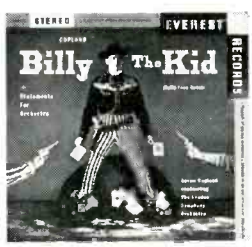
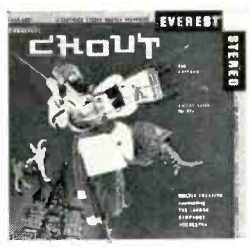
Copland: "Appalachian Spring"; **Gould:** "Spirituals"—Walter Susskind, the London Symphony Orchestra.
LPBR-6002 SDBR-3002†



Copland: Billy the Kid (Suite); Statements For Orchestra—Aaron Copland, conducting the London Symphony Orch.
LPBR-6015 SDBR-3015†



Prokofiev: "Chout" (the Buffoon) Ballet Suite—Walter Susskind conducting the London Symphony Orchestra.
LPBR-6001 SDBR-3001†

Stravinsky: Ebony Concerto (Woody Herman); Symphony in Three Movements. Sir Eugene Goossens, the London Sym. Orch. **LPBR-6009 SDBR-3009†**

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Photo of Mr. Susskind: Anni Landes, Tel-Aviv. †Stereo recording *T.M. **Two-disc set

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Sound on Tape

By BERT WHYTE

AS I reported in my last column, the New York Audio Fair was distinguished by the lack of any production models of the four-channel magazine-load tape machine. I suppose, like everything else, it will just be a question of time before such machines will actually appear. But evidently, there are a few people who feel that this time will be inordinately long. These are the people who are espousing the cause of what may turn out to be the best compromise after all, namely a four-channel, 3¾ ips tape machine, utilizing standard reels instead of magazines or cartridges.

First in the field and principal proponent of this scheme is *Ampex*, which has had its universal-type 900 machine, which is capable of handling the reel-type four-channel sound, on the market for some time. Now several other companies appear to be following suit and perhaps before very long, four-channel tape, at least in the reel form, will be a commercial entity.

This approach to four-channel "half-track" stereophonic sound, would appear to be basically sound. After all, it would be impossible to equip existing stereophonic tape machines with some means of handling cartridge or magazine-load tape, whereas it is not difficult to imagine simple head conversion kits and the necessary electronic gear which would enable the user to play the reel-type of four-channel sound.

I have said at the end of this column for the past several months that new stereophonic tapes were becoming increasingly scarce and hence there hasn't been much to review. Naturally, this has been an almost direct consequence of the appearance of the commercially successful stereophonic disc.

Logic and just plain old commonsense tell me that there are many thousands of people who own perfectly good reel-type stereophonic machines, for which they have paid good money, and I cannot believe they are very happy about the current tape situation. It was less than a year ago that the stereo tape market was becoming an important sales factor for many companies and at the time the stereophonic disc was as yet an unrealized dream. All this activity was pegged at an admittedly high price level, yet despite this, people were buying tapes. Now, these people have invested their money in these machines and while many of them may have subsequently invested in stereophonic disc playback equipment, you can't tell me that . . . (*a*) they don't feel a twinge in the region of their pocketbooks every time they look at said tape machine and (*b*) if you offered these people a relatively inexpensive four-channel conversion head kit and they have the prospects of being able to enjoy the superior quality of stereophonic tapes, at a price almost comparable to that of the stereo disc, they wouldn't jump at the chance.

Evidently a few of the manufacturers are beginning to think along these lines and not only has there been, at long last, some new releases in the normal 7½ ips mode, but production plans are under way for the introduction of four-channel reel-type stereo tapes. There is even some original thinking being done by these proponents of reel tape and one outfit has developed a less troublesome method of handling and loading reel-type tapes. There is even talk of incorporating in some new production what is, in essence, a tape reel changer, although this would seem to be more in the province of the tape cartridge.

In any case, it all adds up to the fact that while stereo tape may be down at the moment, it certainly isn't out, and I feel that the longer the magazine-type machine is delayed and the more aware people become that even on the best of terms the stereo disc cannot equal a top stereo tape, there will be a resurgence of interest in the manufacture of "normal" stereo tape. I hope to be able to bring you a report on some new developments in reel-type tape technology. In the meanwhile, here are a few new tapes that have come my way.

WILLSON, MEREDITH
THE MUSIC MAN
Hollywood Radio City Orchestra conducted by Tom Davis. Omegatape Stereo ST 3033. Price $9.95.

This, of course, is a potpourri of tunes from the hit Broadway musical, "Music Man." It is not the first of these to appear, but it has much to recommend it in the way of sound quality. The Hollywood Radio City group is a better-than-average "pop" ensemble and with the able assistance of Conductor Davis, they tackle this work with great gusto and in the sparkling stereo sound which follows, they sound like they are enjoying themselves.

This tape was made at a very high level and is characterized by fine di-

rectivity, good instrumental separation, and big close-up, very full sound. Overall balance was well maintained and judicious use was made of hall acoustics to heighten the illusion of depth. As to the music itself, outside of the amusing and rollicking "76 Trombones" I find it a crashing bore, in which overworked clichés have been further done to death, and it all comes out sounding like freshly popped hot buttered corn. However, maybe I'm just getting old and grouchy and gosh knows it must have something or it wouldn't have been on Broadway this long.

If you are a lover of show tunes and similar ilk, this will probably furnish a nice evening's entertainment. Certainly it will be hard to fault in matters of sound and this may just be the thing you're looking for.

BACKGROUND FOR BRANDO

Elmer Bernstein and his orchestra. Omegatape Stereo ST 3020. Price $9.95.

Obviously this tape is intended for fans of Marlon Brando. If this does not apply to you, read no further. I must confess I'm one . . . I like the guy. He's got a lot of genuine talent and certainly the wide scope of his roles has proved the versatility of his acting. Since he almost always appears in big productions, he generally has the benefit of some pretty good background music written by some of Hollywood's most able themesters. So here we have various moods, reflections, and points of action that have accompanied Brando's histrionics.

There is "Music for Condemning Brutus" from Julius Caesar, "Music to Accompany Wild Motorcycle Rides" from The Wild Ones, "Music for Making Love Japanese Style" from Sayonara, to say nothing of "Music to Get Beat Up By" from Water Front, and many other musical backgrounds which have made Brando's efforts more memorable.

All kidding aside, strictly as a vehicle for background listening, this is a very good tape, with the talented Elmer Bernstein conducting a group of excellent instrumentalists. It has all the stereo attributes and is an especially clean, well-balanced tape. Nothing earth-shaking here, but certainly among fellow Brando *afficionados,* a good stimulus for conversation about their favorite boy.

GERSHWIN
RHAPSODY IN BLUE

Eugene List, pianist, with Eastman Rochester Symphony Orchestra conducted by Howard Hanson. Mercury Stereo MWS 5-47. Price $6.95.

Here is a companion piece to the same artists' recent "Concerto in F" and it is every bit as enjoyable as that memorable tape. Eugene List gives a fine idiomatic performance which, for my money, is the best since the old San Roma performance of so many years ago. His technique is very assured and facile, but apart from these considerations he imparts a great deal of expression and feeling to the music

and you feel that he genuinely enjoys playing the piece.

Fortunately, neither he nor Dr. Hanson try to engage in any phony jazzifications which have been the bane of so many recordings of the "Rhapsody in Blue." There is no denying that the "Rhapsody in Blue" is jazz-derived, but this should not be a license for some of the tawdry and vulgar expositions I have heard of this score.

Dr. Hanson, for his part, plays it straightforwardly, and while his sense of rhythm and syncopation, if you must, is excellent, he never lets things get out of hand. Soundwise, this is fine concerto stereo, meaning that the piano stays just left of center in the ghost channel and does not wander between the speakers.

One thing I cannot for the life of me understand, is that I have read several reviews of this tape, in which the critics complained of a "lack of room resonance and dry acoustics." How they reach this conclusion, I'll never know, for although the recording is made close-up and is highly detailed, there is no paucity of hall reverberation and while I would not say that this has an over-powering sense of depth, it certainly has some and it adds considerably to the over-all realism.

Incidentally, here is one more instance where you champions of stereo tape can compare tape with the same piece on disc. Good as the disc is, it isn't in the same league with the tape!

-30-

Your Service Data

(*Continued from page 60*)

peering—just one extraction. The index will also enable you to see at a glance that you do not have a particular schematic on file at all; so there is no time wasted in fruitlessly searching through the file.

Requirement 2: To be easy to find and extract, the service data should be in folders of uniform size and with stiff covers. The most useful are the manila folders of standard letter-filing size. One is shown in Fig. 2. There are "left-tab" and "right-tab" types and it is convenient to have a quantity of each. Thus odd-group numbers can be scanned on the left side and the even-group numbers on the right. This further simplifies the operation of finding a folder. When a folder gets dog-eared or limp, throw it away—folders are cheaper than your time.

Requirements 3 and 4: How do you deal with the various service letters, modification sheets, service hints, etc. that come in the mail from manufacturers? It is a fact that most of these invaluable sources of information are "filed" away and promptly forgotten. Here is a way to make good use of this "dope" without trying to pack it away in your already overburdened head.

Inside each folder, staple a blank sheet of paper. When a letter comes in, make a note on the appropriate flyleaf as a reminder in the future. If it is a simple reference, like: "For better vertical lock replace C_{208} with a 220-$\mu\mu$fd. mica capacitor" it is easily entered as just stated. If it is more complex, a note such as, "To eliminate buzz in audio, see *G-E* letter 2nd Jan. 1957" is better. You will find yourself adding odd scraps of useful information on this flyleaf: "C_{36}, .03 μfd., shorts—no H. V. Normal across video load resistor, Channel 2, 2.5 volts."

What's more, if your experience follows ours, you will find yourself scanning the flyleaf for help before servicing the set. After a couple of years of accumulating data, a large proportion of shop repairs will be handled "straight out of the book." If a technician leaves the shop to plow a furrow elsewhere, he leaves behind, in black and white, a goodly slice of the experience he has gained for the benefit of his successor.

Requirement 5: This is met by the provision of the numbered system described and by the use of stiff, uniform-sized folders. Beside the index should be hung a sheet of paper on which a note can be made of missing schematics. It is not often convenient to drop a job to write asking for service data, but a note to that effect should be made immediately and the necessary letter can be sent off at some more suitable time.

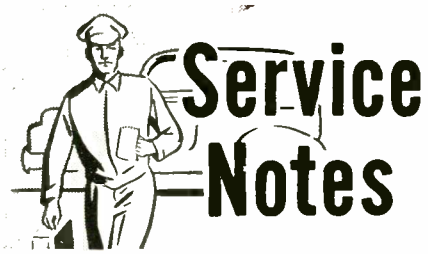
It is also a good idea to have a blank space in one corner of the index sheet, or a sheet attached, on which helpful notes relative to schematics can be written, such as: "*RCA* 17T705 is like 799 except for horizontal oscillator," or "Space Challenger much like 23-12."

Using the Schematic

Do you find that the set under repair, the test equipment, and the schematic have to compete for space on the bench? There is a simple and effective way to accommodate schematics just *off* the bench: incorporate a sliding shelf, similar to that used in many office desks. The shelf should be at least 12" wide and about 20 to 24 inches should project from the front edge of the bench when drawn out. The total length, including the hidden portion, should be as long as possible—the longer it is, the more stable and level will the surface be when it is withdrawn for use, as shown in Fig. 1.

The use of this device not only speeds up work, it also helps to protect valuable schematics from abuse. (*Requirement 6.*) A simple time and motion study will also prove that the bench technician can be spared much unnecessary movement and fatigue when the schematic is readily accessible.

There is a regrettable tendency, in TV service operations, to treat lightly such "details" as filing systems and labor-saving devices, but it definitely pays off to give some serious thought to these aspects of the business. The summer season will usually provide some opportunities to implement projects like this, resulting in a workshop better equipped to meet the rush of Fall business. -30-

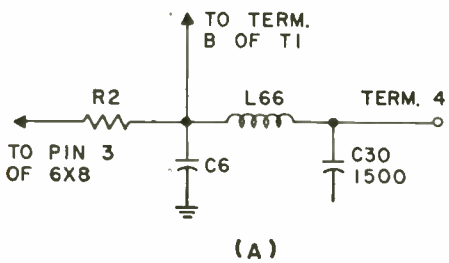


RCA: TVI FROM TUNERS

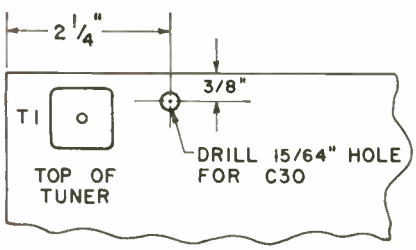
Field reports show that second-harmonic radiation from the oscillator in the KRK11 tuner, when it is on certain v.h.f. channels, may produce interference on certain u.h.f. channels. Specifically, when the KRK11 is tuned to channel 10, 11, 12, or 13, second harmonics of its oscillator will fall in the bandwidth of channel 15, 17, 19, or 21 respectively.

The simplest way of dealing with this problem is to connect a .001-μfd. disc ceramic capacitor between terminal 4 on the rear of the tuner and ground. The ground connection must be made to the rear shield of the tuner, *not* on the outside case. Capacitor leads should be kept as short as possible. The oscillator tube shield must be securely grounded and held in place with the spring wire clip. The tuner top shield cover must be securely grounded too. If necessary, the spring edges should be bent inward to obtain better grounding.

In severe cases, this method may not work. A decoupling network (C_{80} and L_{66} in Fig. 1A) will then have to be installed. C_{80}, 1500 $\mu\mu$fd., is *RCA* Stock No. 75166. Inductor L_{66} is Stock No.



(A)



(B)

Fig. 1

77153. To mount the capacitor, drill a hole in the top of the tuner chassis as shown in Fig. 1B. A mounting clip for C_{80}, Stock No. 76143, should be used. The inductor is mounted inside the tuner chassis between C_{80} and terminal *B* of T_1. As with the first method mentioned, make sure that the tube shield and the tuner top shield are securely grounded. Later versions of this tuner —KRK11A and —B—have this decoupling circuit already incorporated in

the "B+" lead to the oscillator-mixer tube.

RETRACE, HOFFMAN COLOR TV

If vertical-retrace lines become evident on receivers using "Colorcaster" chassis 703 and 704, a simple elimination circuit may be added. That portion of the circuit involved in adding the blanking circuit is shown in Fig. 2. Instead of applying a vertical pulse directly from the vertical-output stage to the picture tube, this arrangement feeds the desired pulse to the chroma amplifier. The technique permits the blanking pulse to be amplified, through the chroma amplifier, before application to the three grids of the color picture tube with sufficient amplitude to provide adequate blanking.

The six components marked *ADD* in Fig. 2 are the additional ones required. The 3300-ohm resistor shown connected

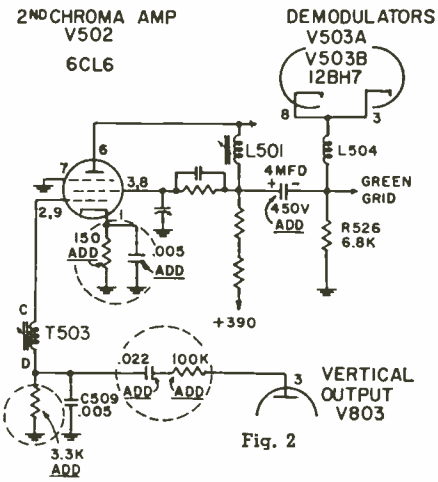


Fig. 2

to point D on T_{503} actually replaces a 1000-ohm resistor originally used in this circuit. Also, the cathode of the original chroma amplifier was returned directly to ground. That connection must be broken to insert the *RC* network shown. The other three components are inserted where no circuit connections existed before. Be sure to observe the indicated polarity and voltage rating on the 4-μfd. capacitor added between the chroma amplifier circuit and the cathode circuit of the demodulator.

Do *not* look for an easy way out by attempting to apply the blanking pulse directly to the cathode of the picture tube. This may deteriorate synchronization, a.g.c. action, and picture definition. The only adverse effect of the alteration shown here is a slight reduction in green color, which may not be noticeable and for which other compensation can be made.

SPARTAN RECORD CHANGERS

If the motor should be excessively noisy on a *Sparton-Collaro* record changer, make sure the fan is not striking or binding on anything. Then tap the motor on all sides with a screwdriver handle, during operation. The motor's self-aligning bearings should seat when tapped. Do not disassemble the motor for any reason. —30—

Dynamic Sideband Regulation Used in New Tuner

By **ROBERT BERKOVITZ**
Allied Radio Corp.

Overmodulation effects are reduced and weak signals are improved by circuit that wobbles local oscillator.

