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1 **Leading Metropolitan Opera Star Leonard Warren converted to stereo quickly, easily and inexpensively...** using a compact Stereoflex-2* "add-on" speaker with his University "Troubadour"

This approach solves many problems for those already possessing a full-range monophonic system, as well as those planning to buy one now with an eye to stereo later. Thanks to the exclusive dual voice coil woofer used in all University stereo-adapted systems, only one such woofer is needed to reproduce the combined bass below 150 cycles† of both stereo channels. Thus all three models of University "add-on" speakers provide a perfect match by direct connection to the original speaker system. Stereoflex-1* is well suited for bookshelf installations; Stereoflex-2, with its narrow silhouette, makes a fine end table. Model SLC* can be affixed to a wall or "lite-pole," its decorative fibreglas housing blending smartly with modern furnishings. Each can also be used with any brand monophonic system not having a dual voice coil woofer, by using a University Stereo Adapter Network Model A-1.

2 **Discriminating music lovers may also enjoy magnificent stereo by simply connecting two University “add-on” stereo speakers to a single dual voice coil woofer** in a suitable enclosure

This approach offers great versatility. Since the woofer's position in the room is uncritical for stereo†, it may be installed wherever most convenient... in a small suitable enclosure, or in a wall, closet, etc. The two "add-on" speakers can then be placed to provide optimum stereo reproduction, without upsetting existing room decor.

3 **Noted maestro Fred Waring chose a pair of University RRL® Ultra Linear Response speakers for his stereo system**

When planning his recent cross country concert tour, Hi Fi Holiday, Fred Waring turned to University engineers for a compact, quality high fidelity speaker system that could overcome the acoustical deficiencies of the theatres and auditoriums in which The Pennsylvanians would be playing. The performance of the S-11 Ultra Linear Response speakers, mainstays for the system, proved so outstanding that Mr. Waring chose two of them for his own home. Two such identical speakers are an excellent stereo solution in rooms where they can be placed in reasonably symmetrical positions. All University systems are ideally suited for this purpose, because they are stereo-matched in production to within 1 db.

4 **Internationally famed violinist Mischa Elman prefers his stereo all-in-one... he selected the fabulous TMS-2**, "Trimensional" stereo speaker that in his words... "approaches the authenticity of concert hall performance."

A totally integrated single-cabinet system, the TMS-2 literally adds a third dimension to stereophonic sound... the perception of depth. Designed to utilize the acoustical properties of the surrounding walls of the room, the TMS-2 performs far beyond the scope of other single-cabinet stereo speakers. Its ingenious combination of electrical and acoustical principles permits placement in a corner or anywhere along a wall... lets you and any number of friends enjoy exciting stereophonic sound from almost any position in the room.

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*Trademark and Patent Pending.
†Bass frequencies below 150 cycles do not contribute to the stereo effect.
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TRADITIONALLY New Years is a time for assessing past performances and planning changes and improvements. In this respect magazines are like individuals since we, too, indulge in stock-taking and soul-searching and resolve to make each new year the best ever for our readers.

Unlike individuals, however, our “New Year’s Resolutions” are the result of innumerable staff meetings and editorial consultations with our readers and our advertisers. From this array of opinion and information we have formulated our editorial policy for the coming year—and we think you will like it.

First of all, we are going to bring you a bigger and better magazine than ever before. Not only will we provide authoritative and timely articles on a wide variety of subjects but we will give you more of them and cover an even wider scope.

In addition, we plan to institute a series of “fold-outs” which will bring you a wealth of pertinent and valuable data in permanent, easy-to-retain form. Each of these “gatefolds,” as they are known in the trade, will carry information you can use in your work or your hobby—in a format which facilitates mounting on your shop or hobby room wall or filing for safekeeping along with your service information folders. The first of these “gatefolds” will appear in next month’s issue. This “Sound Chart” will include the “Fletcher-Munson curve,” the frequency range of all musical instruments as well as that of the male and female voice, thresholds of hearing and feeling, sound levels of music and speech, etc.

The service technician will find more and more material designed to be of dollar-making and money-saving help to him in his day-to-day operations. The audiophile, whether professionally involved or an enlightened hobbyist, can look to this magazine for up-to-the-minute information on every facet of the field. We will keep you abreast of every new development in stereophonic tapes and discs—and the equipment being produced to play them; of the progress in multiplexing, in FM networking, simulcasting, TV simulcasting for stereo—in fact every single thing the hi-fi fan wants to know.

The general reader who prides himself on keeping up with the world of electronics will find that his interests are being catered to as never before. Today’s educated man is expected to be conversant with a multiplicity of topics not necessarily connected with his everyday bread-and-butter job. To amplify and round out the news coverage of important events—as provided by the daily papers and the weekly news magazines—we will bring you background material and full details on the equipment and techniques making their mark in our exciting world of electronics.

Physically, too, we are planning to increase the over-all attractiveness of the magazine by giving you a sturdier cover, changing some of our type faces for improved readability, and brightening up our layout of the articles. You will find more color in the magazine—used in new and interesting ways. Our “New Year’s Resolutions” are designed to make this magazine your Number One source for all that is best and most authoritative in the field of electronics.

We want you to come to rely on us for all the information you should have and want on what is going on in the fascinating and dynamic world of the vacuum tube and transistor—the World of Electronics!

Making such an expansion possible entails a number of unusual expenses which are not now covered by the subscription price of the magazine or the advertising rates. In this period of the 46-cent dollar the cost of physically producing any magazine (otypesetting, printing, mailing, paper, and ink) has risen along with your grocery bill and the cost of every service you use. These increased production costs plus the expense of the new projects we have in store for our readers necessitate a modest upward adjustment in the newsstand and subscription prices of this magazine. The decision to raise our price was not taken lightly but the consensus was that our readers would rather have a top quality magazine which brings them ALL the information they want about the world of electronics than settle for less-than-the-best at a pre-inflation price.

Next month when you step up to your newsstand for your copy of the bigger, brighter, and better Radio & TV News the man will ask you for 50 cents for your favorite publication—but we sincerely believe that the additional pages, additional information, and wider scope of the magazine will have you agreeing that this is the “best half buck I ever spent”.

Limited space prevents our revealing all of our plans now—but next month we will tell you more about the important and exciting changes in store for you. See next month’s “For the Record.”
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WHAT IS IT?

To the Editors:
Here is a photograph of a piece of equipment which we have picked up in an old house. Can any of your readers tell us what the unit is? All we know is that it was made by RCA, and the manufacturer of the French hi-fi amplifier, it is as follows: B.T.H. Cie Franc- caise, Tomson-Houston, Group Petite Materiel, 173, Boulevard Haussman, Paris 8, France. We suggest you contact them directly for further information.—Editors.

* * *

ASSOCIATION OF THE MONTH

To the Editors:
The Electronic Service Association is very grateful to Radio & TV News for extending to us the honor of being the "Association of the Month" in your September, 1958 issue.

We, who are so often forgotten by the TV manufacturers whose sets we repair and for whom we retain so much good will, wish to thank the editors and the publisher for the time and trouble it must have taken to write and edit such a very fine article.

I, as corresponding secretary, have been receiving compliments from everyone who reads the article as well as from members of ESA for sending the information on to you.

HOWARD C. LARSEN
Corresponding Secretary
Electronic Service Association
Detroit, Michigan

We are pleased to know that you and your Association liked the coverage received in "Service Association of the Month." We certainly would like to invite all service associations to give us the opportunity of telling their story as well. Simply fill in the coupon which usually appears along with our coverage of the "Service Association of the Month."—Editors.

* * *

IGNITION ANALYZER

To the Editors:
I have received several letters concerning the lack of synchronization in the ignition analyzer described in the July issue. Actually, I should have foreseen the difficulty and warned of it in the article.

For example, assume a 6-cylinder automobile engine is idling at 300 rpm. Since each cylinder fires only once every two revolutions, we get 150 displays per minute. This means that for a 6-cylinder engine, a scope's sweep must operate at 900 sweeps-per-minute or 15 sweeps-per-second. Many commercial scopes will not sweep at this slow rate.

There are two solutions to this problem. The first is to slow the sweep of the scope by adding an external capacitor. Many scopes have external jacks for such an addition. The second solution is to use the analyzer only at...
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PACO KITS ARE DISPLAYED AND SOLD BY YOUR FAVORITE LOCAL ELECTRONIC PARTS DISTRIBUTOR. YOU CAN ALSO BUY THEM FACTORY-WIRED, TESTED AND CALIBRATED.

SPECIFICATIONS

VERTICAL CHANNEL—3 stage push-pull
SENSITIVITY: DC—70 mV/in.
AC—25 mv RMS/in.
FREQ. RESPONSE:
DC—Within 3 db to 4.5 Mc.
Within 5 db at 5 Mc.
AC—Within 3 db from 1 cps to 4.5 Mc.
Within 5 db at 5 Mc.
RISE TIME: Better than .08 microseconds
INPUT IMPEDANCE: 1.5 megohms shunted by 33 mmfd
VERTICAL INPUT STEP ATTENUATOR
VERTICAL POLARITY REVERSAL SWITCH
HORIZONTAL CHANNEL—push-pull output
SENSITIVITY: 0.6 v RMS/in.
FREQ. RESPONSE: Within 3 db from 1 cps to 400 Kc
INPUT IMPEDANCE: 5 megohms shunted by 22 mmfd
CATHODE-FOLLOWER HORIZONTAL INPUT CIRCUIT
LINEAR TIME BASE: 10 cps to 100 Kc, TV-V and TV-H, plus provisions for external capacitor sweep to 1 cps, Automatic “positive” and “negative” synchronization.
BUILT-IN VOLTAGE CALIBRATOR
ILLUMINATED SCREEN GRAPHIC AND CAMERA-MOUNT BEZEL
MODEL S-55: Complete with all tubes including CRT, PACO-detailed assembly-operating manual, in louvred steel cabinet with two-color, easy-reading panel, 5" x 13" x 84" x 17½".
Kit Net Price: $87.50
MODEL AS-1: OSCILLOSCOPE PROBE SET
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70-31 84th Street, Glendale 27, Long Island, New York

A DIVISION OF PRECISION Apparatus Company, Inc.

RADIO & TV NEWS
January, 1959

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January, 1959

15
NO STRIP!

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In just a matter of seconds, new quality engineered B-T couplers featuring 'No-Strip' terminals provide a low loss, matched installation for superior multi-set performance.

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Speedy, Secure Positive Installation — No Stripping. Simply slide the 300 ohm ribbon into groove provided on the coupler and tighten slotted hex head terminal screws. 12 sharp teeth bite through the insulation making positive electrical contact . . . secure, weather-proof. Eliminates loss and impedance mismatch caused by exposed wires.