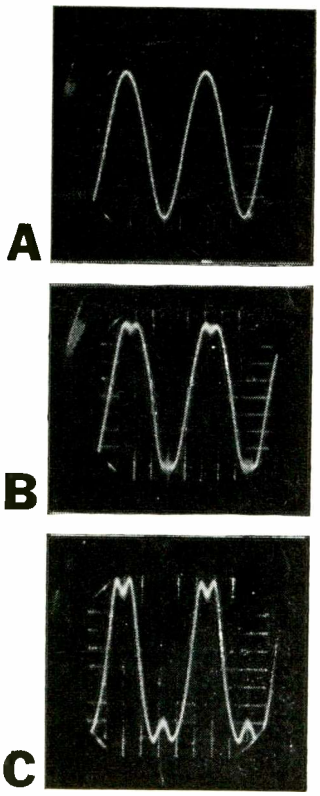
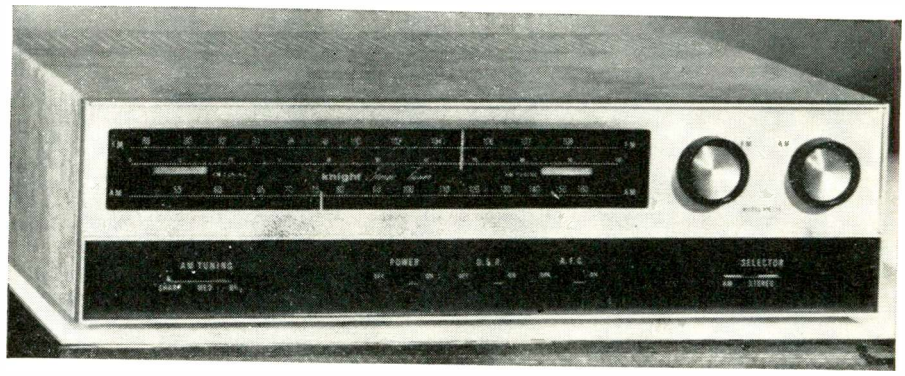


Fig. 1. The "Knight" stereo tuner that uses the D.S.R. circuit is shown here. The scope trace at (A) is the discriminator output of the tuner with an input signal having a deviation of ±150 kc. (B) shows the output with D.S.R. circuit switched out. (C) is the output of another tuner without D.S.R.

THERE is an interesting problem associated with high-fidelity FM broadcast reception. Between the setting of the audio level at the transmitter and the volume control at the output of the FM tuner in the listener's home, there has until now been no way to adjust the amplitude of the transmitted program material. The very nature of FM transmission makes the problem a knotty one, since the audio information consists of frequency changes in the transmitted r.f., rather than the amplitude changes of AM, which can be dealt with in comparatively simple ways. As a result of this situation, volume peaks in the transmitted program can cause momentary high levels of distortion in comparatively good FM tuners. Moreover, signals which are too weak to produce good limiting action may be seriously distorted by the narrowed tuner bandwidth which results. A new FM tuner circuit development, Dynamic Sideband Regulation* (D.S.R.), has been devised by engineer Richard Medal to cope with these problems. Commercially available in a newly designed FM-AM stereo tuner, the D.S.R. circuit is claimed to provide very listenable reception at double the maximum modulation level permitted by the FCC, at signal levels of as little as 20 or 30 microvolts. Applicable to any good tuner with an a.f.c. circuit, the additional components required for D.S.R. consist of a triode cathode-follower and a few resistors and capacitors.



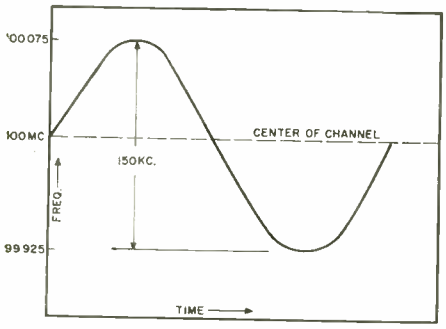
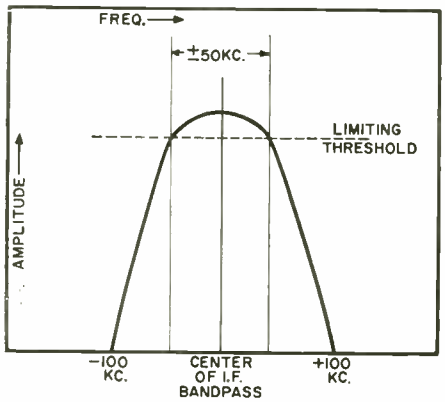


Fig. 2. Maximum carrier frequency swings.

Fig. 3. A typical i.f. amplifier response.



Deviation and Bandwidth

Stated most simply, D.S.R. works by reducing the deviations in frequency of the incoming FM carrier. Before going into the details of the circuit itself, it will be well to explain why this serves to reduce the distortion. Fig. 2 represents the maximum changes in frequency which may take place in the FM carrier during a broadcast; in the example illustrated, the amount of frequency swing, or deviation, is plus-and-minus 75 kilocycles on either side of the center frequency. The deviation is proportional to the amplitude of the program material being transmitted, and is controlled at the transmitter, where changes in amplitude in the program are converted to changes in frequency of the carrier. To pass this transmission without distortion, an FM tuner would have to have an over-all bandpass of at least 150 kc. in those parts of the circuit preceding the detector. Actually, according to the higher mathematical analysis of FM transmission suggested by the theory of FM sidebands, the bandpass may have to be as great as 240 kc. Because of the extended high-frequency response required by some methods of FM multiplex broadcasting, this figure may need to be even larger. Few commercially available FM tuners attain these figures, and it may well be that only a perfectionist would demand that they do, since the usual deviation during most FM broadcasts rarely requires the theoretically necessary bandpass.

Musical program material, however, appears to be obedient only to the laws of art and of statistical probability. Unless the FM broadcasting station engineer chooses to operate at relatively low audio levels—which a little dial-spinning shows to be rare—his only choice would be to audition each performance or recording to be broadcast alongside an accurately calibrated oscilloscope. There is another alternative, the limiting amplifier, which can trim down the audio automatically by electronic means whenever overmodulation is likely, but this begins to make serious inroads against the whole idea of high-fidelity broadcasting with full dynamic range, an idea which has become an important part of the satisfaction listeners expect from FM. For these reasons, as several anonymous

* Patent applied for.

engineers have confessed to the author, sudden dynamic peaks in musical program material which appear unexpectedly may cause carrier deviations greater than 75 kc. Although FCC-required "guard bands" exist between stations beyond the 75 kc. limit, these serve mainly to protect the stations from each other, rather than to protect the listener from the stations themselves.

Reception at low r.f. levels, as in fringe areas, introduces the problem of adequate bandpass in the tuner in another way, independent of the material being broadcast or the bandwidth or the conscience of the studio engineer on duty at the time. Fig. 3 shows a typical i.f. amplifier response curve. When the incoming signal is weak, the limiters which follow the i.f. amplifier stages will do no more than flatten out the very top of the curve. The amplitude variations which are then introduced as the frequency swings from one extreme of the curve to another will pass on to the discriminator, producing severe distortion. In very good tuners, of course, this limiting threshold is quite low, but no matter how low it is, one may always presume the arrival of a signal whose intensity just fails to make it over the threshold. Under these conditions, it is desirable to reduce deviation in order to keep the frequency variations within the portion of the i.f. curve which is subject to limiting.

How It Works

To reduce the deviation of the incoming signal D.S.R. frequency-modulates the local oscillator of the tuner, by applying a fraction of the discriminator output, before de-emphasis, to the grid of the a.f.c. reactance tube. Fig. 4 helps to clarify just what happens as a result. Almost all FM tuners use the beat-frequency, or heterodyne method of reception. An oscillator in the tuner is tuned to a frequency exactly 10.7 megacycles above the center frequency of the incoming FM carrier; the two are mixed electronically, and a 10.7-megacycle beat, or intermediate frequency (i.f.) results. As the carrier frequency deviates, the i.f. deviates by exactly the same amount, since the local oscillator frequency remains constant.

Now, suppose that the oscillator frequency is made to shift in-phase with the changes in the carrier frequency, but by a smaller amount. As Fig. 5 indicates, the deviation of the i.f. from its center frequency of 10.7 megacycles will be reduced, since the difference between the oscillator and carrier, although still fluctuating, will not fluctuate by as much as it did when the oscillator was held at a constant frequency. Theoretically, the deviation in the i.f. can be almost completely extinguished by making the variations in the local oscillator sufficiently great. In the D.S.R. circuit to be described, the oscillator is made to vary by a fixed fraction of the carrier deviation, reducing the deviation of the i.f. by a predetermined amount when the D.S.R. is switched on. The resulting audio output is very similar to that which would have come about had the transmitter reduced the deviation; it is dif-

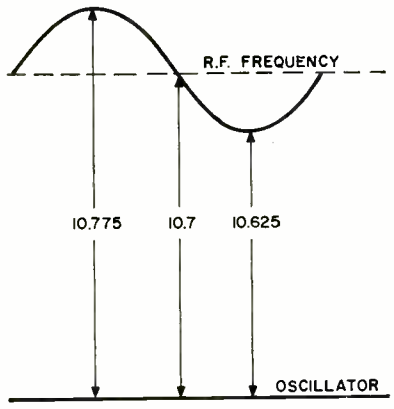


Fig. 4. Normal beat-frequency operation.

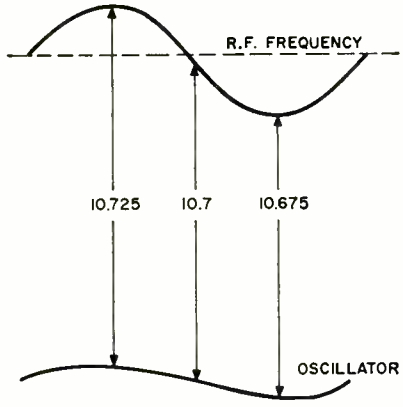


Fig. 5. Operation with oscillator swinging.

Fig. 6. Complete block diagram of the new tuner which employs the D.S.R. circuit.

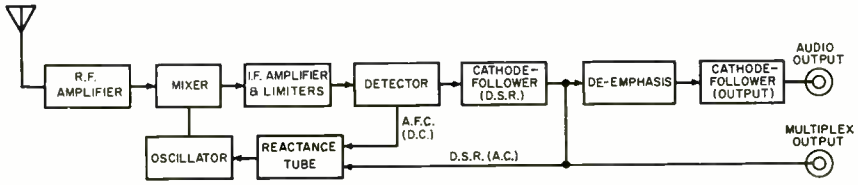
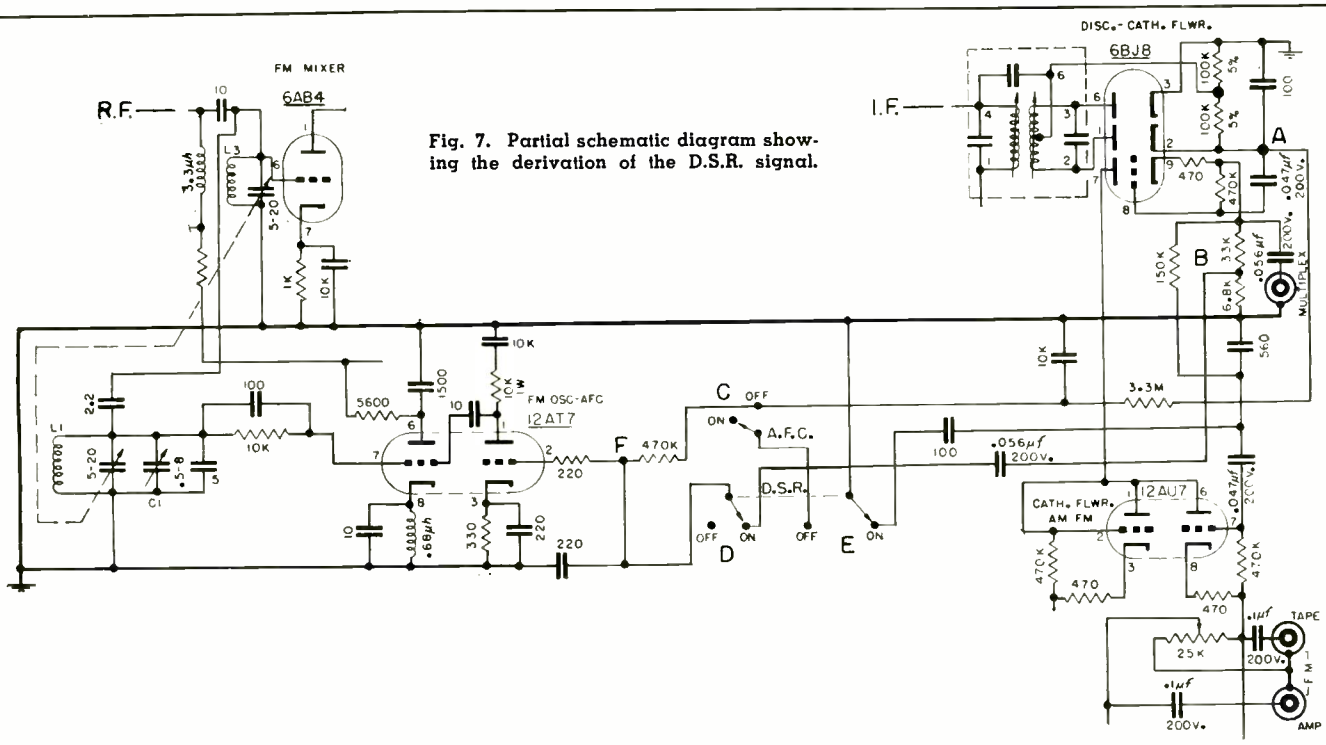


Fig. 7. Partial schematic diagram showing the derivation of the D.S.R. signal.



ferent mainly because deviation in the carrier due to interference has also been reduced.

Effectiveness of D.S.R.

The effectiveness of D.S.R. may be gauged by an examination of the three photographs in Fig. 1. The oscilloscope trace in (A) shows the discriminator output of the tuner incorporating D.S.R. when a 107-megacycle carrier is frequency-modulated plus-and-minus 150 kc., at an r.f. input of 18 microvolts. Photograph (B) was made under identical conditions, but with the D.S.R. switched out of the circuit. The third photograph was made under the same conditions, with an excellent, well-aligned tuner without D.S.R., which is deservedly well-respected for its high sensitivity and effective limiting.

Block Diagram

Fig. 6 is the block diagram of an FM tuner incorporating the D.S.R. circuit. The normal output of the discriminator in an FM tuner consists of two voltages: an a.c. voltage, which is the audio signal being transmitted, superimposed upon a d.c. voltage, which is produced by slightly detuning the receiver, and eliminated by accurate retuning. In a conventional a.f.c. circuit, the audio component of the discriminator output is filtered out and the remaining d.c., if any is present due to mistuning, is applied to the grid of a triode which is used as a variable reactance in the local oscillator circuit. This alters the frequency of the local oscillator, raising or lowering it according to the polarity of the discriminator d.c., until the receiver is retuned and the d.c. is no longer present.

For D.S.R. operation, a portion of the a.c. audio voltage is also applied to the reactance tube grid. This causes the oscillator frequency to vary in the same manner as in a conventional a.f.c. circuit, but at a much faster rate, of course. The result is frequency modulation of the local oscillator in-phase with the frequency variations of the incoming FM carrier, since the audio voltage controlling the oscillator frequency is derived from the frequency variations of the carrier. Because of the low impedance presented by the grid of the reactance tube, a cathode-follower triode is used after the discriminator to supply the D.S.R. control voltage at low impedance. In addition to its function in the D.S.R. circuit, the cathode-follower provides a multiplex output at low impedance, a highly useful by-product in view of the extended high-frequency response that may be required for a multiplex transmission system.

Circuit Used

In the schematic shown in Fig. 7, a 6BJ8 dual-diode triode serves both as discriminator and cathode-follower. From *A*, the discriminator output, the a.f.c. line proceeds through its a.c. bypass network and switch to *F*, the re-

actance tube grid. Also from *A*, the audio output of the discriminator is applied to the grid of the triode in the 6BJ8 through a d.c. blocking capacitor. In order for the frequency variations introduced by the D.S.R. to accurately reflect the deviation of the incoming carrier, the audio must not be allowed to pass through the de-emphasis network, where high-frequency response is pared down. From the cathode-follower, the D.S.R. control voltage passes to a voltage divider at *B*, where it is picked off below the multiplex output and the lead to a second cathode-follower which provides the final audio output of the tuner.

A ganged D.S.R. on-off switch is required for several reasons. Since the D.S.R. control voltage variations must be in-phase with the incoming signal, detuning must be avoided to prevent the noisy results of regenerative feedback. This requires that the a.f.c. and D.S.R. switching be arranged in such a way that the a.f.c. cannot be switched off when the D.S.R. is on, and this is accomplished by the switch circuit shown in the schematic (*C*, *D*, and *E*.) A second requirement in the switching is brought about by frequency response correction which takes place at an earlier point in the tuner, intended to flatten response which may not be perfectly linear due to slight irregularity of the discriminator frequency response. When the D.S.R. is switched into the circuit, the resulting frequency response is so linear that the corrective network must be "un-corrected," a task accomplished by the capacitor running from the audio signal line to ground through switch gang *E*. At the grid of the reactance-tube half of the 12AT7, the a.f.c., and D.S.R. lines meet.

Just as in a feedback audio amplifier, the degree of audio fed back through the D.S.R. circuit has an optimum maximum value. Too much feedback introduces instability, as well as decreasing the audio output of the tuner too much. Too little feedback, of course, fails to accomplish the results for which the circuit is intended. In the circuit illustrated, the voltage divider at *B* feeds back a voltage approximately one-fifth that of the output at the multiplex jack. Although noticeable, the drop in output level which results is easily compensated by a slight turn of the volume control on the amplifier to which the tuner is connected. Where the D.S.R. has been switched on to tame a station which is overmodulating, the listener is compensated for the volume loss by the fact that the audio level is now where it should be, were the transmission being properly monitored. Both under these conditions, and in the case of weak signals, D.S.R. adds a degree of quality to FM reception which makes pleasant listening possible under conditions which would otherwise make it quite difficult. The D.S.R. circuit shown is used in the new "Knight" KN-120 Stereo FM-AM tuner, a product of *Allied Radio Corp.*, Chicago, Illinois. —30—

Record Number of Sets in Use During '58

FCC issues year-end report showing big radio-TV gains

AT year end the FCC issued an annual report on the "health" of the radio industry and, to nobody's surprise, it indicates that the "patient" is robust and growing phenomenally.

During 1958 radio permits and licenses increased by about 200,000 for a total of more than 2,100,000 current authorizations in the radio field alone, with some 1,500,000 transmitters in actual use—250,000 more than at the close of 1957. Holders of licenses range from individual citizens to business, industry, and public agencies.

The 40 groups in the Safety and Special Radio Services account for some 465,000 authorizations covering more than 1,400,000 fixed and mobile transmitters. Over 300,000 of these units are operated by public bodies in connection with safeguarding life and property.

Private industry operating in this category account for nearly 420,000 transmitters which are used in a wide variety of applications.

Amateur radio stations involve the use of approximately 185,000 transmitters with radio usage by individual citizens accounting for 125,000 of the transmitter licenses outstanding.

Broadcast Services

Thirteen categories of broadcast authorizations are approaching an all-time-high total of 9500. Of this number more than 5100 are stations offering programs and the remainder are auxiliaries.

Interestingly enough, the nation now has more broadcast receivers than it has people and almost three times as many sets as automobiles. The industry estimates that there are more than 200,000,000 receivers in use — 150,000,000 radios and 50,000,000 TV sets.

Of the nearly 670 commercial TV stations authorized (about 470 v.h.f. and nearly 200 u.h.f.) more than 500 are on the air (430 v.h.f. and nearly 80 u.h.f.). In addition, the programs of some of these stations are being picked up and re-transmitted locally by about 200 translator stations.

Today, over 90 per-cent of the population is within range of at least one operating TV station and 75 per-cent is in the service areas of two or more TV stations. About 85 per-cent of all homes have one or more TV receivers.

Commercial FM broadcast stations continued the numerical upturn that began in 1957. Of nearly 690 commercial FM broadcast authorizations, more than 570 are on the air. They hold about 100 authorizations for subsidiary services as well.

There are some 3400 AM stations authorized with over 3300 of these in actual service.

Licensed Operators

More than 1,500,000 commercial radio operator permits of different grades are held by those who operate the ever-increasing number of non-Government transmitters for a livelihood as distinguished from "hams" who operate their amateur stations as a hobby without monetary return. —30—

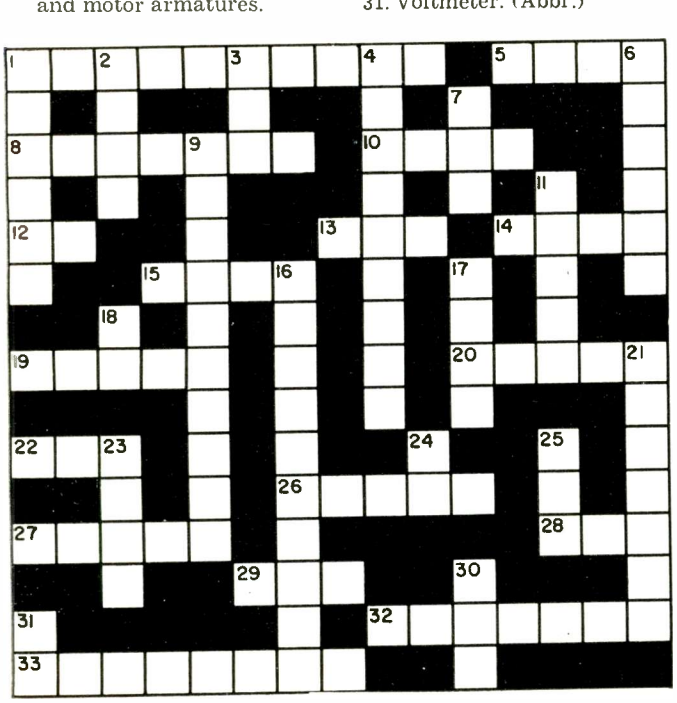
test equipment teaser

By **JOHN A. COMSTOCK**

EVERY electronic service technician should be familiar with the various test instruments associated with his profession and the terminology of his trade. How do you score in this respect? Work this anagram to determine the depth of your electronic test instrument "know how" then check your answer on page 166.

ACROSS
1. Resistor used to increase voltmeter's range.
5. Type of frequency meter.
8. The indication that a meter gives.
10. Maximum instantaneous value of an a.c. current or voltage.
12. Letters symbol for voltage measured across a resistance.
13. Type of color-TV test signal generator.
14. Type of connector used at end of test lead.
15. Amplifying device used in a v.t.v.m.
19. Resistor used in conjunction with an ammeter to increase its range.
20. Type of TV alignment signal generator.
22. Letters symbol for voltage measured on tube's screen grid.
26. To line up circuits or bring them into tune.
27. This, too, should be considered before one buys a test instrument.
28. Short for a type of variable resistance.
29. Some service technicians prefer to build their own instruments from a ——— to save on the purchase price.
32. An electromagnetic device for locating shorted coils in dynamos, generators, and motor armatures.
33. A meter's deflection mechanism which converts electrical currents or voltages into needle deflections.

DOWN
1. Type of TV signal generator used for visual alignments.
2. The device to which power is delivered.
3. Type of test jack.
4. A small test coil used for measuring magnetic fields.
6. Type of resistance box containing a precision variable resistance.
7. When one a.c. wave follows behind another, it is said to ———.
9. Type of bridge.
11. Device often used with a signal tracer.
16. Application of a test signal to the input of a circuit.
17. Test instrument protective device.
18. Type of audio measuring meter. (Abbr.)
21. Indicates the reading given by a test meter.
23. How much a given amplifier can raise the input signal.
24. Letters symbol for grid voltage.
25. One should ——— a tube to determine if it is microphonic.
30. Voltohmmeter. (Abbr.)
31. Voltmeter. (Abbr.)



"Atlas" Satellite Uses Special Radio System

Communications relay inside the missile includes a compact magnetic tape storage-playback system.

THE communications relay inside the "Atlas" missile that is circling the earth uses a special radio system developed by *RCA* for the U. S. Army. The system includes an array of lightweight communications and control equipment in the satellite itself, and complementary equipment of a more conventional type in the ground stations situated at points beneath the satellite's orbit. The service employs v.h.f. and code communications hitherto unattainable at these frequencies over distances of a thousand or more miles without intermediate relay stations. The success of this experiment opens up the early prospect of revolutionary communications techniques, such as international television and microwave voice and code services on a global basis, using satellite relays capable of spanning the oceans.

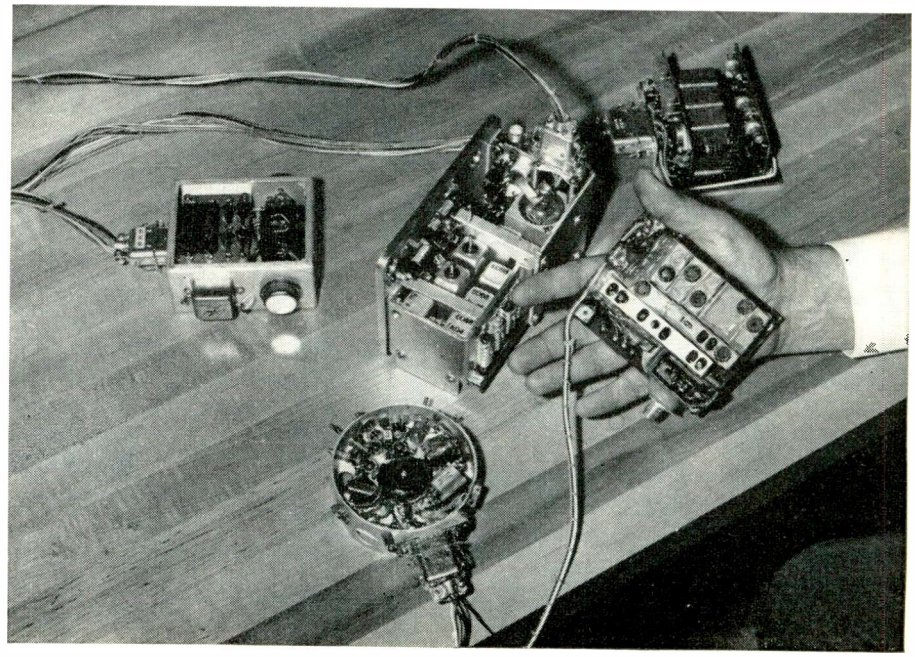
Among the elements aboard the satellite are the following: Two transistorized receivers, each weighing 10 ounces, for receiving messages from the ground stations. These receivers are enclosed in special shock-resistant coverings and employ ruggedized assemblies. Two 8-watt transmitters, each weighing 2½ pounds, to relay the messages on command to another ground station. Two electronic control units, of ¾ pound each, which respond to commands from the ground to activate the receivers, transmitters, or the magnetic tape system that stores the radio messages until time for their delivery to a ground station. Two beacon transmitters, ¾ pound each, which send out a steady signal for tracking and temperature recording. These operate at the 108-mc. frequency adopted for satellite tracking and are picked up by the IGY "Minitrack" stations as well as the ground stations in the system.

Each of the five Army mobile ground stations includes a 1-kw. transmitter, a 250-watt standby transmitter, two receivers, and a control unit. The ground equipment, mounted in vans, also includes a beacon receiver and a tape recorder.

The Army Signal Laboratory was responsible for developing the beacon equipment and the tape recording gear both in the satellite and on the ground as well as handling the supervision of over-all completion of the entire communications system.

The *RCA* elements of the Army System were developed and largely produced at the engineering and production plant of the company's Astro-Electronic Products Division at Princeton, New Jersey. —30—

The communications relay system installed in the Signal Corps Orbital Relay Experiment satellite includes the equipment shown here. Being held at right is transistorized receiver. Behind it is the control unit. Large unit at center is the transmitter. At left is a power converter for the transmitter. Round unit in foreground is beacon transmitter. Two of each of units shown are in satellite. Not shown are special tape recorder along with the battery power supply units.



Testing Electrostatic Speakers

(*Continued from page 64*)

polar pressure between the beams of the individual radiators. The reverberation of the listening room must be relied upon to smooth these out.

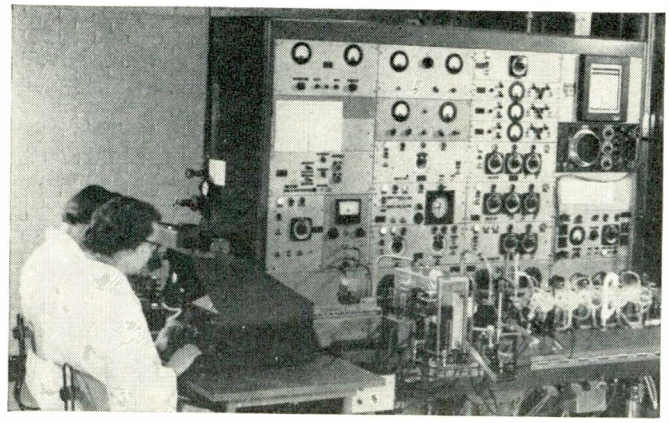
The impedance-frequency curve is important in determining the "power" transfer of an amplifier for a given distortion. Maximum undistorted power transfer can be attained generally when the amplifier load is resistive and equal to the nominal output impedance of the amplifier. The loudspeaker carries nominal impedance ratings of 8 ohms or 16 ohms. The actual impedance, as in most loudspeakers, deviates considerably from the nominal rating. Fig. 7 shows the measured input impedance of a randomly selected unit. The impedance is near the rated value in two frequency regions, around 600 cps and around 7000 cps. At the lower frequency, the impedance is primarily resistive, while at the higher frequency it is primarily capacitive.

To obtain the desired pressure response from the unit, as indicated in Fig. 4, it is essential that the signal voltage applied to the radiators be constant within the passband. Therefore, only power amplifiers with a high damping factor (low source impedance) are recommended. Such amplifiers deliver a constant voltage to the input terminals of the speaker over a wide frequency range. Speaker impedance variations then are important only as they affect the ability of the amplifier to deliver undistorted and constant voltage. The undistorted power that a good amplifier can deliver into a 2-ohm resistive load at 20 kc. from its 8-ohm terminals is usually not greater than about 10 per-cent of its rated power output. But since the power-per-cycle in music is maximum in the region between about 100 and 500 cps and falls off rapidly above 1000 cps, the impedance mismatch that occurs at the extreme high end of the hearing range does not normally degrade the performance.

Since only the upper 50 per-cent of the musical scale is reproduced by the electrostatic unit, it must be used with a low-frequency loudspeaker, or woofer. Several are readily available. The power transfer capabilities of the amplifier are more important for the combination of woofer and tweeter than for the tweeter alone, since it is the combination that acts as load on the amplifier. Fig. 7 also shows the combined impedance of a typical 16-ohm dynamic woofer with the tweeter. The upper end of the impedance curve is almost identical with the curve for the electrostatic unit alone, while in the region of maximum music power density (100 to 500 cps), the impedance is within the limits of 13.2 and 16 ohms.

The electrostatic radiators described in this article are covered by patents issued and pending to the author. —30—

Transistors Produced by Automatic Line

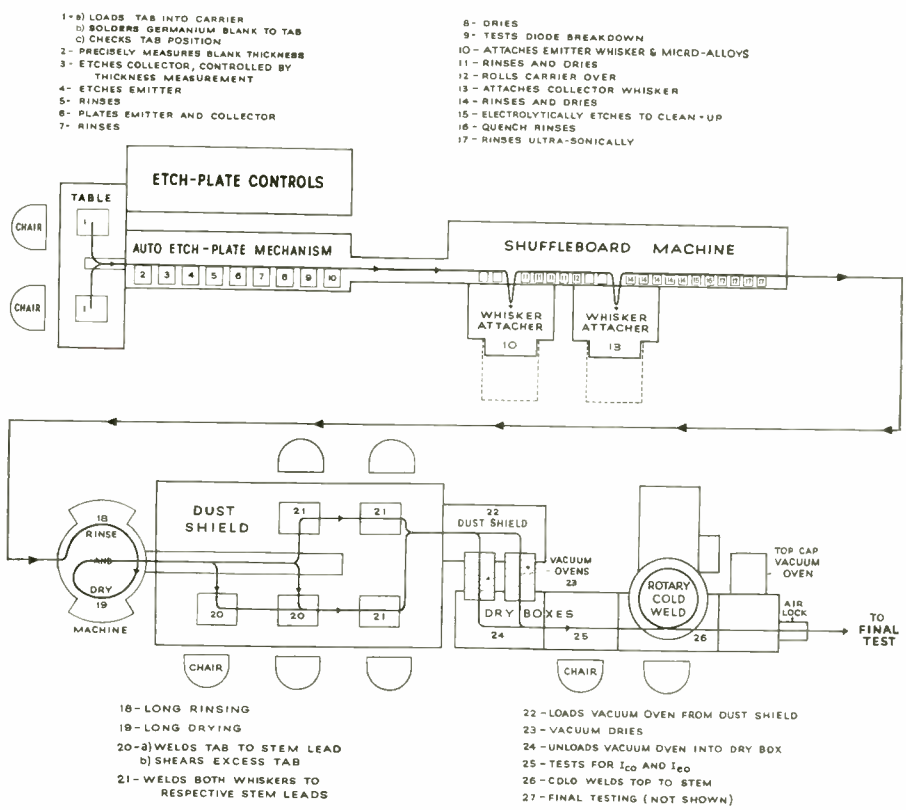


Two operators are stationed at beginning unit of the new Fast Automatic Transfer series of machines developed for high-speed transistor production. This is the etch-plate unit which prepares the transistor blank by electro-chemical techniques.