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A-105 HI-LO ANTENNA COUPLER — Combines low-band and high-band VHF antennas or provides separate low and high outputs from a common line or antenna. List 3.95.

A-107 UHF-VHF ANTENNA COUPLER — Combines VHF and UHF antennas, or provides separate VHF and UHF outputs from a common line or antenna. List 3.95.


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Available at parts distributors. For further information write Dept. RTN-1, BLONDER-TONGUE LABORATORIES, INC. 9 Alling Street, Newark 2, N. J.

Audio "MIX-IT" BOX

To the Editors:

I have had some correspondence with readers who are anxious to duplicate my audio "mix-it" box (September, 1958 issue).

One question that has come up is the identification of the various knobs that are on the front panel of the box. The four large knobs are, left to right, R1, R2, R3, and R4. A small screwdriver adjustment next to the meter is R5. The two small knobs below are the 'on-off' switch and R6, the master volume control.

Another question has to do with whether a tape head could be used with the mix-it box. It might be possible to connect some tape heads to J1. However, most heads require special equalization, which is not provided by my mixer. Therefore, a tape preamp would be needed.

Finally, some readers have wanted to know whether a microamperemeter could be used for M1. It would be possible to use a 50-microampere meter, for example, with a series diode rectifier or a bridge rectifier ahead of it for this purpose.

LEON A. WORTMAN
New York, New York

We are glad to pass along Author Wortman’s suggestions for those who are interested in constructing the mixer he described — Editors.

COUNTING COIL TURNS

To the Editors:

Referring to the brief item "Counting Coil Turns" on page 134 of your October issue, I believe it would be easier to count the turns of the handle of the drill rather than its chuck. You do not need to do this to determine the gear ratio. For instance, the chuck on my drill turns 3% times for each turn of the handle, so when I want a coil of 300 turns, it is much easier to simply count 80 turns of the handle.

LAWRENCE DAVIS
Columbus, Ohio

Reader Davis’ suggestion is a good one, provided the relation between the handle turns and the chuck turns is fairly simple. Just as soon as some fractions start to enter the picture, the additional calculations involved and the resultant lack of accuracy may make it easier just to turn the drill more slowly and count the turns made by the chuck. — Editors.

7½ IPS 4-TRACK STEREO TAPE

To the Editors:

I was very interested in the articles "Stereo Tape or Disc?" and "Behind the Stereo Scene," which appeared in your October issue.

I have had quite a bit of experience with tape recordings made at 3½ ips,
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The Engineering Staffs of H. H. Scott and London Records Introduce the new ffss matched stereophonic arm and cartridge

"...in a class apart from all the others..."

— Saturday Review, September 27, 1958, Page 46

The Saturday Review went on to say: "...the new (London-Scott) FFSS pick-up emerged as easily the outstanding stereo pick-up to be seen at Earl's Court (London, England High Fidelity Show) ... Only (this) pick-up is of quality to satisfy the exacting demands of most Hi-Fi addicts. This is a really first-class piece of design and, moreover, of great flexibility since, in addition to the normal pair of 45/45 coils, it contains a third coil which enables it to be used for monaural, single-channel performance ... The (London-Scott's) performance does place it in a class apart from all the others, and its price... is by no means excessive for an instrument of its class".

---

1. The Type 1000 is a completely matched arm and cartridge system designed to give optimum performance from wide frequency range recordings. 2. This integrated design minimizes tone arm resonance problems and assures proper alignment of stylus on record. This is extremely important when stereo-disks are played as it keeps cross-talk to almost unmeasurable levels (cross-talk 20db). 3. Extremely low tip mass (less than 1 mg.) reduces record wear to an absolute minimum and assures accurate tracking even at high volume levels. This tip mass is at least 50% lower than cartridges of conventional design. 4. Frequency response 20 CPS to 20,000 CPS. This extended response is far beyond the range of ordinary pickups. 5. High vertical compliance of this pickup minimizes record wear and prevents damage even if cartridge is dropped on record. 6. Tracking pressure 3.5 grams for optimum response and minimum wear. 7. Output 4 millivolts. 8. Stylus tip of polished diamond. 0.5 mil radius. This small radius assures minimum distortion. 9. Length of arm from pivot to stylus 12.5". Height of arm adjustable. 10. Frictionless precision roller bearings minimize lateral tracking force. 11. Performance of this pickup on monaural records is superior to conventional monaural pickups because of the extremely low mass and extended frequency response. Price of arm and cartridge assembly: $89.95.

and I have found that many tape recorders develop quite a bit of wow at this speed after prolonged use. On the other hand, 7½ ips stereo tapes with just two tracks are too expensive today. Therefore, I think the solution to the tape dilemma is to use the higher speed but go to four tracks. So, how about some manufacturers thinking over the idea and coming out with recorded stereo tape that runs at 7½ ips, but which has four tracks on it. In this way, we will get tape economy and high quality too.

EGON E. ECKERT
Danbury, Connecticut

The arguments expressed by Reader Eckert certainly have merit. On the other hand, there is enough confusion in the tape market today so that the proposal of still another standard might not make too much sense. The fact remains, however, that the new, smaller heads that are suitable for four-track stereo ought to result in still better performance at 7½ ips than the low-speed machines for which they were designed.—Editors.

TRANSPORT SUPERREGEN FM TUNER

To the Editors:

When I came across the article on the transistor superregen FM tuner in the November issue, I was all enthused and ready to build it, that is, until I saw the price of the 3N25 tetrode transistor. My catalogues list this little item at $16.00. This price, in conjunction with the cost of the zener diode, transformer, and other components, probably make the cost of this project well over $25.00.

KENNETH GREENBERG
Chicago, Illinois

Our article carefully mentioned the prices of all special items, and indicated that the total cost would not exceed $25.00. However, according to the information available to the author at the time the manuscript was written, the 3N25 sold for $18.50. According to the latest catalogues, the price is now $16.00 so that Mr. Greenberg certainly appears to be right. The tuner would still be of interest to anyone who wants to experiment with the new tetrode transistor and who wants a simple circuit that works well. However, we certainly must warn our readers of the cost.—Editors.

* * *

SUPREME ROLL CHARTS

To the Editors:

Can you supply me with a roll chart or reprints of articles for use with a Supreme Model 504A tube tester for newer type tubes?

WILLIAM WEBB
Bellevue, Washington

The Supreme line of tube testers is no longer in production, and we know of no source from which up-to-date roll charts are available. However, we are planning a 2-part article telling owners of older tube testers how they may be able to set up these instruments for testing newer tube types.

RADIO & TV NEWS
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You Build Vacuum Tube Voltmeter
Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

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Help pinpoint and correct faults
Day in, day out, tubes are cycled and checked under accelerated conditions at low (105 v) and high (140 v) line voltages. Components and dynamic operating conditions are controlled to point the finger unrelentingly at the exact nature of tube failures. They may be opens, shorts, gas, gradual deterioration of electrical characteristics, etc. Once the tests locate the fault, the correction is invariably the same: improvement of tube design or manufacturing techniques.

CUT YOUR CALL-BACKS. This new controlled dynamic life testing is your answer for dependable, universal replacement tubes for all TV sets. It is a big reason why CBS-Hytron tubes can cut your call-backs. Be sure to ask for CBS-Hytron tubes.

January, 1959

CBS-HYTRON, Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.
Within the Industry

DR. PHILIP N. HAMBLETON has been appointed supervisor of research and development, tubes, for CBS-Hytron, a division of Columbia Broadcasting System, Inc.

Dr. Hambleton was previously senior physicist in the tube research and development laboratory. Prior to joining the firm he was associated with Sylvania Electric Products and Philco Corporation. In addition, he served as supervisor of Superior Tube Company's electronic laboratory.

He received his Doctorate in Physics from The Johns Hopkins University, and is a member of the Institute of Radio Engineers, the American Institute of Physics, and the American Physics Society, among others.

HARRY L. BRYANT, vice-president and chief engineer at Radio Recorders, Hollywood, Calif., has been elected executive vice-president of the Audio Engineering Society.

Mr. Bryant is the first westerner ever to hold post in the association, the only national engineering society devoted exclusively to audio technology. He is a fellow of the organization and served previously as western vice-president.

HAROLD J. ADLER has been named vice-president in charge of operations at Shure Brothers, Inc. In this capacity he will be responsible for all engineering and manufacturing activity at the company.

A licensed engineer and a senior member of the Institute of Radio Engineers, Mr. Adler was graduated in 1930 from Armour Institute, now part of the Illinois Institute of Technology, Chicago.

He was chief electrical engineer of the Sentinel Radio Co. for 17 years and was director of engineering of the Hallicrafters Co. for five years. Mr. Adler also was vice-president of Edwin I. Gutman Co. and for the past three years he has been a private consultant to industry on engineering, manufacturing, and sales.

COMPONENTS CORPORATION announces the formation of its Nuclear Instrument Division. Jerry B. Minter will be in charge of this new division.

The entire master television and tenna business of AMY, ACEVES AND KING has been acquired by AMPLITEL INCORPORATED. The purchase includes patents and all existing contracts for service and future installations.

DI-AN CONTROLS, INC. has been formed in Boston, Mass. Products planned include magnetic logical elements, shift registers, special purpose computers, industrial control systems, digital storage systems, and servo amplifiers.

SID N. COTTIN has been appointed show director for the Institute of High Fidelity Manufacturers.

He was formerly sales and advertising manager for Great Records and Shelley Products Ltd. Previously he had been an advertising and printing consultant.

Mr. Cottin will be responsible for the handling of all Institute-sponsored shows throughout the country.

WALTER L. BROUGH has been named manager, manufacturing division, of ORadio Industries, Inc., a new position with the company.

Prior to joining the firm Mr. Brough was associated with Hercules Motors Corp. as executive vice-president. He was also chief engineer, Union Drawn Steel Div., Republic Steel Corp., and spent many years with Timken Roller Bearing Company.

Mr. Brough is a graduate of Penn College, Cleveland, Ohio and saw service in the Navy during the Second World War. He is a member of the American Society of Mechanical Engineers.

E. LEON CHAFFEE is among those named to receive a 1959 award from the Institute of Radio Engineers. He is to receive the "Medal of Honor," the highest technical award in radio electronics field, for "his outstanding research contributions and his dedication to training for leadership in radio engineering." Dr. Chaffee is the former director of the Cuit Laboratory, Harvard University and is Rumford Professor of Physics, Emeritus, and Gordon McKay Professor of Applied Physics, Emeritus.

In addition, the Morris Liebmann Memorial Prize will go jointly to Charles H. Townes, Professor of Physics, Columbia University, and Nicolaus Bloembergen, Gordon McKay Professor of Applied Physics, Harvard University.

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— Dan M. Heinrich, Westlake, Ohio

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— Luther W. Wilkes, Houtzdale, Pa.

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— Joseph M. Decker Jr., Newton, N. J.

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— Emilio Conzo, Newton, Mass.

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— Samuel S. Sawyer, Ketzar Falls, Maine

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— Kenneth E. Jenkins, Big Stone Gap, Va.

**CALIFORNIA**

"With PHOTOFACT, the information I need is always at hand. I don't have to worry about a repair job because I know I will have a schematic that gives me correct information in the simplest possible form..."

— J. R. Stukes, Norwalk, Calif.

**WISCONSIN**

"In my business, I service all makes of TV sets. Without good service literature such as PHOTOFACT, this would be an impossible task—especially to do a quick, intelligent job. In my estimation, Sams PHOTOFACTS is unequalled. I would hate to conduct a business without them. Keep up the good work!"

— William F. Dumke, Menasha, Wis.

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— Sam Rogondino, Lake Forest, Ill.

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Harry Diamond Memorial Award and the Vladimir K. Zworykin Television Prize goes to Paul Weimer of RCA Laboratories.

These awards will be presented at the 1959 IRE National Convention to be held in New York City next March.

* * *

DR. ALFRED N. GOLDSMITH has been elected to the board of directors of RCA Communications, Inc.

Dr. Goldsmith joined the parent company in 1919 and for 12 years served as director of research and then vice-president and general engineer. Since 1931 he has served as a technical consultant to the company.

He has been president of the Institute of Radio Engineers and the Society of Motion Picture and Television Engineers. In addition, he is a Fellow of the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Acoustical Society of America, and the American Association for the Advancement of Science, to mention just a few.

Among Dr. Goldsmith's citations are the Medal of Honor and Founders Awards of the IRE, the Progress Medal Award of the SMPTE, and the Modern Pioneers Award.

* * *

ELECTRONIC INDUSTRIES ASSOCIATION'S tube and semiconductor division is now operating the EIA Standards Laboratory, 32 Green St., Newark, N. J.

The new agency performs test measurements for tube and semiconductor manufacturers of the Association in connection with the recommendations of the appropriate Joint Electron Tube Engineering Council committees, and operates under the direction of the Association's engineering department with supervision by the executive committee of the tube and semiconductor division.

G. F. Hohn will head the Laboratory's operations.

KENNETH C. MORITZ has been named sales manager of the semiconductor division for Raytheon Manufacturing Company . . . C. R. (RUSS) ROBERTSON has been elected vice-president, sales, at Weller Electric Corp. The appointment of G. W. TUNNELL to the post of manager, broadcast, systems, and shop repair service sales, has been announced by RCA Service Company . . . AARON NEWMAN has been appointed chief engineer of Lafayette Radio's 1st division . . . JAMES A. HANAN is now manager of the international division of Centralab, a division of Globe-Union, Inc. . . . Conrac, Inc. has named CHARLES V. DICKMAN national sales manager for the firm's "Fleetwood" products . . . The appointment of F. J. VAN POPPELEN as sales manager of Motorola's semiconductor (Continued on page 103)
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January, 1959

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January, 1959

Desk RN-25
"Just being called a Field Engineer—an impressive title for a man without a degree—that really gives me a lift."

This is Jim Pieratt talking. With a high school education and Navy Technical training behind him, Jim holds a key job in one of America's most important electronic projects. He's an IBM Computer Units Field Engineer on Project SAGE.

Jim is 25, lean, crew-cut and soft-spoken. He smiles modestly when you ask him about his accomplishments.

"The truth is that I didn't become interested in electronics until I joined the Navy," says Jim. "Before that, the only technical thing I might have done was to take a couple of alarm clocks apart. I chose electronics in the Navy because I thought there was a future in it."

Change of attitude

"A lot of fellows may think, as I did, that a computer is too complicated for anybody but an Einstein to understand. It's not so. Even the largest computers like SAGE, which occupies space equivalent to a city block, can be comprehended by the ordinary man. But I didn't know this when I went for my employment interview—and I wondered if the algebra and trig I'd taken at Kalamazoo Central High would qualify me. Then my interviewer told me a little about computers... how they work and what my job would be after I finished IBM school. I made up my mind right then; I wanted this job."

Training school

Soon, Jim and 21 other fellows like himself started training in Kingston, New York, getting on real intimate terms with IBM's electronic giant. Marvel of complexity though it is, when it sits on the floor and you study it part by part, the computer loses its mystery. Little by little, you begin to understand the whole from the sum of the components.

"The 25 weeks I spent in training were very happy," says Jim. "It's interesting all the way. They encourage you to think for yourself and you're rewarded for your effort. Field Engineers can merit salary increases based on school performance."

Strategic job on Project SAGE

Jim is stationed in Virginia, near Richmond. His duties include installing, checking and testing out computer units. The giant electronic computers are the very heart and mind of Project SAGE (Semi-Automatic Ground Environment). To the input section of the computer comes data from radar sites, ships, reconnaissance planes and ground observer posts throughout the country. The display consoles give a visual representation of the complete air defense situation. Jim's prime responsibility is to keep the display consoles running.

8 pleasant hours a day

"I'm essentially my own boss and I'm encouraged to think for myself. For me, this is an ideal environment."
What do I like best about my job? Trouble-shooting, I think. I enjoy being able to repair anything that isn't working properly. As a Field Engineer, I have opportunities to assume other engineering functions. For instance, while I have nothing to do with design engineering, I do suggest changes for review by the Design Engineers. I also rewrite engineering procedures."

Where do you go from here, Jim?
"There's plenty of room for me to grow at IBM. My next step up should be to Systems Engineer. This calls for more headwork. After that, if I display enough initiative, I may become a Group Supervisor."

Family, friends, recreation
Jim, his wife and three-year-old daughter live in a pleasant ranch home, just a few miles from the site. Social life? "We've made quite a few friends here," says Jim. "Mostly among the IBM fellows and their wives. We play golf together."

Where do you go from here?
Can you look ahead, as Jim Pieratt does, and see yourself as a man on the way up? Maybe you should give some thought to IBM Military Products and the Project SAGE program. Opportunities are greater than ever. IBM's long-range program will continue to grow in importance and vast sums will be invested in hiring the right men to accomplish its vital objectives.

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.

WRITE TODAY TO:
Mr. N. H. Heyer
Dept. No. 650A
Military Products Division
IBM Corp., Kingston, N. Y.

You'll get a prompt reply. Personal interviews arranged in all areas of the United States.
Dave Garroway, NBC-TV star, tells his viewers to replace their old antennas with T-W's.

Let Garroway show you

...how CHANNEL MASTER promotes antenna replacements on network TV, in national ads

There are millions upon millions of over-aged, obsolete antennas in use today — providing weak TV reception for their owners. **These antennas must be replaced immediately** — and that's just what Channel Master has been telling the public in a no-punches-pulled ad campaign. We're also telling them that the best way to get good, clear reception and more years of peak performance is to replace their old antennas with Channel Master T-W's — the world's most powerful and largest-selling fringe area antennas.

We've wheeled advertising's Big Berthas onto the firing line for this campaign. Leading the barrage is Dave Garroway on his "Today" show, with 134 NBC-TV stations from coast-to-coast. This is the first time that network TV has ever been used to advertise antennas. A battery of 6 top consumer magazines — LIFE, SATURDAY EVENING POST, LOOK, TV GUIDE, FARM JOURNAL and PROGRESSIVE FARMER — also takes aim on the antenna replacement target.
Tame the Toughest TV Replacement Spot with a Mallory Gem Capacitor

This circuit should be familiar—half of a 6SN7 serving as the horizontal oscillator in a typical TV receiver circuit. The marked spot in the diagram is a tough assignment for a capacitor. If it opens, you lose raster. If it changes capacity, or if the replacement is beyond tolerances, the horizontal sweep will not sync in.

When replacing this capacitor, always use a Mallory Gem. It's moisture-proof—won't drift in capacity or internal resistance. Conservative voltage ratings guarantee reliability—in this, or any circuit. Get Gems today from your Mallory Distributor in the handy 5-pack.

FP Capacitors—the original 85°C filter
Sta-Loc Dual Controls—tailor-made in 30 seconds
Gold Label Vibrators—unequaled performance and life
RMC Discaps—world's leading ceramic capacitors

Depend on Mallory components for service

January, 1959
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How to save 77 years

The boy Galileo sat in the sanctuary of Pisa's great cathedral, observing the movement of a lamp which had been set swinging by a sudden gusty draft. The chain by which it was suspended from the high ceiling was of such a length that the arcs decreased but slowly. Strange thing, though. No matter how far the pendulum swung, its movement consumed the same time. Galileo made a note of that. The year was 1581.

The old man sat at his writing desk, sixty years and a thousand disputes later, writing down a new theory. The regularity of a swinging pendulum might be combined with a spring mechanism to improve the unreliable clocks of that day. So Galileo scribbled on, and did nothing more about it. A number of years after his death Huygens took the notes and invented the pendulum clock. Seventy-seven years had elapsed since the boy made the observation upon which it was based!

The creative thinker today still need not have a specific use in mind when, by equation or formula, he branches off from the accepted to the hitherto unknown. The classic invention of this decade, the transistor, evolved in the Bell Telephone Laboratories as scientists sought a deeper understanding of semiconductors. On the other hand, another great invention, the feedback amplifier, came from the acutely creative mind of one Bell engineer faced with a specific problem.

Current Bell Laboratories activities—in such areas as data transmission, radar and submarine cable development—call for the coordinated efforts of all types of thinkers and all types of approaches. One type complements another.

Today, seventy-seven years would not have elapsed between the swinging lamp and the swinging clock pendulum—certainly not at Bell Labs, where ideas, though not rushed, are carefully advanced toward fruitful application in national defense, industry and communications. An important part of this harvest is the efficiency of America's telephone service, unequalled anywhere else in the world.
TV TO JOIN TELESCOPES IN STRATOSPHERE BALLOON FLIGHTS—A new role for television in high-altitude astronomy is now being blueprinted by the National Science Foundation and the Office of Naval Research. The program calls for linking of a TV system to remote-controlled balloon-mounted 12 and 36-inch telescopes which will probe celestial objects 80,000 feet above the earth.