A HIGHLY automated production line that can produce 450 transistors an hour at low cost is now operating at *Philco's Lansdale Tube Co.* division. The transistors being produced are entertainment types that may make possible in the near future the transistorization of FM tuners and TV sets. The transistors are not only being made for use in *Philco* products, but will also be made available to other manufacturers as well.

Tiny germanium blanks, about 1/16" square, are soldered to tabs which are held by a small drill-chuck-like assembly on a carrier block. These carriers move the blanks through the automated line from one automatic operation to another. The line etches and plates the germanium blank to extremely precise measurements. It forms and attaches the fine electrode wires, and chemically cleans, washes, and dries the assembly. It checks itself through control points that feed back corrective information to previous operations. With some manual assistance, it vacuum dries the assembly and pressure-welds the tops. Several tests are applied to the transistors as they are moving along the line. Results of these tests are in the form of cathode-ray tube displays. About the only thing that the line does not do is to plate, final-test, brand, and pack the finished transistors for shipment. —30—

The complete setup of the automated production line used to produce transistors.



What's New in Radio

TV I.F. PENTODE

Three heater versions of a wide-band, high-frequency pentode are now being offered by *CBS-Hytron* of Danvers, Mass.

The sharp cut-off types 3DK6, 4DK6. and 6DK6 are especially designed for use as i.f. amplifiers in TV receivers and feature a high transconductance of 9800 micromhos.

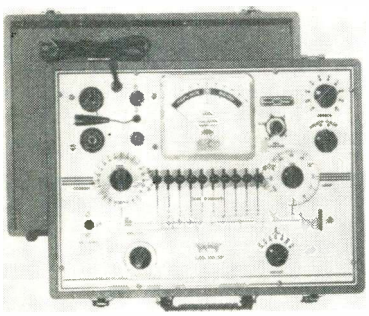
The 3DK6 and 4DK6 are designed for use in 600 ma. and 450 ma. series-string sets respectively while the 6DK6 is for parallel-heater operation.

Data on the three types is available in Bulletin E-315 which the company's Advertising Service, Parker Street, Newburyport, Mass. will supply on request.

NEW TRIPLETT TESTER

The Triplett Electrical Instrument Co. of Bluffton, Ohio is now marketing a new tube tester which provides fast, accurate tests with maximum flexibility as its Model 3414.

All switch settings can be made before the tube warms up, making it extremely fast in operation. Burned out tubes are rejected instantly without waiting for the filaments to heat. The



neon indicator shorts test is new, fast, and accurate, according to the manufacturer.

The tester will handle receiving types, gaseous rectifiers, scries filament, resistor and ballast tube continuity, etc. The continuity test circuit may also be used to check electrical appliances for shorts and open circuits.

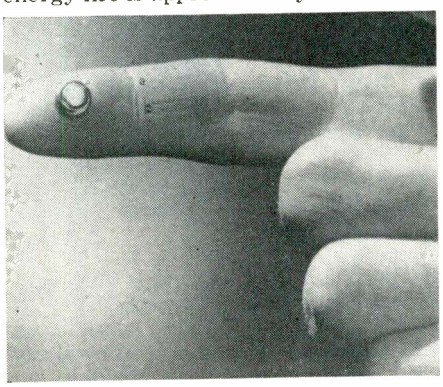
For complete specifications and price on the Model 3414, write the manufacturer direct.

MICROMINIATURE MERCURY CELL

Mallory Battery Company, a division of *P. R. Mallory & Co. Inc.*, 13000 Athens Ave., Cleveland, Ohio has developed a new mercury battery which is said to be the smallest ever made for commercial use.

A mere .300 inch in diameter and .125 inch high, the new battery is designed to fit the dimensional requirements of the military micro-module program. Its indicated uses include extremely small hearing aids, portable radiation detectors, and other miniaturized electronic devices.

Designated as the RM-312, the cell's energy life is approximately 36 ma.-hrs.



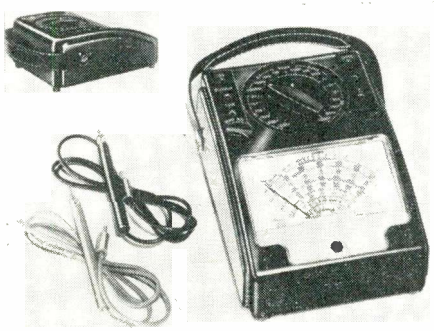
at a discharge of 2 ma. at 1.22 average volts. Like all mercury batteries, the cell features flat discharge. Voltage remains substantially constant out to the end of its useful life. It can be stored for periods in excess of one year without appreciable loss of capacity.

Complete technical data and production samples are available from the manufacturer.

POCKET-SIZED V.O.M.

A new low-cost portable v.o.m. for all servicing applications has been announced by *The Hickok Electrical Instrument Co.*, 10524 Dupont Ave., Cleveland 8, Ohio as its Model 457.

The 5" meter has easy to read scales and a time-saving single "function-range" control. The outstanding design feature is the inclined panel whereby the new instrument lies flat in normal use position eliminating the universal hazard of knocking over and breaking



which is so prevalent with these lightweight test instruments.

Sensitivity is 20,000-ohms-per-volt d.c. and 1000-ohms-per-volt a.c. Voltage ranges include six for a.c. (0-1200) and six for d.c. (0-1200). Resistance is measured in four ranges covering from

0 to 100 megohms. There are center-scale ranges of 5, 500, 5000, and 500,000 ohms. Current measurements include 50 μa., 1, 10, 100, and 1000 ma., and 10 amps. The decibel scale covers −18 to +57 in five ranges.

The circuit is frequency compensated for accurate readings over the entire audio range. The instrument is battery operated, uses a full-wave rectifier circuit, and comes complete with test leads.

NEW T/R SWITCH

Barker & Williamson, Inc. of Bristol, Pa. has developed a new transmit-receive switch with selectable bandswitching and capacity to handle the full legal-limit power for ham transmitters.

The Model 381 T/R switch covers the 80 through 10 meter bands and is suitable for AM, DSB, SSB, and c.w. It has been designed especially for high-power transmitting applications. It provides a safety margin when used with antennas not in the ideal category with respect to s.w.r. conditions and freedom from the effects of intermodulation from strong local radio and TV stations. Under s.w.r. conditions not exceeding 1.5:1 it will handle more than 1 kw. AM phone and up to 5 kw. on SSB and c.w. when 72-ohm coaxial line is in use and higher power with 52-ohm lines.

The switch has a "fail-safe" design and keeps the transmitter connected to the antenna in case the unit is not energized or its tubes fail. It matches 52-75 ohm coaxial lines and is completely self-contained in a cabinet measuring 4¾" x 4" x 4½".

A descriptive bulletin on this new accessory is available from the manufacturer upon request.

LOW-COST CITIZENS GEAR

Radio Corporation of America has announced the development of a low-cost Citizens Band transceiver which is tradenamed the "Radio-Phone."

Capable of two-way voice transmission over a distance of several miles, the new radio is expected to find wide application among small-boat enthusiasts, hunters, fishermen, farmers, etc.

The unit weighs less than 10 pounds and measures 9" x 7" x 5". It operates from a 6- or 12-volt battery or from a standard 117-volt a.c. power source. First of these units were previewed early this year.

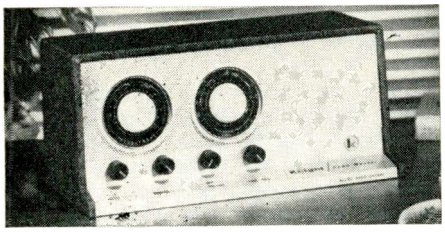
4-BAND RECEIVER KIT

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Illinois is now offering a new 4-band receiver in kit form as its "Knight-Kit Span Master."

Providing world-wide short-wave coverage in addition to the standard broadcast band, this new unit will re-

ceive foreign broadcasts, ships-at-sea, aircraft, time signals, amateur radio stations on the 80-, 40-, 20-, 15-, and 10-meter bands, as well as local AM stations.

The sensitive regenerative circuit also features bandspread dial and fine

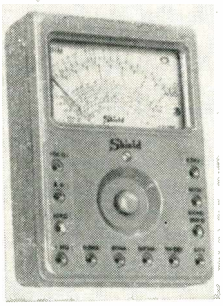


regeneration control to simplify critical tuning. Each band coil has its own antenna winding for maximum sensitivity. Additional features include headphone terminals and a speaker cut-out switch to permit private headphone reception.

The kit is supplied with a fabrikoid-covered cabinet measuring 6¾" x 13$^{11}/_{16}$" x 6$^{3}/_{16}$". It comes complete with tubes, all parts, wire, solder, instruction manual, and a world-wide listing of stations. Write Dept. PR837 of the company for further details.

A.C.-D.C. MULTITESTER

Olson Radio Warehouse, 260 S. Forge St., Akron, Ohio has released a compact 2000-ohm-per-volt multitester in its "Shield" line as the Model TE-117.



Featuring a 2½" rectangular meter and 1% precision shunts and resistors, the instrument has seven a.c. and d.c. ranges (0-10-50-250-500-2500 volts); d.c. current ranges 0-500 μa. and 0-50-500 ma.; and ohms ranges 0-10,000 ohms and 0-1 megohm; the instrument is housed in a durable grey crackle finished metal case which measures 3¼" x 1⅜" x 4¾". Ranges are selected by means of pin jacks on the front of the meter case.

The multitester is supplied with test leads and operating instructions.

TUNG-SOL'S SILICON RECTIFIERS

Tung-Sol Electric Inc., Newark, N. J. has announced the availability of a new line of eight silicon rectifiers ranging from a peak inverse voltage of 50 to 500 volts.

Designed for radio and TV set applications, the new units have been assigned type numbers 1N2072 through 1N2079. The components are of the diffused junction type enclosed in epoxy resin cases with flexible pigtail leads. In configuration they closely resemble small capacitors.

The 1N2078, with a peak inverse voltage of 400 volts, has wide application as a radio and TV replacement. It provides the low forward voltage drop and low leakage current characteristics of silicon. The resulting higher output voltage, coupled with the ability to

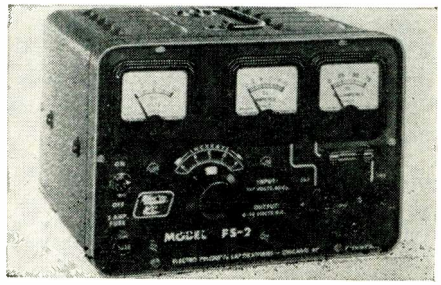
withstand heavy current surges, assures reliable operation of the equipment, according to the company.

For specifications on this new line, write the manufacturer direct.

DUAL-PURPOSE POWER SUPPLY

Electro Products Laboratories, 4500 N. Ravenswood Ave., Chicago 40, Ill. is now offering a new dual-purpose d.c. power supply as its Model PS-2.

Designed for servicing all transistor and hybrid circuits as well as 12- and 6-volt auto radio receivers, this well-filtered unit provides two output ranges, each with its own output current meter and output terminals. The transistor radio output range is 0 to 20 volts at a rating of 75 ma. Minute variations in transistor current can be detected on the 0-75 ma. meter for this range. Transistor protection is provided by an exposed, panel-mounted fuse in the secondary circuit.



The auto radio output range is 0 to 16 volts with a continuous rating of 5 amperes with 10 amperes handled for periods up to 8 minutes. The current meter for this output has a range of 0-10 amps.

The Model PS-2 is housed in an 18-gauge steel blue-grey wrinkle finished cabinet with recessed panel, carrying handle, and rubber feet. It measures 8½" x 8" x 6" and weighs 13 pounds.

STEPDOWN TRANSFORMERS

A complete line of low-power transformers for remote control and signal circuits has been announced by *Anderson Controls, Inc.,* Franklin Park, Ill.

Among the features offered in the new line are windings insulated from the core with nylon plastic, low heat rise, small size, high temperature plastic and metal shells, screw terminal molded into the plastic case, and moisture-proofing. The units are available with various mounting arrangements and connection facilities. Two power ratings of 10 va. and 23 va. in five outputs from 6 volts to 24 volts are standard. This new line carries *UL* approval.

For complete descriptive literature and diagrams, write the manufacturer direct at 9959 Pacific Ave. in Franklin Park, Ill.

PRINTED-CIRCUIT RESIST

Screen Process Laboratories, 5-33 48th Avenue, Long Island City 1, N. Y. has developed a new plating and etching resist for the production of printed circuits.

According to the company, the new resist prints easily and very sharply with a minimum of drag. It will resist the usual plater's cleaning solutions and etchants. It can be easily and completely removed from the copper laminate in a perchlorethylene, trichlorethylene, or carbon tet vapor degreasing system or with mineral spirits. It will force dry in about 15 minutes at 150 degrees F and air dry in about an hour.

The new resist is dimensionally stable, expanding about .0005 inch as compared with the usual .005 inch. It is not affected by humidity or other atmospheric conditions and will not break down through the evaporation of solvents. No strong solvents are necessary to clean screens. The resist is nontoxic and almost odorless.

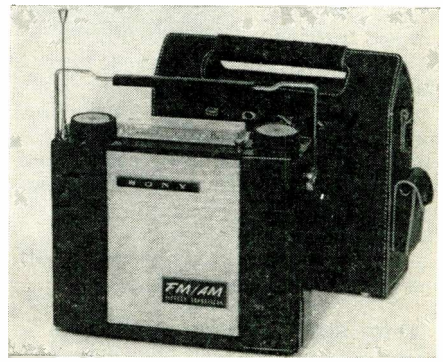
Interested manufacturers may obtain free quart samples on request.

TRANSISTOR AM-FM PORTABLE

Delmonico International, 42-24 Orchard, Long Island City, N. Y. is handling the U. S. distribution of the new AM-FM all-transistor portable being manufactured by *Sony Corporation* of Tokyo.

The Model TFM-151 uses 15 transistors, 4 germanium diodes, and 1 varistor. The set covers the 88-108 mc. FM band and the AM band from 535 to 1605 kc. Switching is accomplished by a single knob and tuning is by means of a slide-rule dial. The circuit includes a.f.c.

The receiver has a built-in 4" x 6" dynamic speaker and telescopic antenna. A 75-ohm terminal is also provided for connecting an external antenna if desired. The set operates on four self-contained flashlight cells. The FM section has 8 transistors and 2 diodes which function as r.f. amplifier,



local oscillator, mixer, four-stage i.f. amplifier, d.c. amplifier for a.f.c., and discriminator. Frequency response is 20 to 20,000 cps ± 1 db and signal-to-noise ratio is 50 db. The AM circuit has 4 transistors and 2 diodes while the audio amplifier portion has two stages and push-pull output stage. Output power is 180 mw.

The set measures 3" x 8¼" x 9" and weighs 5½ pounds.

PHONO-PIN PLUG

DeRo Electronics, 134 Nassau Road, Roosevelt, Long Island, N. Y. has recently introduced a new phono-pin plug as the "Grip-A-Lip" Model PPP-1.

The new component features an outwardly flanged bead at the open end of

the plug which provides positive finger grip for inserting and removing the pin plug. In addition, the unit includes a means whereby the attachment and soldering of the cable shield is considerably simplified.

Currently available at jobbers, the plug is being sold in packages of 4 and 8.

TUBE CHECKER KIT

A new tube checker in easy-to-build kit form has been announced by *Allied Radio Corporation,* 100 N. Western Ave., Chicago 80, Ill. as the "400" in its "Knight-Kit" line.

The "400" will check for filament continuity, shorted elements, and cathode emission on 400 tubes, including the most commonly used hi-fi, radio,

and TV receiving tubes. The unit has sockets for 7-pin miniature, 9-pin miniature, octal, and loctal tubes. A red-green "Replace-Good" scale shows condition of the tube at a glance. In addition, there is a special scale for checking diodes. The "400" employs universal-type selector slide switches which are used in conjunction with Flip-Cards for the rapid selection of any combination of tube-base pin connections.

The kit has a metal case finished in grey with front panel of ivory. Over-all dimensions are 2⅜" x 9½" x 8". Weight is 5¼ pounds. The kit comes complete with all parts, wire, solder, and instructions. It is catalogued as the No. 83 Y 707.

PYRAMID RC BRIDGE

The Jobber Division of *Pyramid Electric Company,* North Bergen, N. J. has introduced a new resistance-capacity-ratio bridge as its Model RC-1 portable tester for the servicing field.

The circuit incorporates a special 3-volt amplifier for checking electrolytics used in miniaturized equipment; features capacity ranges from 10 μμfd. to 2000 μfd.; resistance coverage from .5 ohm to 200 megohms; and ratio test ranges (reactance ratio between any two capacitors, inductors, or resistors) between .05:1 and 20:1. It will also test leakage of micas, paper, and electrolytics.

The tester is designed to operate from any 60-cps, 117-volt power source and draws about 25 watts.

The portable case is of ripple finished steel with an easy-to-read multicolor panel. It measures 7" x 11½" x 5".

Complete technical data will be supplied by the manufacturer upon written request. —30—

Service Industry News

SEVERAL recent developments indicate that the efforts of electronic service associations to gain a voice for independent service dealers in plans and programs that affect the service business are bearing fruit. In times past, both industry and political sessions called to study the problems of TV consumer service were held without representatives of the independent service industry. This odd state of affairs usually led to a complete stalemate in finding a workable solution to the service problems under discussion.

One significant and encouraging development in this direction occurred recently in New York City. Representatives of both local and statewide service associations were named to serve on a committee formed to study ways and means of combatting fraud in TV service and components. One objective of this committee is to determine whether legislation will be necessary to promote fair practices and ethical standards in the television supply and repair industries.

The men named to serve on this body and their industry affiliations are: Samuel E. Ewing, *Radio Corporation of America;* Irving Sarnoff, *Bruno-New York Distributors;* Harry Esdale, staff member of the National Electronic Distributors Association; Gerald Sohne, National Tube Tester's Association; Robert Larsen, president of the Empire State Federation of Electronic Technicians' Associations; Arthur Startz, Better Business Bureau, Inc., of New York; and Martin Boxer of the Associated Radio & TV Servicemen of N. Y.

At its first meeting the Committee agreed on the three fundamental issues upon which any program to combat fraud must be based. They also agreed that the objectives to be achieved in any program evolved by the committee would have to provide satisfactory solutions to the following questions:

1. How can the TV industry and its supply channels insure greater competence on the part of the TV service technician? 2. What can be done to further limit deceptive advertising practices in soliciting TV repair business? 3. What can be done to cope with the problem involved in the sale of rejected or defective tubes as new tubes?

Arthur Startz of the Better Business Bureau, Inc., of New York, was elected temporary chairman of the committee.

Another significant development was the action of the Service Committee of the Electronic Industries Association in approving a program designed to stimulate and achieve over-all industry cooperation between EIA and the na-

tion's independent electronic technicians. The new program was outlined in a report of the Service Industry Relations Subcommittee, under chairman S. R. Mihalic of the *General Electric Co.* The report stated:

"EIA, from its inception, has endeavored to provide the electronic service industry with training and other technical information to aid in providing the best possible service to the products of the industry. EIA now recognizes that it has an opportunity to make an additional contribution by working to increase the prestige of the service technician.

"While many segments of the industry have taken advantage of the opportunities presented by rapid growth, some have failed to realize the business changes that must be made and the industry-wide responsibilities that must be accepted under conditions of growth and maturity. This maturity of electronics has resulted in new and unexpected problems. The solution of these problems can best be achieved by mutual effort of the independent service industry, individual manufacturers, and EIA. The EIA Service Committee stands ready to work and cooperate with all segments of the electronic service industry, in the knowledge that mutual benefits and improvements can come only by working together.

"For its part, the EIA Service Committee plans, within its limits as a trade association, to supplement its basic and advanced vocational training program, now widely accepted by the technical and vocational schools of the nation, with a program of:

"1. Welcoming opportunities for discussions of mutual problems with electronic service leaders. 2. Being represented at service association conventions. 3. Promoting press articles and public relations publications which will enhance the prestige, reputation, and public understanding of the independent service industry. 4. Providing and distributing articles of technical, professional, and business interest to independent service.

"The independent electronic service industry, individual manufacturers, and EIA—working together—will insure the success of this program."

The third significant development during the closing months of 1958, was the acceptance of the program developed by the Independent Dealers Emergency Action Committee (IDEA) on the part of both dealers and associations as they became acquainted with the precepts of the plan. Karl Heinzman, president of TSA of Michigan, was elected chairman of the IDEA Committee at a national meeting of the newly formed organization held in Kansas City.

In accepting the chairmanship, Mr. Heinzman again stressed the fact that the IDEA plan was *not* a national association and the Committee had no intention of building it into a national association. He said that, "the IDEA program must not get involved in association politics. It represents the

voice of all associations without regard to their local, state, regional or national affiliations as well as that of those high-minded service dealers who currently are not members of any service association. IDEA is the unified effort of all service elements to raise the prestige and to insure the stability of electronic service as a business."

Product Testing

The Federation of Radio & TV Service Associations of Pennsylvania recently expanded its policing program to include a continuing review of advertising claims for the quality, performance, and range of hi-fi equipment.

Claiming that "various producers and dealers are making exaggerated claims concerning the performance of their products," the Federation has established a research division which, it is said, will check the performance features of all hi-fi and stereo units, covering all parts from the cartridge to the speaker. The FRTSAP research division is now functioning in Wilkes-Barre under the supervision of the Luzerne County Service Dealers Assn., P.O. Box 309, Wilkes-Barre, Pa. —30—

Citizens Band Transceiver

(Continued from page 51)

plug. It should measure infinity with the volume control switch off and about 20 ohms with the switch on. Measure the resistance from pin 8 of the 5Y3 to ground. It should show a very low resistance until the filter capacitors charge up. The ohmmeter should stop moving upwards somewhere above 20,000 ohms.

If these simple tests are satisfactory, plug in the 6AQ5A and the 12AX7 tubes. They should light up immediately. After they have warmed up, in a minute or so, turn the volume control up and touch pin 7 of the 12AX7 with an insulated screwdriver. You should hear a click and buzz in the loudspeaker of the unit.

Once all these checks have been performed, we can proceed further.

The next step is to insert the 6AN8 detector tube. Turn the regeneration control to the full counterclockwise position and allow the tube time to warm up. Turn the volume control on and slowly advance the regeneration control. At one point, the detector will break into a rushing sound which will resemble the noise of escaping steam. The regeneration control should be set to the point where the rushing sound just starts. If the detector does not want to "take-off," the "gimmick" may be twisted too tightly. For those of you not familiar with this term, a "gimmick" is two pieces of wire (in this case one-inch long) twisted together to

form a "capacitor." The number of twists determines the capacity between the two wires. If this capacity is excessive the detector may not work properly. The final setting of the regeneration control should be made (with the transceiver connected to an antenna) for best reception.

If the detector is functioning properly, you should start hearing "things" as soon as the antenna is connected. The receiver is tuned by varying the capacity of C_8. The setting of coil L_2 will determine what frequencies may be received by adjusting C_8. Thus coil L_2 will have to be adjusted experimentally to find the 11-meter Citizens Band. With the slug all the way out you should hear 10-meter amateur stations and with the slug all the way in you will receive commercial teletypewriter, telephoto, and other broadcasts. Somewhere in between these extremes lies the 11-meter band. You will probably hear a lot of tone modulation signals, the raspy buzz of diathermy machines and, if you are lucky, possibly some conversations. As soon as you have the unit tuned up to receive the 11-meter band, adjust coil L_1 for maximum signal strength. The adjustment will be quite broad.

The final step is to tune up the transmitter. A pilot lamp "antenna" (dummy load) will be very useful for the tune-up operation. The dummy load can be made by wiring a #47 pilot lamp to a mating connector for the antenna jack. Plug in the dummy load, the 6AU8 tube, and the crystal. After warm-up, place the "transmit-receive" switch in the "transmit" position. Connect a vacuum-tube voltmeter to pin 7 of the 6AU8 and measure the voltage while varying the slug in L_3. The negative voltage on this grid will be very low, then at one point will rise to 5 or 10 volts. If you are lucky the dummy load may start to glow. The increase in grid voltage indicates that the oscillator circuit is working properly and "according to Hoyle."

As soon as you are sure that the oscillator is functioning correctly, adjust coil L_1 for maximum brilliance of the bulb. Adjust L_3 and L_1 alternately for maximum brilliancy. To make sure that the oscillator is stable, turn the "transmit-receive" switch on and off several times. The bulb should light up each time. If it does not, turn the slug in L_3 a half turn counterclockwise and repeat the "on-off" test until a point is reached where the bulb comes on each time. Next, connect a crystal mike to the transceiver and modulate the rig. The bulb will decrease in brilliancy as you talk but this is normal with this type of circuit. When an antenna is connected to the transceiver, this effect will not be noticed.

There is one more test that must be made before the transceiver is ready for use. You must establish that the power input to the final amplifier is within the 5-watt FCC specification. Be very careful when making the following tests for there will be high voltage (250 volts) on the wires you will

be working with. Before making any adjustments, pull the power plug from the outlet and short out pin 8 of the 5Y3 tube to the chassis.

The power input of the transceiver may be checked in the following manner: Disconnect the wire between T_1 (audio transformer) and coil L_1 and insert a 0-25 ma. meter in the circuit. Note the current reading which should be something less than 20 ma. Now reconnect the wire and measure the voltage between this wire and ground. Also make a note of this reading. It will be in the vicinity of 250 volts. To find the power input, multiply the voltage by the current (in amperes). In a typical unit you may get readings of 250 volts and 18 ma. (.018 ampere). Multiplying these figures, we find that the power input is 4.5 watts. If either the voltage exceeds 250 volts or the current is more than 20 ma., you can loosen the coupling between coil L_1 and the antenna link to reduce the plate current in order to bring the total power input below five watts. These measurements should be made with the antenna connected.

Antenna

A permanently installed antenna system cannot exceed 20 feet in height above its mounting structure and the coaxial transmission line cannot be more than 25 feet long, according to the FCC rules.

You can construct a very satisfactory antenna using Fig. 3 as a guide. It consists of a 25-foot length of RG-58/U or RG-8/U coaxial cable connected to two 8-foot, 6-inch lengths of copper antenna wire, forming a dipole antenna. Three insulators are used in the antenna. There is one at each end of the dipole elements to insulate the wire from the rope. The third insulator is used at the center of the dipole for the coax connections. Note that a short length of stout cord is used to support the weight of the coax. It is tied between the coax and the insulator. The distance between the two elements (two inches) is not critical and can be varied to accommodate available insulators.

Operation

The FCC requires that the registered serial number appearing on each Citizens Radio station license shall be the assigned call sign. This call is to be given at the beginning and end of all communications as well as at ten minute intervals during messages lasting longer than 10 minutes.

As far as operation of the transceiver is concerned, you simply switch to "transmit" and talk into the microphone. When you have finished transmitting, turn back to "receive" and tune stations on the right-hand knob, adjusting the volume to suit yourself. It's as simple as that.

I wonder who will be the first to issue a certificate for "Worked All States—Citizens Band (WASCB)?

—30—

Infrared

(*Continued from page* 41)

yond which their response falls off. Of the various photoelectric effects the one most common for infrared detection is the photoconductive effect. As a result of this effect, the conductivity of certain solid materials changes when radiation is encountered. Photoelectric effects are usually considerably greater than thermal effects, so that special precautions are not usually taken to reduce temperature effects in most photodetectors. The usual circuit for photoconductive detectors is similar to that for the thermistor bolometer detector, except that instead of a compensating element a fixed dropping resistor is used. Some of the most common photoconductive detectors are lead sulfide, lead telluride, lead selenide, indium antimonide, and specially treated germanium. Most photoconductive detectors require cooling to extremely low temperatures for efficient operation.

Basic Infrared Radiometer

The infrared radiometer can be considered to be the basis of most infrared instrumentation. If the operation of a radiometer is understood, more complex arrangements can be readily followed. Radiometers receive infrared radiation from sources in their fields of view and transform the received energy into electrical signals which can be measured, recorded, and interpreted. Infrared radiometers do not require physical contact with sources being measured; in addition, they have great sensitivity, measuring range, and speed of response.

A basic infrared radiometer includes an optical system, chopper, detector, reference source, synchronizing signal generator, and electronics system. A typical arrangement is shown in Fig. 11, while Figs. 8 and 10 show portable radiometers.

The optical system is frequently a mirror telescope consisting of concave primary and convex secondary mirrors. Each mirror is aluminized and hard coated. Focusing is usually accomplished by moving the secondary mirror along the optical axis. An infrared detector is located at the focal point of the optical system. Thermistor bolometer detectors are most frequently used because of their very uniform response.

A black-body radiation reference source is used as a standard against which target radiation is continuously compared. In the most basic arrangement, the detector is mounted behind a thick metal block and receives incoming radiation through a cylindrical aperture in that block. The aperture has serrated and blackened walls so that it forms a black-body cavity when closed by a reflecting surface. The cavity wall temperature is accurately monitored by a thermistor bead.

A mirror-surfaced sector-disc shut-

ter, or optical chopper, is driven by a motor and rotates in front of the blackbody aperture. As the aperture is opened and closed by the chopper blades, the detector alternately senses target radiation and black-body radiation. Detector output is an alternating signal, the peak-to-peak voltage of which is precisely proportional to the difference between target radiation and the known radiation from the black body.

The synchronizing signal generator develops a square-wave signal which drives a phase-sensitive rectifier in the electronics system. As the blades of the optical chopper rotate, they interrupt the light beam between a small bulb and a phototransistor, which generates a square-wave signal of exactly the same frequency as the detector output signal. The synchronizing signal generator can be moved so as to adjust the phase of its output.

A preamplifier located close to the detector amplifies the detector output signal to an amplitude and impedance level suitable for transmission through a cable to a remote signal-processing system. The simple signal-processing system shown uses an electromechanical synchronous rectifier. This is a magnetically actuated single-pole, double-throw switch driven by the synchronizing signal and functioning as a keyed full-wave rectifier. It demodulates the preamplifier output, producing a d.c.-output signal exactly proportional to the difference between the radiation from the target and the known radiation from the reference black body. The polarity of the output signal indicates whether the target is hotter or colder than the reference source. Variations in the output signal are precisely proportional to variations in target radiation; so that the d.c. signal can be connected to a voltmeter, calibrated recorder, or control system for continuous radiation or temperature monitoring or control.

Other circuits and devices can be added to the basic radiometer. Thus the arrangement can be developed to a form suitable for making thermal photographs, making spectral analyses of materials, tracking a plane or missile, or directing a missile towards a target. All-in-all, this remarkable branch of science which combines electronics and optics promises even more useful and fascinating applications in the future. —30—

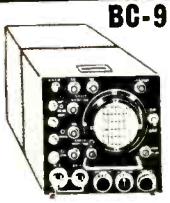
MARS NET ANNIVERSARY

THE First Army MARS SSB Technical Net has just rounded out its first year of operation with an enviable 97.5% record of transmission reliability for the 37 talks presented during 1958.

Telephone patch techniques were used to permit speakers in distant cities to talk to members of the net through the stations of net members near New York City. Engineers from Cedar Rapids, Chicago, and Dayton were brought on channel using this technique.

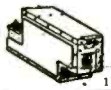
The net has attracted a listening audience within a 1000 mile radius of New York City, with one report arriving from the Azores! —30—

BC-929 3-INCH SCOPE



Low cost station monitor and/or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BP1 CR Tube. Voltage req. 115V 400 cy. and 24VDC. Complete with tubes, exc. used **$12.95**
BRAND NEW $14.95
Conversion instructions for 110V 60 cyc AC ..... 65¢

ARC-5/R28 RECEIVER



2-meter Superhet, 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. **BRAND NEW** **$24.45**
110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. **BRAND NEW** **$21.50**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters.
BRAND NEW, less tubes $7.95
Excellent Used, less tubes $5.95

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes **$16.95**

Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal **$12.45**

MODULATOR for above, new with tubes $4.95

LORAN R-65/APN-9 RECEIVER & INDICATOR

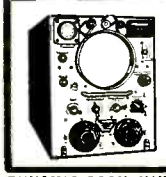
Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used. Value $1200.00. Our Price **$88.50**

BC-620 FM TRANSCEIVER, 20-28 Mc. **$9.95**
BRAND NEW .....
PE-120 6-12V POWER SUPPLY, with **$11.95**
Tubes and Vib, NEW .....
Shock Mt. Rack, NEW $2.95

LORAN APN-4
FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-68/APN-4, and RECEIVER R-98/APN-4, complete with tubes. Exc. used **$42.50**
Receiver-Indicator as above, BRAND NEW $59.50
Complete Kit of Accessories for Above: PE-206 Inverter, Set of Plugs, Visor for Indicator, Operation Manual. ALL BRAND NEW **$49.50**

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.

Completely Assembled

LIKE NEW! Supplied with 5" Scope, type 5CP1 only **$14.95**
Brand New $19.50

DYNAMIC BOOM MIKE M-33/AIC. Low impedance. With mounting bracket for attachment to headsets. A REAL VALUE at $3.95
DYNAMIC HANDMIKE, with "Press-to-talk" Switch on handle, cord and plug—BRAND NEW, only $2.95
DYNAMIC HANDMIKE, aircraft, made by Telephonics Corp. Press-to-talk switch on mike. BRAND NEW $4.95

Hi-Fi DYNAMIC HEADSET with Cushions
Freq. Range: 40-14000 CPS. No Distortion. **$7.95**
BRAND NEW .....