THREE-DIMENSION RADAR DEVELOPED FOR ARMY—A three-dimensional transistorized radar which detects airborne targets at extreme range and for the first time simultaneously computes distance, bearing, and altitude, has been announced by the Department of the Army. Called "Frescanar", the new technique, developed by the Hughes Aircraft Company, Fullerton, California, is the eye of a "missile monitor", an Army air defense guided-missile fire distribution system for mobile use with a field army. Citing five basic advantages of the system over conventional radars, Army spokesmen said that "Frescanar" concentrates all available power in sharp pencil beams of energy flashing on and off in fan-shaped array to pinpoint targets at great distance with extreme accuracy; uses a single antenna and operator—conventional systems need two or more radars, operators, and master consoles to achieve similar results; computes range, bearing, and altitude at the same time; provides greater speed—all three types of data (range, bearing, and altitude) are transmitted to missile batteries, helping them to direct missiles on targets more rapidly; and sees targets more clearly. For more information and pictures, refer to page 69.

NO PAY-TV APPLICATIONS FILED THUS FAR WITH COMMISSION—According to FCC Commissioner Robert T. Bartley no request for subscription TV service has as yet been received in Washington, and it appears as if the whole problem will have to be resolved by the Congressional committees now investigating the situation.

N. Y. INDUSTRIAL ELECTRONIC FIRMS CITED FOR LICENSE-INTERFERENCE VIOLATIONS—Two New York industrial electronic companies specializing in r. f. heating equipment have been ordered by the FCC to cease and desist from violating Part 18 of the rules by operating equipment which is neither licensed nor certified by a qualified engineer or the manufacturer and which is causing interference to TV and radio service in the New York City area.

CLOSED-CIRCUIT TV PROVIDES INSTRUCTION ON GUIDED MISSILES—Telecasting of a two-hour course on guided missiles over a 280-mile closed-circuit has been inaugurated from the U. S. Army Ordnance Guided Missile School at the Redstone Arsenal, Huntsville, Alabama, to the U. S. Army Armor School at Fort Knox, Kentucky. The courses deal with the maintenance of six Army missiles: Nike-Ajax, Nike-Hercules, Corporal, Lacross, Hawk, and the Redstone. Cameras have been set up to make pickups from five locations and provide images to screens that measure 6' by 8'.

STEREOPHONIC BROADCASTING UNDER STUDY BY FCC—The Commission has invited comments on the use of stereophonic techniques by TV, AM, and FM broadcasters. In the past, most test broadcasts have been by jointly operated AM and FM stations in the same locality reproducing the same program on their respective channels. Combination TV-AM or TV-FM broadcasts are now being demonstrated. Also a limited number of FM stations are experimenting under a developmental authority granted by the Commission, with dual FM channel transmission—one on the regularly assigned channel and the other on a multiplex subchannel. In this system only one receiver is required but a special adapter is necessary to extract the sound from the multiplex subchannel.
The familiar RCA carton is the hallmark of a quality repair job.

You know, yourself, how comforting it is to see a familiar face among strangers. Well, to the majority of your customers, TV is strange, too. They don’t understand it. They count on you to “keep ’em going”. And, the “familiar face” is the famous RCA monogram. When they see it on that famous red/black carton, they know you know your business...and use the best replacement tubes and parts money can buy.

You can cash in on the built-in prestige of RCA. Make this best-known name your stock-in-trade. Your Authorized RCA Tube Distributor handles a complete line of RCA Tubes to meet your service needs.
NEW STEREOPHONIC EQUIPMENT

HFS5: Stereo Dual Preamplifier is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifiers, controls any stereo source—tape, discs, broadcasts. Specially variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate level input in each channel for mag. phono, tape head, mic. Separate hi-level inputs for AM & FM tuner, FM Multioxide. One each auxiliary & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensation. 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/CC108, 6X4. Works with any 2 high-quality power amplifiers such as EICO, HFS14, HFS22, HFS30, HFS50. HFS50. Kit $39.95. Wired $64.95. Includes cover.

HFS1: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—a feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically 14W 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 amplifiers. Kit $99.95. Wired $319.95. Inc. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HFS6: superb new design, Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. Distortion 0.04% @ 20 out. Attractive "low silhouette" design HFS6A KIT $29.95 (w/ power supply) Kit $33.95. Wired $49.95.

HFS61: "Rivals the most expensive preamps" Many new features, AUDIOCRAFT HFS1A Kit $24.95, Wired $37.95, HFS1 (with power supply) Kit $29.95. Wired $44.95.

MONAURAL POWER AMPLIFIERS (use for Stereo)


HFS65: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer, identical in every other respect to HFS60, same specs at 50W. Kit $57.95. Wired $87.95. Cover E-2 $4.50.


MONAURAL INTEGRATED AMPLIFIERS (use for Stereo)


HFS3: 30-Watt Integrated Amplifier. Kit $57.95. Wired $89.95. Both include Cover.


HFS12: 12-Watt Integrated Amplifier. Kit $29.95. Wired $49.95. Both include Cover.

HFS2: 2 Watt Amplifier with complete factory built Jensen 3/4" speaker, Jensen compression driver exponential horn tweeter. Smooth Clean bass, crisp extended highs. 70-20,000 cps range. Capacity 25 w. 9 ohms. HFD: 11" x 23" x 9". Wiring time 15 min. Price $139.95.


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NEW! RF SIGNAL GENERATOR #324

 WIRE 200,000 mc sweep output for max. accuracy. Fine & Course (3-speed) RF attenuators. RF output 100,000 mc; AF sine wave output to 10 v., 50-ohm output Z, 5-wa jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

COLR ARMONCHER DC TO 5 MC LAB & TV 5* OSCILLOSCOPE #460

Flat from DC-4.5 mc, unable to 10 mc, VERT. AMPL: 5m volts/inch input Z 3 mags; direct-coupled & geared to pulshread. 3-steps coupling between . Mags; 4-step freq-compensated attenuator up to 1000. SWEEP: perfectly linear 1000 mc-100 kc (ext. cap. for range to 1000); preset TV & H positions; auto sync. amp. & lim., Poly. TLF. direct or coaxial coupling, flat, or variable inputs; edge-lit engraved Lucite screen; dimmer; selector fits all phone-ends. High intensity trace CRT, 0.66 usec rise time. Push-pull bias, flat to 900 kc, range 0.5 mvs/min. Built-in volt. calib. 2-Amps mod. save: top 400 mc output. Line control. Baskets: blanking. Phasing control. 1" PUSH-PULL Oscilloscope #470. Kit $34.95, Wire $129.00.

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 Kit Wired $29.95 $49.95

Self-turn of probe tip selects DC or AC-O.m.s.
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RADIO & TV NEWS
By DAVID SASLAW
Amperex Electronic Co.

INDUSTRIAL TUBES & THEIR USES

The growing industrial electronics field relies on special electron tubes designed to do special jobs.

NOWADAYS the magic words in the electronics industry are "transistor" and "micro-miniaturization." Mere mention of these words induces visions of miniature components going into miniature equipment having miniature power requirements. However, this is only part of the picture; a more detailed examination of the industry reveals a strong upsurge in the use of large electron tubes which go into massive industrial equipment having correspondingly high power requirements.

At first glance it is hard to understand how these apparently contradictory trends could be part of the same picture. The connection becomes clear only when we realize that the large tubes are an essential part of the production machinery used to produce transistors. In truth the transistor could not have been developed to its present state if it had not been for the prior development of large industrial tubes.

For instance, one of the obstacles which faced the would-be transistor manufacturer was to produce, in quantity, germanium crystals pure to within a few parts in a billion. It was not until specialized induction heating equipment was developed that large scale crystal growing became a reality. In turn, the induction heating equipment could not be developed until suitable industrial tubes were available.

Let us not forget, however, that these advances in industrial electronics are relatively recent. Despite this the electronics industry has done a tremendous amount to further automation technology by developing tubes and circuits to control production machinery and also by developing tubes and circuits to increase the efficiency of the industrial processes. In fact, it is through processes such as induction and dielectric heating and ultrasonics that the extent of the upsurge in the use of large tubes can be measured. For example, in the case of the ultrasonics industry, commercial volume in 1957 exceeded about $25,000,000, up from practically nothing several years earlier. It is predicted that within a few years sales may top $100,000,000.

As for induction and dielectric heating, the volume of industrial equipment sales has increased from about $185,000,000 in 1954 to over $300,000,000 in 1957.

This rapid growth, in conjunction with its relative newness, makes the field of electronics of special interest to the technician. Although most of the present equipment is serviced by the manufacturer, the trend is away from this type of arrangement and towards servicing by individual companies within the neighboring area. This is one place where the independent TV and radio technician, if he is alert, could find additional business income. To succeed he must understand the general scope of the field, the types of tubes and where they are used, and
be able to identify the different types of equipment.

**What Is an Industrial Tube?**

Before going into the specific uses of high-frequency energy, we should get some idea of what an industrial tube is. After all, the tube is really the heart of industrial high-frequency equipment. In reality there are two operating conditions which clearly separate the industrial tube from other similarly rated tubes. These are: 1. The industrial tube works into loads which vary widely in impedance. 2. The industrial environment includes constant vibration plus large intermittent shocks.

In the early development stages of high-frequency equipment, communications tubes were used because they were immediately available and nominally satisfied the frequency and power requirements. However, it soon became obvious that many of these tubes wouldn't hold up in industrial service. The first approach to solving the problem involved decreasing the length of the tube elements to improve mechanical strength. This still didn't do it. The problem wasn't fully solved until the tubes were designed to withstand overloads on the anode and grid caused by the varying load impedances. It was at this point that industrial tubes became really different from communications tubes. Massive graphite anodes were incorporated in the radiation-cooled tubes and very heavy copper anodes in water—or forced-air-cooled tubes. Naturally the grids were made proportionately heavier too. The result is that for an equivalent power and frequency rating, the industrial tube is larger and more rugged than the communications tube. Table 1 lists some r.f. oscillator triodes and mercury vapor rectifiers used in various industrial applications.

Of all the applications of industrial electronics, induction and dielectric heating, and ultrasonics represent the greatest potential to the technician—they are new enough for him to get in on the "ground floor." In addition, circumstance is working in his favor since all three fields use similar high-frequency generators to power their working elements. By becoming familiar with the type of generator used in one field, a good insight is gained about the generators used in the other two.

Electronic generators are built with outputs ranging from a fraction of a kilowatt to several hundred kilowatts. However, no matter what the power output, the generator always contains both a rectifier and an oscillator section. Mercury vapor tubes are usually used in the rectifier section to provide the high-voltage d.c. used by the oscillator. The oscillator tube, in a suitable circuit, produces the required high-frequency energy.