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike	$4.95	$6.95
T-30	Carbon Throat Mike	.39	.79
T-45	Army and Navy Lip Mike		1.33
T-24	Carbon Mike		5.95
TS-9	Handset		3.88
RS-38	Navy Type	2.79	4.95

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.79	$4.75
HS-33	Low Impedance	2.79	4.75
HS-30	Low Imp. (featherwt.)	1.25	1.99
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW, PER PAIR $3.45
CD-307A Cords, with PL55 plug and JK26 Jack ..... .99
Earphone Cushions for above—pair ..... .50

FL-5 FILTER 79c
FL8 Filter $2.45

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. **BRAND NEW.** 3 5/8" x 1-13/16" x 2 3/8". Uses Standard Electrolyte ..... Only **$2.69**

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery $2.79
1—2V. 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) .. 1.45
ALL BRAND NEW!
Combination Price **$5.45**

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

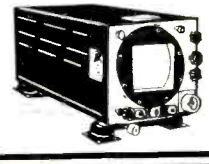
$48.50 Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%. class "B." A Real "HOT" Ham buy at our low price! Original cost $1800.
Exc. Used $49.50
0-16 Low Freq. Osc. Coil for ART-13 .... 7.95
24V Dynamotor for ART-13 ..... 11.95

AN/APA-38 PANORAMIC ADAPTER

And Wave Analyzer. 30 Mc Center Frequency, 2Mc Band Width. Total scan 10 Mc at one clip. Regular saw-tooth sweep. Variable sweep freq. control 1600 cycles. Use it as regular service scope! Including 11 tubes and 3" scope tube type 3DP1, **$19.50**
BRAND NEW .....

ASB-5 'SCOPE INDICATOR



BRAND NEW, including all tubes, together with 5BP1 'Scope Tube. Originally used in Navy Aircraft RADAR equipment. Easily converted for AC operation.
VALUE $250.00!
OUR LOW PRICE **$15.95**

BC-733 VHF 10-TUBE AIRCRAFT RECEIVER. 6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks! **$9.95**
Exc. used .....
BRAND NEW $12.95
Dynamotor for above 12/24 V.—New $5.95

AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision laboratory instrument used to monitor or indicate frequency of any signals within its range. Includes wide and narrow band IF strip selected from panel. Outputs provided for attachments to pulse analyzer, panadapter, etc. **$69.50**
Input 115 V 60 cy. LIKE NEW
Tuning Units for above—each $39.50

AN/ARN-5A AIRCRAFT RECEIVER. 11 tube superhet, 3-crystal control UHF for static-free reception. **$16.95**
Exc. used with tubes .....
BRAND NEW $19.50

BC-645 XMTR RECEIVER
15 Tubes 435 To 500 MC

BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton. **$29.50**
Shipping weight 25 lbs. .....
PE-101C DYNAMOTOR for BC-645, has 12-24V input (easy to convert for 6V Battery operation) ..... only **$7.95**
UHF ANTENNA ASSEMBLY, for BC-645 .. $2.45
Complete set of 10 Plugs for BC-645 ..... **$5.50**
CONTROL BOX for above $2.25
SHOCK MOUNT for above 1.25
CONVERSION BOOKLET. Instructions for most useful surplus rigs **$2.50**

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc F.M. Two preselected channels crystal controlled. 5 to 10 watts. Complete with speaker, tubes. Brand New **$11.95**
Exc. Used $7.95

Vibrator Supply for 6-12-24 Volts, NEW ... **$9.95**

Please include 25% Deposit with order—Balance C.O.D. 50c Handling Charge on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C.

G & G Radio Supply Co.
Telephone: CO 7-4605
51 Vesey St., New York 7, N. Y.

TG-34A CODE KEYER

Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.

BRAND NEW, in orig'nal carton. **$16.88**

Set of Code Practice Tapes (15 lessons), 3/8" inked paper $15.95

SCR-522 2-METER RIG!

Terrific buy! VHF Transmitter-receiver, 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION ..... Special **$33.33**
Receiver only, with all tubes $19.50
Transmitter Only, with all tubes $22.25
Accessories for above available.

ARB Receiver 4 band 195-9050 Kc, with all Tubes, Like New **$17.95**
Brand New, with Tubes and Dynamotor $34.50

MOBILE-MARINE DYNAMOTOR

Input 12V DC. Output: 625 V DC @ 225 Ma, for press-to-talk intermittent operation. Shpg. wt. 14 lbs. **$6.45**
OUR LOW PRICE

OTHER DYNAMOTOR VALUES: Type	Input	Output	Excellent Used	BRAND NEW
DA-19-A	28V 11A	400V .400A	$4.99	$6.95
DM-28	28V	224V .07A	2.95	4.95
DM-32A	28V 1.1A	250V .05A	2.95	4.45
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.95
DM-34D	12V 2A	220V .080A	4.25	5.50
DM-53A	28V 1.4A	220V .080A	3.95	5.95
PE-73C	28V 20A	1000V .350A	8.50	11.50
PE-86	28V 1.25A	250V .050A	2.95	5.24

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$14.95	$16.95
BC-454	Receiver 3-6 Mc	9.95	12.95
BC-455	Receiver 6-9 Mc	10.95	13.50
BC-450	3-Receiver Control Box	1.49	1.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$7.95**
Factory wired, tested, ready to operate ... $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW **$7.85**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. **$7.85**
BRAND NEW .....
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal. **$12.95**
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ARC-5 T-19 TRANSMITTER—3 to 4 Mc. BRAND NEW complete with all tubes & crystal **$8.85**

	USED	NEW
BC-456 Modulator	3.45	4.95
BC-451 Transmitter Control Box	1.25	1.49

POWER SUPPLY KIT, for All Command Transmitters. Provides all needed voltages. **$29.50**
A quality kit. only .....
(See full description above)

BC-906 FREQ. METER—SPECIAL!

Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE **$9.88**

BC-603 FM RECEIVER

10-channel push button tuning or continuous tuning, 20-28 Mc. Complete with speaker, tubes, squelch. BRAND NEW **$14.95**
12 or 24V Dynamotor for Above
Exc. Used $4.25 ..... Brand New $5.50

AC POWER SUPPLY FOR BC603, 683

Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220VDC @ 80 Ma. 24VAC @ 2 Amps. **$8.45**
Complete kit, with easy instructions $10.49
Wired .....
Complete 240-page Technical Manual for BC-603, 604 ..... $2.95

BC-221 FREQUENCY METER

SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. At our smashing low price it's FIRST COME FIRST SERVED! Hurry, quantity is limited! Like New ..... Only **$88.88**
BC-221 Modulated Type $129.50
Original 1000 Kc Crystal for BC-221. .....
BRAND NEW $8.45

SCHEMATIC DIAGRAMS For any equipment on this page, each .. **65c**

Tips on FM Alignment

(*Continued from page 67*)

modulated signal. This time saver is particularly acceptable if final alignment will be completed with the oscilloscope anyhow.

When the FM generator and scope are brought into play, remember that we rely on the latter to indicate amplitude changes during adjustment of the detector primary and the i.f. channel. Therefore limiting action in the detector is disabled temporarily by disconnecting electrolytic capacitor C_1 in Figs. 3 and 4 and making the scope connection at this same point. In the balanced circuit, it is satisfactory to remove either end of the capacitor. In the unbalanced version, the negative terminal should be removed.

When i.f. adjustments have been completed, reconnect C_1 and transfer the scope to the de-emphasis network, as already noted, to adjust the transformer secondary for maximum symmetry of the crossover pattern. In some sets, it will be necessary to re-adjust the primary to a very small degree at this time to get the crossover point to straighten up.

The locked-in oscillator-detector employing the FM1000 tube was developed by *Philco*. Refer to Fig. 5. The oscillator grid, pin 2, is first grounded which causes the section to operate as an AM detector. The i.f. frequency used here is 9.1 mc. The output indicating instrument is connected either to point "A" or to any other audio-frequency signal point. Alignment of the i.f. section is then made by employing the same procedure as given for the discriminator detector. When the i.f. adjustments have been completed, the ground jumper on the oscillator grid is removed, and the quadrature circuit is short-circuited, as shown in the schematic, to disable the locking action of the plate feedback into the oscillator section. With the signal generator set for 400-cycle AM output at 9.1 mc., adjust the oscillator trimmer until a beat note is heard in the loudspeaker. This audio note results from the heterodyning of the oscillator and i.f. signals. Continue to adjust the oscillator trimmer until a condition of zero beat is obtained (a null between two low-pitched growls).

When the short circuit is removed from the quadrature circuit, the audio signal will again be heard. Reduce the signal generator output to the lowest value at which a usable signal can be heard. Re-adjust the tuning slug in the quadrature circuit until a zero beat is again obtained. Repeat the entire operation as necessary until the removal of the short from the quadrature circuit has minimum effect on the zero-beat condition obtained when the oscillator trimmer is adjusted. When the jumper is removed from the quadrature circuit, the complete response curve can be observed on the screen of the scope with FM sweep. The

quadrature slug is then adjusted for maximum linearity. Fig. 6A shows a proper response curve, while that of Fig. 6B is poor.

Once the detector is properly aligned, the oscillator grid is again grounded and the receiver front end adjusted in the usual manner.

In receivers employing the 6BN6 type of gated-beam detector, Fig. 7, alignment of the i.f. stages is accomplished by measuring the r.f. voltage at the signal grid of the detector. A suitable probe is therefore required with the indicating instrument.

Attach the r.f. probe to the detector signal grid and adjust the i.f. transformer for maximum r.f. voltage reading. Next, tune in a local FM station for maximum indication and adjust the quadrature circuit coil for best audio results. Finally, tune in a weak signal accompanied by a large amount of noise and adjust the variable control in the cathode circuit for the best signal-to-noise ratio. It may be necessary to disconnect the antenna and do some juggling with the degree of coupling to the receiver input in order to maintain the noise level sufficiently high so that changes can be detected readily. A slight re-adjustment of the quadrature coil may then improve fidelity.

The main point to remember is that poor alignment can cover up an otherwise skillful repair job. When in doubt, go over all adjustments. It only takes a few minutes to get the difference between mediocre and satisfying results and the concomitant approval of your musically oriented customers. —30—

STEREO SOUND FOR TV

AT a press preview held recently, Motorola Inc. premiered, by closed-circuit transmission from WGN, Chicago, a compatible stereo sound system for television. Viewers of prototype equipment heard dual-channel stereo sound from two separate speaker systems while watching a corresponding taped segment of a regular TV show.

To produce the stereo effect, FM multiplexing of the sound carrier was used in conjunction with the "sum and difference" technique. The left plus right sound signal frequency modulated the TV sound transmitter; the left minus right signal frequency modulated a 23.6-kc. subcarrier. This frequency was picked since it is above the audible frequency range and it falls exactly between the fundamental and second harmonic of the horizontal scanning frequency. A 5-kc. top limit and a 5-kc. deviation were employed for the subcarrier.

A conventional TV receiver will respond only to the sum signal, a complete monophonic transmission. From this viewpoint, then, the system is fully compatible. The stereo TV set differs from the conventional set only in the audio circuits following the sound detector. These circuits recover both the sum and difference signals and combine them in such a way that the original separate left and right signals are reproduced.

It must be emphasized that the equipment shown were laboratory prototypes, unveiled to dramatize for the trade and the public products that may become available in the future. —30—

next month in RADIO & TV NEWS!

Special Service Features for the Pro, Small Shop or Home Workshop!

In May, the name of RADIO & TV NEWS *officially becomes* ELECTRONICS WORLD.

In addition to all regular articles, April RADIO & TV NEWS will include more than a dozen exclusive features on radio and TV repair. You'll find helpful, practical tips and information in each of these special articles:

NEW TV DESIGNS FOR 1959 — Here's a rundown on circuitry in the newest TV sets. Tells of layout problems you'll face, unusual new features, innovations, design trends.

SCHEMATICS OF 1959 TV SETS — Six pages of valuable diagrams of latest TV receivers.

1959 TUBE INVENTORY FOR SERVICE SHOPS—What tubes should you stock to keep up with changing requirements, new designs and models? Here's RADIO & TV NEWS' annual guide to tubes for servicemen—with valuable recommendations on keeping your inventory flexible and efficient.

ANTENNA INSTALLATIONS: FACTS AND FICTION — There are a lot of "old wives' tales" concerning antenna installations still circulating. In this exclusive feature,

expert Jack Beever of Jerrold Electronics reveals how too many technicians are wasting time, effort, and money by sticking to outmoded antenna techniques.

TEST EQUIPMENT—Featured are three extensive articles—complete guides to basic test equipment, additional equipment needed when you expand, and special test instruments.

All in all, you'll find a wealth of information in April RADIO & TV NEWS. What's more, you can subscribe right now and save up to 44% on the new newsstand price of 50c per copy. If you're not already a subscriber, it's a good idea to act today—before subscription rates go up!

CURRENT SUBSCRIPTION RATES:
One year $4 Two years $7 Three years $10

plus all these features scheduled for April, too.

- LOUDSPEAKERS FOR STEREO, Part I
  A survey of all speaker manufacturers resulting in a compilation of the various methods and ideas for stereo speaker operation, placement and design principles.
- CROSSOVER NETWORKS, Part I
  Complete, how-to-do-it article on the design and construction of two and three-way speaker crossover networks. Part 2, to follow in the May issue, will be accompanied with a 4-page gatefold pertaining to design charts for crossover networks. Don't miss the beginning of this 2-part series next month.
- TRANSISTORIZED DOUBLE SIDEBAND SUPPRESSED-CARRIER TRANSMITTER

  A simple suppressed-carrier transmitter that can operate on the 20, 15, and 10-meter amateur bands and that can be driven by means of a small, low-power r.f. unit such as the "Mighty Milliwatt" described in our September 1958 issue.

- DRIFT & A.F.C. IN FM
- 20 CPS TAPE RECORDER SWITCH
- CERTIFIED RECORD REVUE
- SOUND ON TAPE
- HI-FI—AUDIO PRODUCT REVIEW
- ELECTRONICS IN NIGERIA
- DEFECTS IN THE HORIZONTAL OSCILLATOR
- SAVE TIME ON TROUBLESHOOTING TRANSISTOR RADIOS
- HINTS ON TWO-WAY RADIO SERVICE
- AN AUTOMATIC "TALK SQUELCHER" FOR YOUR RADIO

ZIFF-DAVIS PUBLISHING COMPANY
ONE PARK AVENUE, NEW YORK 16, N. Y.

How Ring Counters Work

(*Continued from page 45*)

combination of resistance *and* capacitance (270,000 ohms and 40 $\mu\mu$fd.) This permits a faster transfer of signal to the grid of V_2 than to the grid of V_3. (The transfer is faster because the RC combination acts as a differentiating or peaking circuit that produces a pulse with a sharp leading edge. The normal rounding off of the pulse applied to the grid of V_3, produced by stray circuit capacitance, constitutes a slight delay.) Furthermore, when V_2 becomes conductive, its plate voltage decreases and lowers the potential of the grid of V_3, preventing conduction.

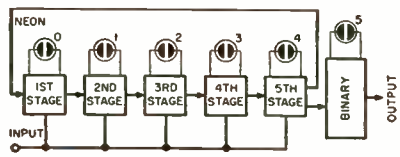
The grid of V_2 actually receives two input signals: the negative pulse applied to the "Input" terminal and the positive pulse from the plate of V_1. Of these two signals, the positive pulse from V_1 predominates because of its greater amplitude (due to the gain of tube V_1). The waveforms shown in Fig. 1 also apply to the circuit of Fig. 2, and neon lamps can be connected in the same manner. The basic action just described continues from stage to stage with each new input pulse.

A ring counter capable of still greater switching speeds is shown in Fig. 3. This *Walkirt Co.* linear counter will operate at input frequencies up to 250 kc. Each stage of this ring counter is a dual triode connected as a flip-flop (Fig. 3A). Interstage connections are shown in Fig. 3B. In the latter, numbers refer to the terminals around the edges of Fig. 3A, rather than to pin numbers of the tubes. Only one stage is in the zero condition (V_1 cut off and V_2 conducting), and all other stages are in the *one* condition (V_1 conducting and V_2 cut off). As shown in Table 2, each input pulse transfers the *zero* condition to the following stage of the ring.

The initial condition of the circuit (first stage in the *zero* condition) is established by applying a negative pulse to the reset terminal. This negative pulse cuts off the left-hand triode of the first stage, forcing this stage into the *zero* condition. The value of the cathode bias resistor, R_1 (Fig. 3B), is such that the plate current of the right-hand triode of the first stage develops sufficient bias to cut off the right-hand triodes of all other stages (V_2 in each). The other stages are therefore forced into the *one* condition.

The input terminal is connected to all of the left-hand cathodes. When a negative pulse is applied to the input terminal, the left-hand cathode of the

Fig. 5. Decade counter consisting of a ring-of-five followed by a binary.



first stage will be driven negative. Since a negative pulse applied to the cathode is equivalent to a positive pulse applied to the grid, the left-hand triode of the first stage will now conduct. As the first stage switches to the *one* condition, the right-hand triode (V_2) cuts off and its plate voltage increases. This increase, coupled to the right-hand grid of the second stage, forces the second stage into the *zero* condition, with V_2 conducting.

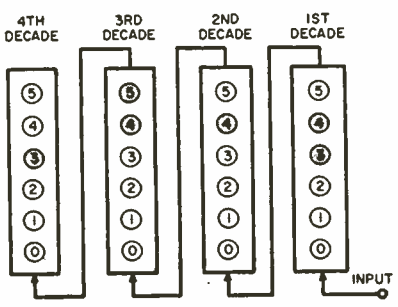
It can be seen that the second stage actually receives two signals: the negative input pulse applied to its left-hand cathode and the positive pulse (from the first stage) applied to its right-hand grid. The negative pulse at the left-hand cathode produces no change because this tube is already conducting at the time the pulse is applied. The positive pulse from the first stage arrives after the negative input pulse is completed and therefore switches the second stage to the *zero* condition.

Ring counters are sometimes used in combination with binary circuits for pulse counting applications. A ring-of-five, for example, may be connected in cascade with a single binary stage, as shown in Fig. 5. This *decade* counter has a scaling factor of ten: ten input pulses applied to the ring will produce one output pulse from the binary. The neon lamps in this circuit indicate the number of pulses applied to the input terminal. After eight input pulses for example, neon lamps 3 and 5 will be on. When the tenth input pulse is applied, the entire circuit will be back to its initial condition and the binary stage will produce an output pulse. (See Table 3.) This output pulse can be fed into another similar decade counter.

For two decades in cascade, the total counting capacity will be 10^2 or 100. If three decades are connected in cascade, the counting capacity will be 10^3 or 1000. Fig. 6 shows the neon lamps for four cascaded decades of the type shown in Fig. 5 after 3947 input pulses. Lighted indicators are shown in grey. Circuits of this type have been used for counting pulses produced by Geiger and scintillation counters.

Although ring circuits are sometimes used in pulse counting applications, they are not economical in terms of the number of stages required. The decade counter of Fig. 5, for example, requires *six* dual triodes. This compares un-

Fig. 6. The neon lamps lit on these four cascaded decades indicate that a total of 3947 pulses have been applied.



favorably with the type of decade counter employing *four* dual-triode binary stages and appropriate feedback networks (see "Basic Decade Counters," RADIO & TV NEWS, August 1958 issue).

The primary area of usefulness of the ring circuit is in gating or commutating applications. In such uses, the ring circuit replaces a multi-position, motor-driven, rotary switch. Not only does the ring counter operate at much higher switching rates than a mechanical switch, but it also eliminates problems of contact wear.

A gating circuit for use with a four-stage ring is shown in Fig. 4. The control grids of the gate tubes (V_1, V_2, V_3, and V_4) are connected to a negative supply which biases them below cut-off. However, one gate tube at a time becomes conductive as the ring circuit switches from stage to stage. The control grid of each gate tube is connected to the left-hand plate of the corresponding ring stage. The ring circuit here is assumed to be of the type shown in Fig. 3.

When a ring stage switches into the *zero* condition, its left-hand tube is cut off and the plate voltage increases. This increase, coupled to the grid of the corresponding gate tube, brings the gate above cut-off by overcoming the negative bias applied. When, for example, the second stage of the ring is in the *zero* condition, the grid of the second gate tube (V_2) will be above cut-off. The signal applied to the suppressor (used as a control grid) of V_2 will now appear at the common output.

When the *zero* condition transfers to the third stage of the ring, gate V_2 drops below cut-off and gate V_3 becomes conductive. At this time, the input signal applied to V_3 will appear at the output. Four different signals may therefore be applied to the inputs of the four gate tubes, and these signals will appear in succession at the common output terminal. Only four stages are shown in Fig. 4, but the circuit can be extended to a greater number of stages.

Circuits of the type shown in Fig. 4 are particularly useful in multiplexing operations because they permit a number of separate signals to be fed through a single transmission channel. In telemetering equipment, for example, the signals from pressure-sensing, temperature-sensing, speed-sensing, or other pickup elements may be fed into gate tubes like those shown in Fig. 4. The output, which will consist of successive samples of the signals from the sensing elements, can then be used to frequency-modulate an oscillator for subsequent transmission to a receiver. For a 1000-cps pulse waveform applied to the ring circuit, as shown in Fig. 4, each gate tube will *open* for one-thousandth of a second and then *close* for three-thousandths of a second while the other three gates open in succession. This *sampling* interval may be changed by varying the frequency of the input pulses to the ring circuit.

—30—

Promoting a Business

(*Continued from page 48*)

Most dealers have found that service advertising in newspapers does not produce results commensurate with the cost. The most consistent users of newspaper space in advertising TV service are dealers who make a play for business on price. The type of business developed by that kind of advertising is neither stable nor profitable for an ethical dealer. The set owners who fall for "price advertising" usually are looking for something for nothing. They represent a type of business that is neither honestly profitable nor pleasant to handle.

Many small dealers spend too much of their limited advertising monies on telephone directory advertising. While telephone directories are used as a sort of buyer's guide by some people, the average person would rather deal with a business he knows something about than to call in a stranger picked at random from a business directory. When a dealer fails to maintain his lines of communication with customers, however, he will not develop the kind of personal relationship that ties service types of businesses to their customers.

The maintenance of communications with customers between calls for service should be of primary concern to every small dealer. One proven plan is to use a "Thank You for Calling Us" card, which is mailed to every customer a day or two after a service call is completed. This is followed at two- or three-month intervals by inexpensive service mailing pieces—just to keep the dealer's name alive in the minds of his old customers.

Then, the dealer has the constant problem of developing new customers. Static management will rely entirely on customer referrals, chance, and phone directory advertising for new business. Dynamic management will use a systematic mailing program to solicit new business within the economical working area of the dealer's store. All of the receiving-tube manufacturers make available professionally prepared, business-promotion cards that are very effective if they are used systematically. These cards are inexpensive. With a planned system of mailing, a dealer can maintain his lines of communication with his old customers and develop new business. He can do it by devoting only about an hour per week to addressing the cards and mailing them out.

Set manufacturers who solicit service work on their TV sets keep a steady flow of direct mail promotions going out to owners who have filed their warranty cards. Small dealers can profitably take a leaf from their notebooks by using direct mail to solicit business on all brands. It is the least expensive type of business promotion and, when used regularly, will produce the best results. —30—

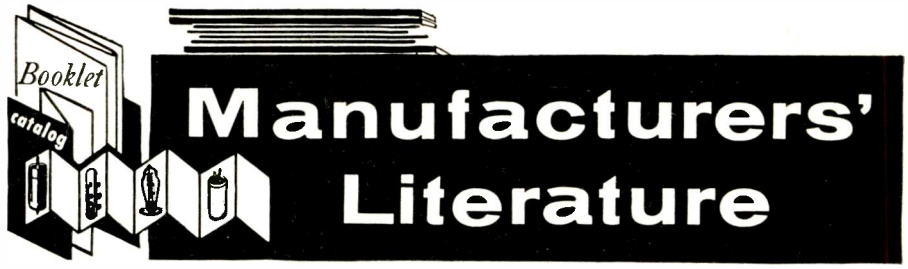
"Data-Prints" Still Available

A recent inventory check reveals that we have on hand a limited quantity of RADIO & TV NEWS "Data-Prints" (numbers 2 and 3) which originally appeared in this magazine during 1952.

Data-Print #2, entitled "Loudspeaker Enclosure Design Data," covers complete how-to-do-it details on constructing your own high fidelity speaker enclosure. The infinite baffle, corner folded horn, bass reflex, and labyrinth types are all included. In addition, the Data-Print includes a decibel table for both power and voltage ratios which should be of interest to the audiophile.

Data-Print #3, entitled "Television Signal Strength Calculation Charts," gives complete details on how one can predict the signal strength from a TV station. It is extremely helpful in determining the proper antenna to be used. In addition, this Data-Print includes a nomograph for determining multi-layer coil inductance. It is of particular interest to those who design coils to specific inductance.

Since our supply is limited this offer is open on the basis of first-come, first-served. In requesting these reprints include 10¢ per copy to cover the cost of handling and postage. Address your requests to Radio & TV News, Box 2045, Church Street Station, New York 8, New York.



COLD DRAWN WIRES

Sylvania Electric Products Inc., Parts Division, has made available a new booklet describing the properties and applications of a wide variety of cold drawn fine wires.

Listing both the physical and chemical properties of the company's alloy, plated, and clad wires, the booklet analyzes factors which determine the most economical and efficient wires for specific applications.

Copies of this new brochure may be obtained from the company, Warren, Pennsylvania.

PORTABLE TV ANTENNAS

JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N. Y., is offering a compilation of all portable TV sets, past and present, by model, year manufactured, screen size, and exact duplicate antenna catalogue number.

This new brochure facilitates servicing and installation by quick identification of the proper antenna to match the portable TV set electrically and mechanically. Dealers desiring the catalogue should address their requests to the company.

SILICON CONTROLLED RECTIFIER

General Electric Company, Semiconductor Products Dept., Syracuse, N. Y., has published a 17-page booklet, "Application Notes For ZJ-39A Silicon Controlled Rectifier," which describes circuit fundamentals for the use of the newly developed controlled rectifier.

The publication, ECG-327, covers general circuit design consideration, firing circuit design, and typical applications for the rectifier. It is available free upon request from the company.

HARVEY CATALOGUE

Harvey Radio Company, 103 W. 43rd St., New York 36, N. Y., has just published a new 304-page comprehensive catalogue of electronic products.

The catalogue contains listings of industrial, service, high-fidelity, commercial sound, and broadcast components and equipment. Detailed descriptions, including specifications and prices, are given for all items listed.

Copies of this publication may be obtained by writing to the company.

TRANSISTOR PRIMER

RCA's Semiconductor Products Division has published a new 48-page booklet, "Transistor Fundamentals and Applications," which contains basic information on transistor theory and circuit applications.

Subjects covered in the 16-section brochure include transistor physics, *p-n, p-n-p,* and *n-p-n* junction transistors, the point-contact transistor, transistor characteristics, types of transistors, transistor amplifiers, power amplifiers, servicing transistor circuits, and many other features.

Copies of the booklet, Form No. 4T37, are available through the company's tube and semiconductor distributors.

NEW BUD CATALOGUE

Bud Radio, Inc., 2118 E. 55th St., Cleveland 13, Ohio, is offering its new catalogue.

The brochure is profusely illustrated and describes the firm's entire line of components. In addition, special fabrication facilities are outlined. To insure case of selection and ordering, complete sizing information is given on each product. Suggestions for uses and applications are also included.

Copies may be obtained by writing to the company.

NEW PLUGS

Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, Calif., has published a new catalogue describing its line of r.f. plugs.

Catalogue ALRF-1 covers 17 pages and is very well illustrated. It describes the firm's new line of coaxial plugs and cable adapters.

This free brochure may be obtained by writing to the firm's advertising department at the above-mentioned address.

SCIENCE CATALOGUE

Herbach & Rademan, Inc., Industrial Products Division, 1204 Arch Street, Philadelphia 7, Pa., is offering a new, 24-page brochure containing hundreds of products and components for use in electronics, science, engineering, biology, and astronomy.

In addition, the catalogue contains telephone, radio and intercom equipment for use in plants, warehouses, and offices.

Write to the firm for free copies.

ANTENNA SYSTEMS CATALOGUE

Andrew Corporation, 363 E. 75th St., Chicago 19, Ill., has released Catalogue 22, a 96-page product and facility book as a reference for antenna system planners and engineers.

It covers the antennas, antenna systems, and transmission line products of the concern. Included are new developments in high power transmission lines, ground-to-air and telemetry antennas, 21-inch waveguide, microwave and two-way communication antennas, and the introduction of two new sizes of "He-

liax" (flexible coaxial line). The booklet also includes a special 16-page section of general antenna systems engineering information.

It is available on request from the firm. Please use your company letterhead when writing for a copy of this publication.

EIA STANDARDS

The Engineering Department of Electronic Industries Association, 11 W. 42nd. St., New York 36, N. Y., has issued three new standards of interest to the industry.

The new publications are RS-168-1 covering dimensional and electrical characteristics defining tube and transistor sockets, an addendum to RS-168 (price 90 cents); RS-185-1 on dimensional and electrical characteristics defining sockets for printed circuits, an addendum to RS-185 (price $1.65); and RS-213 covering test point locations for printed wiring assemblies (price 25 cents).

Any one of the above described standards, or all three of them, may be ordered directly from the Engineering Department of the Electronic Industries Association at the above mentioned New York City address. Please be sure that the correct payment accompanies all requests. —30—

Sun	Mon	Tue	Wed	Thu	Fri	Sat

CALENDAR of EVENTS

MARCH 23-26

National Convention. Sponsored by the Institute of Radio Engineers. Coliseum and Waldorf-Astoria Hotel, New York City. Additional information from E. K. Gannett, Executive Secretary, IRE Headquarters, 1 E. 79th St., New York 21.

Sixth Annual Amateur RTTY Dinner. Sponsored by Amateur Radioteletype Assn., New York City, New York. Advanced reservations required. Contact Clay Cool, 443 W. 47th St., New York 36, N. Y.

MARCH 31-APRIL 1, 2

International Symposium on Millimeter Waves. Sponsored by Polytechnic Institute of Brooklyn, Department of Defense Research Agencies, and IRE. Engineering Societies Building, 33 W. 39th St., New York, N. Y. Additional information from Prof. Herbert J. Carlin, Microwave Research Institute, Brooklyn Polytech., 55 Johnson St., Brooklyn 1, N. Y.

APRIL 5-10

Fifth Nuclear Congress. Sponsored by IRE, Instrument Society of America, and EJC. Cleveland, Ohio. Program information from L. W. Nierman, 141 W. Jackson Blvd., Chicago 4, Ill.

Test Bench PUZZLER: No. 5

By **BOB ELDRIDGE**

Time out for thinking may mean time saved in less point-by-point testing of individual components.

AS A REAL "DOG," this one was rather mild. With a little logic, it was cleared up without the loss of much time. Nevertheless, it was an interesting exercise in deduction from available facts. As such, it does make the grade as a legitimate puzzler.

The fault: no setting could be found for the sync gating control, shown in the accompanying schematic, that would hold good for all channels. Normally this control is set so that the picture is just stable on the strongest channel available. After such adjustment, stability should then be maintained on all other, weaker channels. All tubes were checked out, but no defects were uncovered in this direction.

Voltages around the 6CS6 sync separator measured just about as given on the schematic when a normally weak and slightly snowy channel was being received. The normal voltages, given by the manufacturer, are indicated on the schematic. As compared to them, actual readings were as follows: point 1, −10 volts; point 2, 41 volts; and point 3, 80 volts. With a stronger signal tuned in, readings became rather higher in amplitude, as follows: point 1, −18 volts; point 2, 44 volts; and point 3, 89 volts.

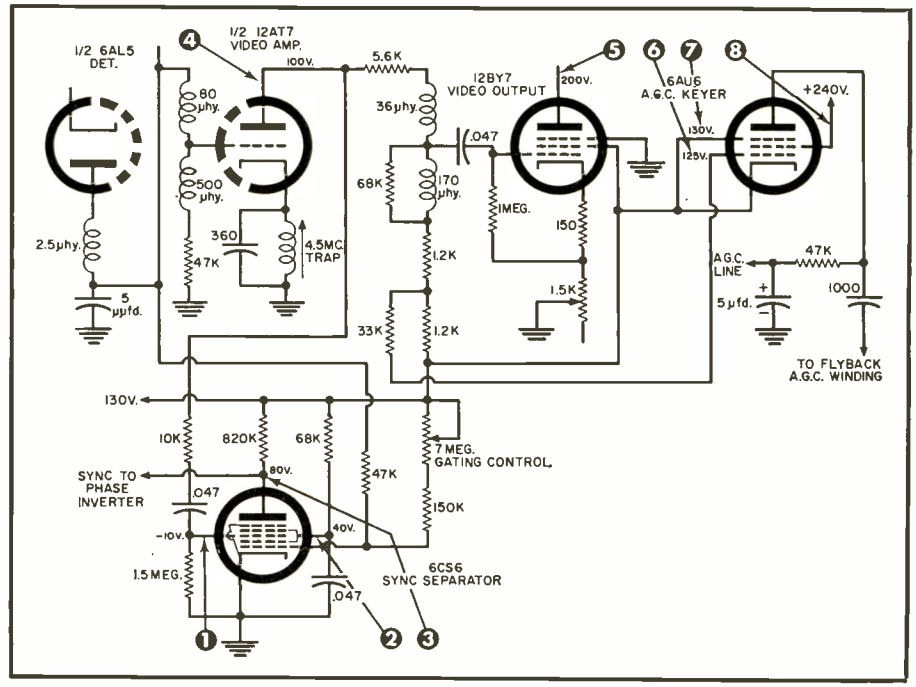
One input grid of this stage (point 1) is fed the composite video waveform from the video amplifier. Signal was checked at this point with an oscilloscope, but there was no evidence of sync-pulse clipping here, whether a weak or strong signal was being received. However, on the two channels compared (one strong, one weak), amplitude of this signal varied over a ratio of about 4 to 1.