Most industrial oscillator circuits are adaptations of the Colpitts and Hartley

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**Table 1. R.f. oscillator and mercury vapor rectifier tubes are listed here along with some of their applications.**

<table>
<thead>
<tr>
<th>TUBE TYPE</th>
<th>PLATE POWER OUTPUT (watts)</th>
<th>FREQUENCY (mcs)</th>
<th>Induction Heating</th>
<th>Dielectric Heating</th>
<th>Ultrasonics</th>
<th>Power Rectifier</th>
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<tbody>
<tr>
<td>833A</td>
<td>1600</td>
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<td>6159/4-125A</td>
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<td>—</td>
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<tr>
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<td>X</td>
<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>

*Higher frequency operation possible at reduced power output.*

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**Laminating press ready to bond inside panel of automobile door.**

**Oscillator for large dielectric-heating plastic laminating press.**
circuits shown in Fig. 2. These circuits are essentially class C amplifiers in which part of the output power is fed back to the input to create the drive. The output power is coupled to the load by either inductive or capacitive action. The inductive coupling is achieved by making the work coil part of the output tank circuit. Capacitive coupling is accomplished by using a portion of the voltage across the tank circuit to develop an electrostatic field in the load.

In general, industrial oscillator circuits are extremely simple to service although the high energy used does create special problems. The main difficulty for the technician will be his lack of familiarity with the effects of varying load impedances. This is of special significance because the variations are very large; as much as 50% from the beginning of an operating cycle to the end.

Induction Heating

As early as 1900, attempts were made to heat metals by inducing currents in them through the medium of a magnetic field. Many of these attempts were successful, but because of technical difficulties, the process remained essentially a laboratory production. In the period from 1930-1940, advances in radio engineering laid the groundwork which made it possible for induction heating to come out of the laboratory. The high-frequency, high-voltage radio tubes developed during this period were not actually successful for industrial applications, but the differences involved ruggedness rather than basic design. It didn't take long for the tube designers to make the required changes and for industry to find still more applications for the new tubes.

Before going into the applications, we should get some idea of how induction heating works. The process basically consists of inducing current in the work piece by placing it in a varying magnetic field. The induced current acts the same as any other current to produce heat as a simple $I^2R$ function. In magnetic materials eddy current losses do the heating while in magnetic materials it is a combination of eddy current and magnetic hysteresis losses. Both these quantities are affected by frequency, but hysteresis losses vary directly with frequency while eddy losses increase as the square of frequency. Since induction heating generators usually operate at fairly high frequencies, the hysteresis losses become insignificant in relation to the eddy current losses. Also, because eddy current losses increase as the square of frequency, it might be assumed that the heating action would increase by the same ratio. Unfortunately, this is only true at the lowest frequencies. Table 2 indicates the power and frequency range usually used in induction and dielectric heating and ultrasonics.

An additional effect of frequency is that the depth of current penetration

January, 1959

COVER STORY

AUTOMATION, and the role played by the electronics industry in achieving it, has been in the news so much of recent years that another story about it hardly creates much interest. On the other hand, a story about the continuing need for hand craftsmanship by an electron tube manufacturer, presumably a prime mover in the trend towards automation, is both interesting and newsworthy. The cover picture illustrates just such a situation at the plant of Amperex Electronics Co., Hicksville, Long Island.

The intricately contoured glass bulbs of many large electron tubes are still shaped by essentially the same methods used in the early days of tube production; that is, by means of hand-held tools manipulated by a skilled operator. The cover photo shows a craftsman shaping the bulb of a modern industrial triode, Amperex Type 5771, using only the paddle in his left hand. He presses the paddle against the flame-softened glass, slowly changing the contours until the desired shape is reached. Working as fast as the process will allow, it takes him fully 20 minutes to shape each 5771. Rotating at the same speed as the envelope are the tube's elements at the right. Our photographer's flash and fast shutter speed "froze" the rotation.

Examination of the finished tube leaves no doubt that a great deal of skill is required to produce its complex shape with precision and speed. But skill is not enough; there are so many differently shaped tubes made today that wide experience is also necessary. For example, Tom Fagan, the operator shown in the cover photo, has been shaping glass at Amperex for more than 20 years. In addition, his crew (Tom is the foreman) averages 10 years' experience per man. This heavy concentration of experience is no accident however, it

The various stages of tube construction. (1) the glass bulb, (2) the metal tube elements, and (3) the assembled tube with its glass-to-glass seal after evacuation of all the gas.
By examining these applications we can draw some conclusions about the type of generator needed for each category. In metal processing only the surface is heated. This requires relatively high frequencies, the exact frequency depending upon the penetration required. See Fig. 1. On the other hand, the amount of power required depends on both the depth of penetration and the material. For instance to case harden steel shafts 1¼ inch in diameter, to a depth of 0.030 inch requires a 25 kilowatt generator.

The power required for metal joining is roughly the same as for processing (see Table 3), but the operating frequency may be higher. For instance, frequencies up to 3 megacycles are used to seam-weld copper tubing. The power needed for metal melting varies widely from much greater than to about the same as the other areas. The much greater power is explained by the large mass of metal normally melted in an induction furnace. However, a recent application such as the zone refining (crystal growing) of silicon for transistors requires only a 10 kilowatt generator operating at 4 megacycles.

In general, then, it can be said that most induction heating generators operate in the frequency range from 10 to 500 kilocycles with some new applications going up to 4 megacycles. Also the most commonly used size is 25 kilowatts, although there are applications which require up to 1200 kilowatts.

Dielectric Heating

Dielectric heating, like induction heating, is also a by-product of the
A Compact, Low-Ripple Radio Battery Eliminator

Simple power supply replaces "A" and "B" batteries without introducing hum.

By WILLIAM V. LOEBENSTEIN

As long as there are battery-operated radios there will always be a certain species of individual who will not rest until he has successfully eliminated the batteries. The reason there isn't doesn't exist because of the high degree of filtering that must be attained in order to eliminate hum caused by line frequency. Doing away with the "B" battery is relatively easy. The current drain is small and normal RC filtering is adequate with a conventional power supply. The real problem arises in trying to eliminate the "A" battery because the current is relatively high and the filaments through which it flows serve also as the cathodes which are extremely sensitive to hum. A filter of the conventional LC or RC design, with sufficiently low ripple voltage to be acceptable, would be prohibitively expensive and quite bulky to say the least. An extremely versatile network and one which is all too often overlooked is the parallel-T filter. It fits the bill perfectly in this application.

Electrifying the battery radio could have been accomplished by rewiring the tube sockets and replacing the tubes with others of similar characteristics but with indirectly heated cathodes. One excellent example which the author has seen described utilizes a very satisfactory arrangement in that there is no need for a separate a.c.-operated power-supply chassis. In the present instance an auxiliary chassis is required for the composite power supply, as shown in Fig. 1. A distinct advantage, however, is the fact that the radio itself has not been modified in any way. In other words, while its versatility has been increased through complete electrification, the power pack can be disconnected and the batteries re-installed in less than two minutes!

The set for which the power supply was designed is an RCA Model BP-10 "Personal Radio" powered by one 6T1/2 volt Minimus "B" battery and one 1 1/2 volt flashlight-type "A" battery. Its tube complement consists of a 1R5, a 1R4, a 1S5, and a 154. By placing a milliammeter in series with each battery, in turn, the current requirement was found to be 9 to 10 ma for the "B" battery and about ¼ ampere for the "A" battery. These quantities could have been estimated from the average characteristics of the tubes. This is less reliable than the actual measurement, however, as any experimenter will agree.) Ohm's Law can now be used to replace the radio by two dummy loads until the power supply has been constructed. The example for the case at hand is: 67.5 / 0.0095 = 7000 ohms dummy load for the "B" supply and 1.5 / 0.25 = 6.0 ohms for the "A" load.

Construction of "B" Supply

The "B" supply is shown mounted on the top deck of the chassis in Fig. 1. It is a conventional half-wave rectifier consisting of an isolating transformer, selenium diode, and a single p-section RC filter. The final step in completing the "B" supply is the choice of a suitable dropping resistor to place in the filter circuit. Again Ohm's Law came to the rescue. The capacitor-input filter would charge to peak if it weren't for the internal impedance of the rectifier. Peak voltage is equal to the transformer high-voltage secondary multiplied by y2 or about 165 volts. The internal impedance of the 65 ma. selenium rectifier is about 500 ohms (assumed to be all resistive). The total resistance of the circuit is equal to the sum of the load resistance, the internal impedance, and the unknown filter resistance R. Remembering that the current is about 10 ma, we have:

\[ 7000 + 500 + R = 165 \times 0.01 \]

or:

\[ R = 9000 \text{ ohms} \]

Therefore, a resistance of this value was used and found to be about right.

Parallel-T Filter

Before continuing with the "A" supply, it would be well to consider the basic circuit of the parallel-T filter. A comprehensive solution for the general (Continued on page 148)
A TRANSISTORIZED TACHOMETER

By RICHARD H. SMALL
and
M. MICHAEL BRADY

A simple, electronic engine speed indicator, powered by 6- or 12-volt battery, for car driver or boat owner.

All components are mounted on a phenolic board disc fastened to meter terminals.

Fig. 1. Basic block diagram and waveforms of the transistorized tachometer.

Many car drivers or boat owners have a need to measure the speed of their engines and many, out of curiosity, find tachometers interesting. Almost all sports cars and a good many power boats are equipped with tachometers which read engine speed in rpm. Automotive tachometers are usually identical to an ordinary speedometer in construction, except that they obtain their mechanical drive from the engine instead of a portion of the transmission geared directly to the drive shaft. Marine tachometers, on the other hand, are often of the generator-indicator type, because the distance between the engine and the instrument panel is usually too great to use a mechanical drive shaft. Both the speedometer-type and the generator-indicator type tachometers require a mechanical drive from the engine. To add such a mechanical drive to an engine is often a cumbersome task requiring at least an extra pulley on the fan belt or an attachment to the distributor.

Another approach to indicating engine speed is to measure the frequency of voltage pulses from the ignition system. Tube circuitry could be used to build such a pulse-frequency measuring device, but the problem of providing filament and plate potentials to tubes almost offsets the advantage of not having a mechanical drive. Transistors, however, can function at low supply voltages and are thus logical devices to use in an electronic tachometer circuit.

The Basic Circuit

The basic block diagram of an electronic tachometer is shown in Fig. 1. The input to the circuit is in the form of low-voltage pulses from the primary side of the ignition coil. In a four-stroke cycle engine, each spark plug fires once every two revolutions of the crankshaft. If the engine has six cylinders, there is a total of three plug firings per revolution; if the engine has eight cylinders, there is a total of four plug firings per revolution. Each plug firing is produced by the opening of the breaker points in the primary circuit of the ignition coil. The direct relation between pulses-per-second from the primary of the ignition coil and engine rpm is: \( f = CN/120 \) where \( f \) is the pulse frequency, \( C \) is the number of cylinders, and \( N \) is the speed of the engine in rpm. For a two-stroke-cycle engine, each plug fires once every revolution of the engine, so this relationship becomes \( f = CN/60 \). The input to the tachometer circuit can then be regarded as pulses of frequency \( f \).