With the information obtained to this point, it was decided that the next move should be a check of the video amplifier, video output, and a.g.c. circuits. Accordingly the v.t.v.m. was again brought into play for voltage readings. The video amplifier plate, point 4, read 92 volts instead of the specified 100. Point 5 was right at about 200 volts. Point 6 was noticeably down to 118 volts (normal 125); point 7 was barely up (132 instead of 130 volts); and point 8 read a normal 240 volts.

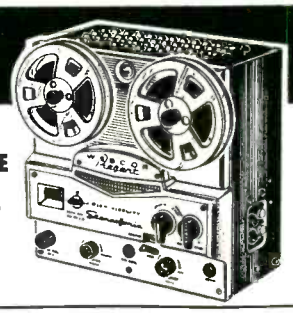
No further tests were made before repair, except for a confirmation check of the suspected component. Not only was the bench man able to diagnose exactly which component had become defective, but he correctly surmised what had gone wrong with it and to what extent.

All you need for this one is straight logic; there are no hidden traps or disguised facts. If you're in a hurry for the answer or want to check it against your own, turn to page 166.

A fault in this circuit caused sync instability with signal-strength variations.



Webcor STEREO Tape Deck from OLSON!



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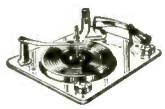
Monarch STEREO Changer



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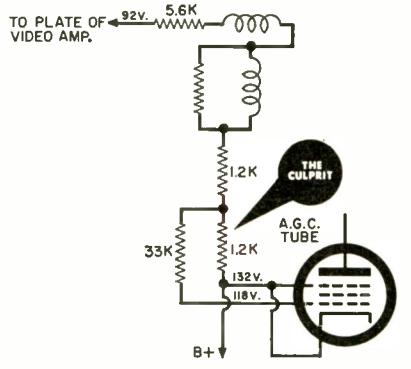
SOLUTION TO BENCH PUZZLER NO. 5

(*See page* 164)

THE TIP-OFF on this defect was the grid-cathode bias on the a.g.c. tube. Normally this should be 5 volts (130 volts on the cathode and 125 on the grid). With 132 volts on the cathode and 118 on the grid, bias increased to 14 volts. Since this prevented the a.g.c. tube from keying properly, a.g.c. action was inadequate, although present to some extent. This accounted for the varying amplitude of video signal measured at point 1.

The bench man surmised that the resistor designated as the culprit in the accompanying partial schematic, nominally 1200 ohms, must have gone up "about three times as high as normal" to produce the voltage changes observed. In fact, it was found to be 3300 ohms when measured.

The 6CS6 requires that a reasonably constant level of signal be fed to its grid for proper operation. This is obviously a job for the a.g.c. system.



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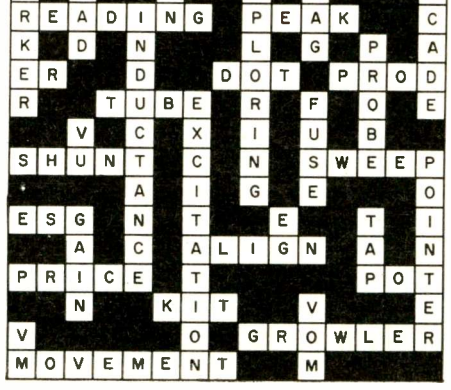
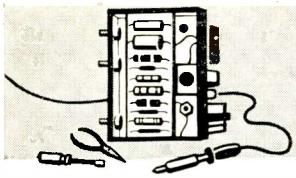
Answer to Puzzle appearing on page 137





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RATE: 50¢ per word. Minimum 10 words. May 1959 Issue closes March 9th. Send order and remittance to: RADIO & TV NEWS, One Park Ave., N. Y. C. 16, N. Y.

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ELECTRONICS! Associate degree—29 months. Technicians, field engineers, specialists in communications, missiles, computers, radar, automation. Start September, February. Valparaiso Technical Institute, Dept. N, Valparaiso, Indiana.

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GOVERNMENT Sells — Surplus Electronics; Walkie-Talkies; Transceivers; Test Equipment; Oscilloscopes; Radar; Voltmeters; Misc.—Fraction of Army costs—Buy direct now from U. S. Government—"Depot List & Procedure" $1.00—Brody, Box 8-RT, Sunnyside 4, New York.

TUBES—TV, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed, 1st Quality, Top Name Brands Only. Write For Free Catalog or Call WAlker 5-7000, Barry Electronics Corp., 512 Broadway, New York 12N, N. Y.

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YOUR classified message placed right here will attract the attention of more than 250,000 electronics fans. You'll get fast results. For full details, write to Martin Lincoln, Radio & TV News, One Park Avenue, New York 16, New York.

YOUR tubetester modernized, checks latest series-string tubes accurately. Simple instructions. $1.00. Adams Laboratory, 68-77 218 Street, Bayside 64, N. Y.

SAVE Money! Don't Buy until you get our price list! All types Radio & TV tubes at Mfrs. prices! 100% Guaranteed! 24-hour Service! Write United Radio Co., Newark, N. J.

BUY Surplus Jeeps, tractors, winches, pumps, tools, hydraulics, electronics, boating, typewriters, generators wholesale direct from government. List and procedure $1.00. Aviation Surplus, Box 8-ZD, Thomasville, Penna.

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CASH Paid! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, Klystrons, broadcast, etc. Also want military & commercial lab test and communications gear We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone. Barry, 512 Broadway, New York 12, N. Y. WAlker 5-7000.

CYLINDER and old disc phonographs. Edison, Conqueror, Idelia, and Oratorio models. Berliner Gramophones and Zono-o-phones, Columbia cylinder Graphophones, and coin-operated cylinder phonos. Want old catalogues and literature on early phonos prior to 1919. Will pay cash or trade late hi-fi components. Classified Box 50 % Radio & TV News, 1 Park Ave., N. Y. C. 16, N. Y.

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WANTED, ARN-14c, ARN-30, ARC-15, OMNI Sets, and components. CRT-3 Victory Girls, AS313B Loops, ARC-12, 51R2-3, 17L3-4, 18S2-3, R-388/URR, R-390/URR, BC-348, Testsets, "Top Dollar Paid." Bill Slep, W4FHY, Box 178, Ellenton, Florida.

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WANTED: Special Purpose Vacuum Tubes: Klystrons, Magnetrons, Power Tubes, Lab Test Equipment: X, S, K bands, Signal Generator, Slotted Lines, Aircraft Communication Equipment. I pay top prices fast! REpublic 5-0215. Bob Sanett, 2033 W. Venice Blvd., Los Angeles 6, California.

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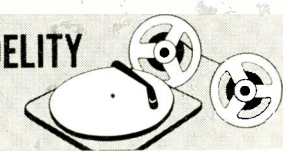

HI-FI Haven, New Jersey's Leading Sound Center. Write for information on unique mail order plan that offers professional advice and low prices. 28 Easton Ave., New Brunswick, New Jersey.

DISGUSTED with "HI" Hi-Fi Prices? Unusual Discounts On Your High Fidelity Requirements. Write. Key Electronics, 120 Liberty St., New York 6, N. Y. EVergreen 4-6071.

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TAPE Recorders, Hi-Fi Components, Sleep Learning Equipment, Tapes. Unusual Values. Free Catalog. Dressner, 69-02F, 174 St., Flushing 65, N.Y.

LEARN While Asleep with amazing new Electronics Educator endless tape recorder. Details free. Research Association, Box 24-S, Olympia, Wash.

LABELS for dual-track tape. New type. Positive identification both sides. Secures tape end. Removable. Revisable. No stickum. No rewind. One package with kit: $1.25 postpaid. Write: Color-Coded Labels, Route 1, Madison, Wisc.

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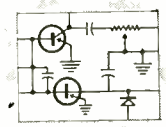
SCHEMATIC, Repair Instructions, HiFi's, T.V.'s, Radio's, Phonographs, Tape Recorders, 99¢. Send Make, Model Number. "Radio Coop," Box 5938, Kansas City 11, Missouri.

INSTRUCTION



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COMPLETE Your High School at home in spare time with 62-year-old school. Texts furnished. No classes. Diploma. Information booklet free. American School, Dept. X336, Drexel at 58th, Chicago 37, Illinois.

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AMERICAN Overseas Jobs. High Pay. Men, Women. Transportation Paid. Free information. Write: Transworld Information Service, Dept. MZ, 200 West 34th St., New York 1.

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MISCELLANEOUS

DECALS—Trademarks, Service, Sales, etc. Write Allied Decals, Inc., 8378 Hough, Cleveland, Ohio.

FRANCHISES available in selected areas to operate radio, television and electronics schools. Nominal investment, annual potential $50,000 to $200,000. Box 569, % Radio & TV News, One Park Avenue, New York 16, N. Y.

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Classified

A HANDY GUIDE TO PRODUCTS, NOT NECESSARILY ELECTRONIC, BUT OF WIDE GENERAL INTEREST.

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YOUR Own home-operated business! Take over your area as our Service Distributor keeping stores supplied. Nationally advertised 28-year-old line pays you 66⅔% mark-up. Less than $100 for merchandise, starts you. For samples, highly successful plan, write Novo, Inc., 1168-P Milwaukee, Chicago 22, Ill.

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$30-$60 WEEKLY Addressing Envelopes at Home. Instructions $1 (refundable). Reiss, 210 Fifth Ave., Suite 1102-M, New York 10.

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MESTON'S the preferred 35mm color slides. Top quality, biggest library, best package. Exciting Preview Package four slides hermetically sealed in plastic plus 80 page catalog only $1.00. Meston's Travels, Dept. RT, 3801 N. Piedras, El Paso, Texas.

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U.S. Stamps. Giant Bargain Catalog—15¢. Raymax 35-VZD Maidenlane, NYC 38.

UNITED Nations. Five Different 10¢. Approvals. Anderson, 1112 Harrison, San Francisco 3, Calif.

NEW! 1959 Bargain American Coin Catalogue! Revised Prices! Only 25¢. Write: Sullivan, 128 EB East Fourth St., St. Paul 1, Minnesota.

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MISCELLANEOUS

FLYING Saucers Latest Reports, Articles. Subscribe for "The Saucerian" magazine. Six issues $2.00. Saucers, Dept. 4, Box 2228, Clarksburg, West Va.

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ENGINES OHV V8's. All Popular Makes 1956, 1959. Ledbetter Enterprises, 1015 West 17th, Texarkana, Texas.

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"WINEMAKING; Beer, Ale Brewing." Illustrated. $2.00. Many others. Eaton Books, Box 1242-TC, Santa Rosa, California.

YOUR classified message placed right here will attract the attention of more than 250,000 electronics fans. You'll get fast results. For full details, write to Martin Lincoln, Radio & TV News, One Park Avenue, New York 16, New York.

PHONOGRAPH Records cheap, postpaid. Catalogue. Paramount, Box 242-N, Williamsport, Penna.

INDEX OF *Advertisers*

MARCH 1959

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

FASTEST

Now, in New Triplett Model 3414 you will recognize another answer to a long standing need—a FASTER, more versatile tube tester.

* All switch settings can be made before the tube warms up; you are ready to test as soon as the filaments reach proper temperature.
* Rejects burned-out tubes instantly without waiting for the filament to heat.
* Complete flexibility for new tube setups; plus the non-obsolescence factor.
* A few simple switch settings give the complete and accurate story of tube capabilities.
* Modified plate conductance circuit—for closer correlation to tube characteristics.

Neon Indicator shorts test—NEW, fast and accurate. Slightest inter-element shorts show while the cathodes are hot.

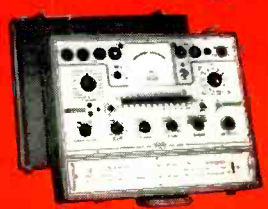
New variable leakage test from 0.3 megohms to over 3 megohms.

Checks all today's and tomorrow's tubes (including new series filament tubes). .With BV adapter TV picture tubes can be tested in the set.

$79.50 NET

TRIPLETT

Two other Triplett testers—



To the left for the ultimate in laboratory quality testing Model 3423 at $199.50 Mutual Conductance Tube Tester.

New Model 690-A Transistor Tester Leakage and Gain test for all low and medium power PNP and NPN type transistors—$29.50 net.

For full information see your Triplett distributor or write

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • B

the case of the stereo HUMMMMMING BIRD *or* MAGNETIC *vs* CERAMIC

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

IT'S A FACT! Audio Engineers agree that magnetic stereo cartridges are excellent, costly . . . but burdened with *hum*. Tests prove that the new Electro-Voice Magneramic cartridge is completely hum-free. No motor or line hum can possibly be introduced to mar soft record passages, because the Magneramic is *non-inductive*.

IT'S AN ENGINEERING AXIOM! The simpler the design of a precision product, the less chance there is of manufacturing defect. Magnetic stereo cartridges are far more complicated than the comparable Electro-Voice Magneramic stereo cartridge. With E-V, you are assured years of trouble-free, high fidelity stereo performance.

IT'S POSITIVE! When the Electro-Voice corps of 60 engineers began intensive scientific stereo studies, they had the choice of either designing a magnetic or a ceramic cartridge. Knowing that two of the most vital factors for true audio reproduction were lack-of-hum and trouble-free performance, they took the positive approach and produced a stereo cartridge incorporating simple elements permitting positive, stable control for uniform output.

And so, with the advent of stereo, Electro-Voice introduced an entirely new concept in ceramic cartridges . . . a true high-fidelity series . . .

THE E-V MAGNERAMIC

which will consistently outperform the best magnetics and do away with the "hummingbird" in your stereo system.

Choose the Magneramic . . . a new improved E-V stereo cartridge which plugs directly into magnetic inputs. See why it's the choice of so many FM stations for critical stereo broadcasts:

- NO HUM
- BEST CHANNEL SEPARATION
  Over 25 db isolation between channels
- HIGHEST COMPLIANCE
  Horizontal and vertical compliance equal to or surpasses the best magnetic cartridges
- WIDEST RANGE FREQUENCY RESPONSE
  Far in excess of any monaural (monophonic) or stereo record
- FLATTEST RESPONSE TO WESTREX 1A VELOCITY CURVE
  From 20 cps to beyond audibility
- HIGH 20 MILLIVOLTS OUTPUT
  All the voltage you need . . . and then some
- PROVEN SUPERIOR
  for conventional monophonic records as well as stereo records
- GUARANTEED OR YOUR MONEY BACK
  We invite you to try an E-V Magneramic, with E-V's unqualified guarantee backed by over 30 years as a manufacturer.

Give the Magneramic a thorough listening test. If for any reason you aren't completely convinced of its superiority, your FRANCHISED Electro-Voice dealer is authorized to give you a full refund.

Step up to the excitement of stereo . . . step up to Electro-Voice Stereo . . . the industry's standard. Over a half-million in use, more than the total of all other stereo cartridges combined, attest to its acceptance as stereo's standard. Choose either the E-V *Magneramic* for magnetic inputs or the E-V *Standard* Stereo Cartridge for non-magnetic inputs.

21 MD with 0.7 Mil Diamond Stylus, net $19.50; 26 MDST Turnunder with 0.7 Mil Diamond Stylus, and 3-Mil Sapphire Stylus for 78 R.P.M.'s, net $22.50; 21 MS with 0.7 Mil Sapphire Stylus, net $9.90; 26 MST Turnunder with 0.7 Mil Sapphire Stylus, and 3-Mil Sapphire Stylus for 78 R.P.M.'s, net $12.90.

GOOD STEREO DEPENDS ON THESE VITAL FEATURES: FREQUENCY RESPONSE, 20-16,000 cps flat (Westrex 1A); ELEMENTS, 2 PZT Ceramic; OUTPUT VOLTS, 20 mv. Nominal; COMPLIANCE, 2 x 10^{-6} cm/dyne; WEIGHT, 3.4 Grams; TRACKING FORCE, 4-6 Grams; CHANNEL SEPARATION, 25 db at 1 KC; MOUNTING, EIA (RETMA) Standard 1/2"-7/16" Center; STYLUS, .7 Mil (Diamond or Sapphire); OUTPUT TERMINALS, Standard .050 Connectors; IMPEDANCE OR LOAD, 22,000 ohm or higher magnetic input.

See your High Fidelity Specialist or write Dept. AD-2

STEREO'S STANDARD

Electro-Voice®

INC., BUCHANAN, MICHIGAN

Over ½ Million in Use . . .
MORE THAN ALL OTHERS COMBINED