Because the low-voltage pulses from the breaker points are not perfectly square and may contain a good deal of noise and extraneous signal due to point contact bounce, a low-pass filter is needed at input to the tachometer to remove signals above the highest frequency expected. The pulses from the output of the filter are then amplified and clipped in an overdriven voltage amplifier and fed to a pulse counter circuit. The output of the pulse counter is a pulse train of total volt-time area...
directly proportional to the pulse frequency of its input. The output of the counter is then amplified and fed to some integrating indicator device.

**Circuit and Its Operation**

The schematic diagram of the transistor tachometer for negative-ground electrical systems is shown in Fig. 2. This circuit is designed for operation on six or twelve volts, as indicated on the schematic. The circuit functions in exactly the same manner as the block-diagram circuit of Fig. 1. The input low-pass filter is formed by resistors R1 and R2, and capacitors C1 and C2. The values of these components are chosen so that the filter attenuates above 350 cycles, which corresponds to an eight-cylinder engine speed of 5250 rpm. If a maximum tachometer indication of greater than 5000 rpm is desired, then appropriate values should be chosen to provide a high input cut-off frequency.

Capacitor C3, diode CR, and resistors R4, R5, and R6 form the "pulse counter" circuit. The function of the counter is to convert constant-amplitude square pulses into constant volt-time area exponential fall pulses. The effective counter circuit is shown in Fig. 3. The transistor driver-clipper, Vn, is represented by an equivalent square-pulse generator in series with an internal resistance R1, the diode CR being represented by a potentiometer. With the input pulse edge of an input square pulse, the diode CR, conducts and capacitor C, charges almost to the peak value of the input pulse in a time determined by the relatively short time-constant R4-C1. Without the input pulses, the output drops to zero with the fall of an input pulse, the diode CR blocks and capacitor C discharges through the output resistance R5 (R5=R1 in Fig. 2), with a rate of fall determined by the time constant R1-C1. In this manner the output of the circuit is an exponential fall pulse for each square pulse input.

The second transistor Vn serves as a current amplifier to amplify the input pulses which are then integrated by the meter M. Capacitor C2 aids the integrating properties of the meter at low pulse frequencies.

Meters M can be any standard 500 microamperes to 1 milliamperes meter. The meter used in the unit shown in the photo was removed from a war-surplus aircraft electronic equipment. Because the meter must be re-calibrated in rpm, allowing meter scale is advisable. A convenient scale conversion would be to use a 0-500 microamperes meter scale for a 0-5000 rpm tachometer.

The component parts used in the circuit are standard miniature transistor-circuit components. All resistors are ordinary 1/2-watt carbon units, while the potentiometer, R5, is a miniaturized unit. Capacitors C1, C2, C3, and C4, are miniature 200-volt units intended for printed-circuit transistor work. C4 is a miniature electrolytic with a 6 working volt rating. Transistors V1 and V2, are ordinary n-p-n audio-frequency transistors. The operation of the circuit is such that the over-all parameters of transistors are not of prime importance; almost any inexpensive transistor will perform the function well. The counter diode CR, is an ordinary germanium diode. The entire circuit can be mounted on a phenolic board and fastened to the meter terminals, as shown in the photo.

**Calibration and Operation**

The unit may be calibrated so that the meter reads full-scale for any desired input frequency. As an example, a six-cylinder engine full-scale deflection of 500 microamperes could be set to correspond to an input pulse frequency of 250 pulses-per-second, or an engine speed of 5000 rpm. The unit should, of course, be calibrated using a pulse generator with a known pulse frequency output. For a very accurate calibration, the oscillator should be set in such a way that further increases in amplitude do not affect the reading of the meter M. The circuit is then operating on the positive peaks of alternate half-cycles of the oscillator output.

The potentiometer, R5, should be adjusted to give full-scale deflection of the meter for the computed maximum frequency corresponding to the desired full-scale rpm reading. Two or three other points should then be checked to determine if the meter reads linearly with input frequency.

The basic circuit of Fig. 2 may be modified in many ways to improve performance and increase the accuracy of the rpm indication. The regulation of the electrical-system voltage in most cars and boats is fairly good except when the engine is idling and the battery is discharging heavily. The pulse counter of the tachometer circuit is partially sensitive to changes in input voltage. If the quiescent output voltage of transistor V2 is not constant, then the tachometer will be in error by an amount proportional to the percentage variation from the normal quiescent voltage at which the unit was calibrated. The input voltage to the counter can be held constant by using a regulator diode (CR, in Fig. 2). The diode in the unit shown is a silicon Zener diode (diode operated at its breakdown voltage in the reverse direction) with a Zener voltage of about 4.5 volts. Many semiconductor manufacturers make Zener diodes; the one in the authors' unit is a National Semiconductor 1N468.

In operation the entire unit draws less than 2 milliamperes from its power source and, in addition, requires no mechanical connections to the engine. The electrical connections are simple: one ground, one power lead from the ignition switch, and one signal lead from the distributor breaker points. The wide variety of meters and components available makes the unit readily adaptable to almost any dashboard or instrument panel layout. The authors have mounted their units in the space provided in the dashboard for the installation of a clock. The cost of the unit is relatively small compared to shaft-drive or generator-indicator types of tachometers. It should have a life expectancy limited only by the life of the transistors used.

![Fig. 2. Complete diagram for negative-ground system. See note for positive ground.](image-url)

![Fig. 3. Effective pulse counter circuit.](image-url)
STEREOPHONIC sound can now be enjoyed without lavish outlays for equipment, as this article will prove. The stereophonic sound system to be described can easily be built by anyone who has ever made a radio or audio amplifier.

The audiophile who considers any speaker costing less than $100 inferior may not appreciate this system since the amplifier and speakers together in this setup cost less than this sum.

The author had been enjoying long-playing records using an old changer and a good fidelity amplifier unit. Then the new stereo records became available and the problem of how to take advantage of this sound “bonus” without spending a small fortune cropped up. After looking at various units and reading many articles on the subject, the author designed this particular system with two thoughts in mind. The first criterion was good stereo sound rather than a system having fancy specifications and the second was to keep costs at a minimum by using parts on hand where possible. Both objectives were met.

The Pickup

The stereo cartridge selected by the author was the Columbia CD compatible stereo cartridge, Model SC-1. It was installed in the tone arm of the old changer with a second shielded cable (supplied with the cartridge) added for stereo. The arm was first balanced to have zero weight since the cartridge weight provides the proper tracking pressure. This was done by adjusting the spring load, but may be accomplished with lead weights on the rear of the arm. A pressure gauge can be used to verify the recommended stylus pressure of 5 to 7 grams.

The Amplifiers

The dual-amplifier was then built using the circuit of Fig. 3. One power supply feeds both amplifiers, and uses an old TV power transformer. Such a transformer is easily obtained and pro-
vides high current with good regulation. The amplifiers are identical. The 7025 (the low-noise version of the 12AX7) was chosen for its low inherent noise and hum level and the 6BQ5 for its high gain. The first stages (6C4's) are included to take care of possible low-level inputs, but since a high-output-cartridge was used (the Columbia SC-1 is rated at 0.4 volt) sufficient gain is derived in the 7025 stage to drive the 6BQ5's. Thus, with this type of cartridge, a further cost-savings can be effected by eliminating the 6C4 stage of each amplifier. No shielding was found necessary due to the short leads from the two-channel, separated layout. The heater leads to the tubes should be twisted all the way and the heater ground should be made at the 6C4 end. If hum level should prove objectionable, an aluminum mesh cover can be used on the bottom of the chassis. Oscillation or motorboating may occur in either amplifier and, if so, the blue and brown leads of the output transformer involved should be reversed.

All resistors and capacitors should be chosen for small physical size since space is at a premium in the front end. All potentiometers are small 1/2-watt units. Considerable saving was effected by using Merit #2904 output transformers. They are rated at 18 watts and exhibit very satisfactory response in this circuit (run within 10-watt rating).

The purpose of the 200-ohm, 20-watt resistor between the 5U4GB and filter choke is to adjust plate voltage to within 6BQ5 ratings. They operate at about 300 volts. This will vary with different power transformers so that, in some cases, a larger resistor may be needed. Rs, Rs2, Rs4, Rs6, and Cs1 provide equalization for the SC-1 cartridge. If a different cartridge is used, these values should be changed to conform to the manufacturer's suggestions.

The positions of the line switch, input jacks, and pilot light (the latter is not shown in the schematic) were chosen only for convenience in the author's built-in cabinet and may be relocated for each individual case, taking care to keep the leads from the jacks to the tubes short and the 117-volt a.c. leads away from the high-gain inputs.

Little further need be said about the amplifier circuits, since they are straightforward. Figs. 1 and 2 show the parts layout. Except for keeping leads short to avoid the necessity for shielding, the parts layout is not critical. Be sure to place the power transformer so that its windings are at right angles to the output transformers to prevent induced 60-cycle hum, since they are close to one another.

The Controls

Referring to the circuit diagram (Fig. 3) and the front-view photograph (Fig. 1), there is a single master gain control for both channels. This control is Rs, Rs2, a dual potentiometer, shown (Continued on page 104)

Fig. 2. Here is the complete schematic diagram and parts listing for the dual 16-watt stereo power amplifier. The circuit is designed to accommodate a ceramic stereo cartridge. If a magnetic cartridge is to be used, a preamp with proper equalization would be needed. In this case the RC networks across the input jacks must be removed. A 6-volt pilot lamp may be wired across heater supply.

Rs, Rs1—100,000 ohm, 1/2-watt pat.
Rs2, Rs3—1 megohm, 1/2-watt dual linear-taper pat.
Rs4, Rs5—50,000 ohm, 1/2-watt linear-taper pat.
Rs6—600 ohm, 1/2-watt res.
Rs7—1 megalohm, 1/2-watt res.
Rs8—150 ohm, 2-watt res.
Rs9—1000 ohm, 2-watt res.
Rs10—700 ohm, 2-watt res.
Rs11—200 ohm, 2-watt adj. res.
C1, C4—.002 mfd., 600-volt disc ceramic capacitors.
C2, C3, C5—.01 mfd., 600-volt disc ceramic capacitor.
C6—.05 mfd., 600-volt disc ceramic capacitor.
C7—.02 mfd., 600-volt disc ceramic capacitor.
C8—.001 mfd., 600-volt disc ceramic capacitor.
C9—.003 mfd., 600-volt disc ceramic capacitor.
C10, C11, C12—450 mfd., 450-volt electrolytic capacitors.
S1—S.P.S.T. switch.
J1—RCA-type phone jack.
CH1—2-kΩ, 200-ma. filter chokes (Author used a TV choke, Merit C1874 or equiv.).
T1—Universal output trans, 4000/7000/8000/10,000/14,000 ohms cts. to 777 to 32 sec. (Merit A-2904 or equiv.)
T2—Power trans, 350-0-350 v. @ 200 ma, 5.0 v. @ 3 amps, 6.3 v. @ 4 amps (Triad R20B or old TV transformer can be used)
V1, V2—6C4 tube.
V3, V4—7025 tube.
V5, V6—6805 tube.
V7—5U4GB tube.
S—Screw-down 9-mm oval. (Author used Lafayette SK75)
Airborne Relay for Intercontinental TV

The French Air Force radar-testing "Bretagne" bomber was specially outfitted as an intercontinental TV relay station.

By A. V. J. MARTIN
Carnegie Institute of Technology

THE first successful attempt at using an airborne relay for intercontinental television transmission took place last summer with Africa and Europe the continents involved. Planned and developed by Radio Télévision Française (R.T.F.), this airborne relay was used twice. On July 14th, Bastille Day, programs originating in Algiers were relayed across the Mediterranean to France and telecast over the entire French television system, which covers roughly 80 percent of the country.

On September 4th, General de Gaulle's historic speech inaugurating the Fifth Republic was telecast throughout France and relayed across the sea to the North African television transmitters.

A single plane was used for both transmissions, the waves thus crossing the Mediterranean in two jumps. The first attempt will be described in some detail since both operations were practically identical. The feat becomes all the more remarkable when it is realized that the decision to relay the first program was taken on July 8th—just six days before the actual telecast. Only the video signal was transmitted via the airborne relay system to be described.

The Links

A special transmitter, radiating towards the plane, was set up in Bouzarea. It received the signal through two microwave links, one coming from the control center in Algiers and the other from the Cap Matifou TV transmitter. Two links were used to insure continuity of the program in case of a failure in one of the microwave systems. Actually, no failure occurred.

The special transmitter had a peak power of 500 watts and used an antenna with a gain of 18 db. The antenna was oriented 15 degrees east of true north. The frequency was 173.8 mc. and the polarization horizontal.

This transmitted signal was received by the plane flying in circles of 12-mile radius at an altitude of 20,000 feet. The flight was made within a carefully chosen zone, east of the Balearic Islands. In the plane the signal was demodulated, amplified, and used to modulate a 500-watt transmitter which operated on 212.85 mc. and whose antenna was oriented toward France.

No automatic device could be relied upon to correctly orient the two antennas aboard the plane so two engineers, with the help of the gyro compass, continuously monitored and oriented the receiving and transmitting antennas. In France, again for precautionary reasons, two receiving stations had been installed—one near Marseille and the other in the Black Mountain range. This latter installation was the one actually used. Both receiving stations were linked by microwave to one of the TV transmitters of the national chain. The link used covered 120 miles in a single jump to feed the 200 kw. transmitter covering the southwestern portion of France. From there the program was distributed throughout the country over the permanent microwave-coaxial system that links the thirty-odd transmitters comprising the national network.

The Audio Signals

As mentioned previously, only the video portion of the transmission was relayed over the airborne link. To avoid unnecessary risks and to eliminate over-elaboration of the equipment which had to be carried by the plane, the sound was transmitted over an entirely different route. The audio portion was sent through the trans-Mediterranean submarine telephone cable, then through post office telephone links to Paris—from which point it was distributed over the television chain.

It is the custom in France to telecast on a nationwide basis only such programs as would be of national interest. However, there is a permanent system, called "Eurovision," linking together the national chains of practically all Western European countries. This means that programs of
International interest could be telecast from England to Austria and from Norway to Italy at the flick of a switch. For example, the recent coronation of Pope John XXIII was transmitted from the Vatican via “Eurovision.” Jet planes were used to carry both kinescope and video tape recordings of the ritual to the U.S. for early televiewing.

The French Air Force cooperated in these intercontinental TV transmissions by lending a “Bretagne” bomber, equipped for flight test of radar units, for the project. It had available a 27½-volt, 7 kw. d.c. power supply plus a rotary converter which provided 5 kilowatts of 50-cycle, 117-volt a.c. Because of weight limitations a 500-watt transmitter was considered to be the largest that could be handled.

The receiver was a high-quality commercial model, modified to pass only 7 mc. instead of the 10.5 mc. of the 819-line French picture. The small loss of detail was compensated by an improved signal-to-noise ratio. At 20,000 feet every signal within the frequency range came in loud and clear—radar, beacons, marine traffic, FM and TV stations from Italy and Spain, etc. The reception was considered proof of the advantage of reduced bandwidth in this application.

The video output of the receiver was visually controlled and fed to a sync signal re-generator which reshaped the line and frame sync signals. This completely re-generated signal was then fed to the 500-watt transmitter.

The transmitting and receiving antennas were simple 4-element yagis, connected to coaxial feeders through a bazooka circuit for good impedance matching. They were supported by retractable masts which could be extended to 5 feet below the fuselage after take-off.

The phone link on 77 mc. took care of intercom requirements between engineers on board the plane and in Africa.

The intense field, generated by the transmitter, permeated the entire plane and degraded the accuracy of the navigational equipment aboard. In addition, the engineers found it a full-time job keeping the transmitting antenna in line with the land-based receiving station. For this and other reasons, the signal received in France varied over very wide limits and a sync re-generator had to be brought into operation at the receiving sites. Although the reception was of somewhat varying quality, on the average it was about on a par with “Eurovision” programs originating in countries with 405- or 625-line systems.

These original results were bettered in the September telecast in which the direction of the program transmission was reversed. Previous experience with the airborne relay was of great help and, as a result, the picture quality, as received in North Africa, was decidedly improved ranging from fair to good.

All-in-all it can be said that the experiments were successful—demonstrating to engineers and the public alike the feasibility of such transmissions. These trials now take their place alongside a number of R.T.F. “firsts” which include direct transmissions from submarines, from deep sea diving bells, from caves, coal mines, helicopters, jet test planes, racing cars, etc. Perhaps the day of trans-oceanic TV is not as distant as we thought!

Map at the right shows how signals originating in North Africa were relayed by a high-flying plane to France. Link was also used for signals originating in France and destined for Africa.

January, 1959
SINGLE PUSH-PULL STAGE
FOR BOTH STEREO CHANNELS

By NORMAN H. CROWHURST

Simple simplex-type circuit for stereo does away
with two output tubes and one output transformer.

If stereo can be recorded in a single groove, why cannot it be
amplified by a single amplifier? As with so many questions, this one has
two possible answers: it can't be done; and the people who do it! In this case
the latter are CBS Laboratories, as reported in a paper before the Audio
Engineering Society, jointly authored by B. B. Bauer, W. S. Bachman, J.
Hollywood and G. Maerkle.

The question, "How does it work?", which this article aims to answer, can
likewise be asked with different attitudes: the man who said it can't be
done has objections, and doesn't think it can work properly; while the person
who is unprejudiced just wants to know, in simple terms, the principles
involved, as well as "Does it do a job as good as two separate amplifiers, of
the same, or lower cost, or with the same total output?"

In an ordinary push-pull amplifier, all the tubes and other components of
the push-pull part are in duplicate, and
handle audio exactly the same, except
that one "pushes" when the other
"pulls". For good push-pull operation, both "halves" of the amplifier carry
identical waveforms, except that one
swings up when the other swings down. Usually great care is exercised to
ensure the two halves are balanced so the waveforms really are identical.

But actually a push-pull amplifier is two separate amplifiers, the only tie
together being at the input, or phase inverter, and the output, a push-pull
transformer. Failure to maintain the ideal balance would not cause any
trouble until the two are recombined at the output. So what is to stop each
side of the "push-pull" stage being used for one channel of stereo, instead
of going to all that trouble to get exact identity for just one output? And
when you look at it, the principle is quite simple (although one can always
say that when someone else has already done it!). In fact it's as simple as
making each half carry the modulation from one side of the record
groove in a 45-45 record (Fig. 1).

By now it is well known that, when the two channels work together, as they
do for a center-located sound, the groove moves from side to side without
any change in depth (Fig. 1C). When only one channel carries program, due
to a sound originating from one extreme side, only one wall of the groove
is modulated (Fig. 1A or 1B). And when the two work in opposition, the
groove goes directly up and down (Fig. 1D).

This last condition does not normally happen at lower frequencies, because
it would represent a sound "off-stage". But it can and does happen at higher
frequencies, because the time difference can then amount to several wave-
lengths.

From Fig. 1 it will be seen that the center-located sound gives the normal
push-pull waveform combination, while the out-of-phase condition gives "push-
push". Stereo program would be mono if it only contained the push-pull com-

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Fig. 1. The relationship between various types of grooves on a 45-45 disc and the outputs from the stereo cartridge discussed in the article. Although coils are shown, ceramic elements would produce the same results. (A) and (B) show sound in one channel only, while both channels have equal signals in (C) and (D). In (C) the cut is completely lateral, in (D) it is vertical.

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Fig. 2. The double-matrixing transformers operate push-pull and "push-push", or single-ended, to produce these waveforms.
CHAPTER II (Continued)

Most common stereo cartridges are phased in such a way that lateral motion produces in-phase signals. By simply reversing the connections to one of the pickup elements, the phase conditions shown in the figure are obtained. With 4-terminal cartridges this is simply a matter of transposing 2 leads; with 3-terminal cartridges the manufacturer must provide the required phasing. See Ques. 2.—Editor.)

If one pick-up output were fed into each side of the so-called push-pull stage, and each side had a separate output transformer feeding its own loudspeaker, we should have a couple of separate amplifiers working from a common power supply, of the quality normally expected using single-ended output stages (Fig. 3). The kernel of the new development is the double matrixing (mixing) output circuit that effects an economy in output transformer requirements, and at the same time enables the normal advantage of push-pull output to be obtained.

Instead of using one output transformer for each channel—left and right—separate transformers handle virtually the "lateral", or push-pull and "vertical", or push-push components (Fig. 2). Remember, the out-of-phase condition never normally happens in stereo program at low frequencies, and only stands a random chance of happening at higher frequencies.

The transformer that carries the two plate currents in parallel does not need a good bass response. Thus the normal objection to a single-ended output—loss of bass—is avoided in having the transformer acting single-ended. The CBS paper also claims an advantage in downgrading bass response to the "vertical"—a built-in vertical rumble rejection, that certainly can often be helpful.

The other transformer acts strictly push-pull, and thus is able to have all the qualities of a push-pull output transformer. Now we begin to see where the saving comes in. Only one high quality push-pull output transformer is needed; the other can be smaller and much cheaper. And we need only one push-pull output stage, as regards all the other components, through which to feed stereo program material.

Feedback is taken from the resultant output to the voice coils, back to the cathodes of the driver stage (Fig. 4). This can reduce distortion in either channel (left or right), correct frequency response, and reduce any error in the double-matrixing action of the output transformers.

That about tells the story as far as the principle is concerned. But a new idea like this will start (in fact it has started) some questions, with the idea "Does it really buy all this?". So let's take some of these questions, as a way of exploring the potentialities of this kind of amplifier.

1. You said the push-pull transformer has all the advantages of a normal push-pull output transformer. I can see that the static, or quiescent plate currents will balance and thus maintain its inductance and low frequency response; but isn't part of the function of a normal output transformer to cancel even order distortion from the amplifier? How can this happen when the amplifiers are handling different channels?

This objection would be true for separate, single-ended output transformers (Fig. 3). But with this arrangement, the push-pull transformer only handles that part of the composite program content that is strictly push-pull. The "single-ended" component is handled by the smaller transformer. There is, in almost any stereo material, a dominance of high amplitude lower (Continued on page 116)
Service-Business Problems

By WILLIAM LEONARD

In discussions about the management problems involved in the operation of an electronic service business, it is interesting to observe the growing interest among dealers in the economics involved. The technical facets of service, which once dominated the thoughts of the majority of the independent service dealers, are being gradually eclipsed by the urgent demands for increased income to meet mounting operating and living expenses.

While the operation of a service business follows the pattern of any independently owned retail store in many ways, there is one significant difference: the service dealer must find ways and means to sell time, experience, and transportation costs at a profit.

A retail merchant operating on an average gross profit of forty per-cent is required only to have the needed merchandise on his shelves when a customer comes in to buy it. The major problem of this retailer is to develop enough volume of business at forty per-cent gross profit to cover operating costs, a better-than-average salary for himself, and a profit on his investment.

Assuming that three dollars per hour is a nominal price for the time, knowledge, and skill of an experienced technician, the service dealer who charges five dollars for a home service call gets the same gross profit percentage for his technicians' time as the retailer gets on the merchandise he sells. However, the service dealer has an additional operating cost that the conventional retailer does not have: he must deliver this skilled service to the customer's home. Thus, out of his forty per-cent, he must pay transportation costs in addition to the normal operating expenses of his business establishment.

The dual expense burden of maintaining a business location for the shop and transportation costs to perform service in the home led many dealers into some type of retail diversification as a means of taking a part of the shop's overhead load off the back of the consumer-service phase of the business. While this diversification has helped many dealers to lighten their overhead burden, they still find it necessary to get adequate charges for service work. An analysis of the ten foremost problems in the management of small service businesses indicates that the governing factor in their success is this very ability to get adequate charges for service time and labor.

The first of these fundamental management problems is that of maintaining an adequate volume of profitable business. This means that the gross profit over and above the cost of materials purchased must be sufficient to pay overhead and operating costs, provide the dealer with at least a normal income, and pay a return on the investment in the business. To accomplish all of these objectives, the dealer must make a satisfactory profit on service time as well as the normal profit on the tubes and parts he sells in connection with his service work.

Since a business must be managed if it is to prosper and grow, another dealer problem is that of allocating part of his time and attention to planning and promotion. In order to afford the time necessary to manage his business, he must make an adequate profit on the time he is in the field servicing sets.

One of the most serious problems of service management is that of maintaining an adequate stock of tubes to handle any tube-failure service job in one call. Here the dealer is faced with a double-sided problem. First, he has the investment to consider. A representative stock of tube types including an adequate number of those most-used, will require more money than the average small dealer can afford to tie up in that one element of his business. The second part of the problem is that of handling a tube caddy stocked with all of the numerous types that may be required in home servicing. As one dealer expressed it, "When one of the larger caddies is filed with tubes, it's one hell of a load to carry up three flights of stairs."

The fourth major management problem is that of determining the type of advertising that will produce the best results with the amount of money available for this phase of business promotion. To determine how best to use his limited advertising budget, the dealer should experiment with direct mail, newspaper, cards, and handbills to determine which produces best in his location and community. It takes time and unfeathered thinking to plan and to evaluate results. This time must be paid for out of adequate profits from service calls.

A basic weakness in service management generally has been the failure to pursue consistently a studied promotion program. While word-of-mouth advertising has been the promotional method of most efficiently operated shops, it also is business that can be lost quickly to competent part-timers whose service charges are less than those of full-time shops. There is a marked public preference for dealing with stable, successful businesses. The only way the public can know about a dealer's business is what they see in the appearance of his shop and the manner in which customers are handled by phone and in personal contacts.

In the development of any business, there come times when it is wise to expand and other times when it is best to hold the line. The controlling factor in making the right decisions about expanding or maintaining the status quo is a sound understanding of the economic forces at work in the particular trading area. A service dealer should be personally acquainted with all of the other businessmen in his community to keep informed about what is going on business-wise.

Call-backs, another problem, are usually expensive. In the first place, it costs the dealer money to make them; in the second place, the average custom-timer goes through a period of loss of confidence when it is necessary to call for service shortly after a set was fixed. Some dealers have drastically reduced

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NO HARD and fast rules for wiring TV distribution systems in buildings with coaxial cable can be laid down—but certain generalities apply to practically all jobs. Familiarity with general technique plus a little ingenuity usually produces a specific, successful installation.

One thing is certain—the particular application may modify the layout of the job. The simplest, cleanest, and generally most satisfying approach to a system installation is to be found in a new building where conduit and outlet boxes have been placed as the building was constructed. As long as the conduit layout was made with a specific wiring plan in mind, the work of installation is simple. The only special tool needed is an electrician’s fish wire.

Beware the job however, where the conduit for a TV system has been laid out by an electrician or draftsman who thinks that TV can be wired like a nurse-call system in a hospital. On these you can lose your shirt, since the building owners will insist on concealed wiring and the conduit layout may make it almost impossible. The author recently turned down a 200-room hospital installation because of this. Some runs had cable losses alone over 70 db! This ignorance of TV systems is a good break-in point for the technician who is looking for this type of work. By offering his services on layout of systems to an architect, he can make a friend and write his own specs, thus getting an immediate bidding advantage.

The harder jobs (and also easier ones) will come when existing buildings are being wired. Here is where much money and labor can be saved by a little preliminary cerebration, which is just a high-priced word for “horse sense.”

The first thing to look for is the presence of “dead space”—areas which adjoin those to be wired, but in which it does not matter if the wire is not concealed. Such spaces are basements (unfinished), attics, or “crawl” spaces above or below finished rooms. Such spaces can accommodate feeder cables in the horizontal direction. When wiring is done so that feeders run vertically, “drops” (as in multi-floor buildings), air-vent ducts, elevator shafts, “furring” for pipe or conduit runs, and even closets such as broom closets may be used when these elements are placed one above the other.

When none of these vertically aligned spaces are available, interior wiring can be considered; and then, as a final resort, wiring concealed in special molding may be the answer. Of course the use of unconcealed wiring, always possible, needs no real discussion.

Let’s consider the case where a dead space is available over the ceiling of a building. At first glance, it looks as if the cable could be run across the ceiling joists, down inside the wall, to an outlet of the combined isolation and matching type, then back up to the dead space, across to the next room, down, up, and so on. This can be done. However, in modern frame construction, there will be a “fire stop” between the studs, usually about half-way up, as in Fig. 1.

The purpose of these stops is to prevent drafts from developing in the walls, thus slowing the spread of fire if one should occur. For the technician wiring a building, fire stops are a solid deterrent to running vertical wires in partition walls. If the job must be done, plaster must be broken above and below the fire stop and the stop itself notched to allow cable passage.

In the motel advantage can often be taken of the closet. If the outlet can be placed on a wall that “backs up” on a closet, the cable may be brought through the ceiling of the closet, then through the wall of the closet into the back of the outlet, as in Fig. 1B. Usually there is no objection to the exposure of the cable in a closet as long as none is visible in the room.

When wiring can be done from a basement or crawl space beneath a one-story building, the fire stop is no deterrent. The difficulty here is in locating the points to drill up into the space between the plaster surfaces. The best technique here is to drill a small hole back an inch or two from the edge of the baseboard through the floor—a hole as small as possible, using a bit of about 3/16”. Measure the distance to the face of the wall from the hole, drop a small piece of bright wire through the hole, then locate the wire below the floor. Knowing the distance from this point to the wall surface, add 2" to this measurement and then drill up into the wall. Fishing cable into the opening for the outlet is then no problem.

In either of these two wiring techniques note that the actual cable length has been increased over the point-to-point distances indicated on drawings. In wiring below the floor, an additional 4 or 5 feet may be added.
Multi-Set
TV
Installations

When confronted with this situation, a change in distribution technique may solve the trouble. We have been discussing the type of tap that combines isolation and matching in one container. By using the type that provides isolation in one unit and match in another, the over-all line length can be reduced.

Fig. 3 illustrates such an application. The isolation unit cuts into the line above the ceiling and a single coaxial line descends to the terminating outlet in the room. With this technique, the feeder cable itself remains very close to the length determined by point-to-point measurement. However, the set on a "drop" in such a wiring method sees the isolation loss of the tap-off unit plus the loss in the drop line. A building drop, usually only a few feet, can be neglected; but if some vagary of construction requires any considerable length this loss must be taken into account when determining set levels of signal at the receiver.

The trick of mounting outlets back-to-back when adjoining rooms are being wired should always be considered. Electrical outlet boxes are available that can be set into a wall in such a fashion that both sides are open, and each side will accept a standard outlet. When you are wiring a series of rooms, these can cut the number of descending and ascending cables in half. Fig. 2 illustrates this.

Care should always be taken that coaxial cable does not rest on uninsulated steam or hot-water pipes. The dielectric of these cables softens with heat and the center conductor can then "migrate" away from its central position. This changes the characteristics of the cable, causing a "lump" or discontinuity in the line, which can be a source of reflections. By the same token, cable fasteners should not be tightened excessively, since "cold flow"—a deformation resulting without heat—also occurs. Many jobs must be done in buildings using solid walls, usually cement block but sometimes brick or tile. If the ceilings do not allow access or the dead space is too small to be usable, wiring can be run externally, usually under the eaves, but sometimes buried next to the wall. These cases almost invariably require separated isolation and matching units. Part of a typical installation using this technique is shown in Fig. 4. The closet trick can be used here, also: enter the closet high up, under the eave; then drop down to the appropriate level for the tap on the outside wall of the closet (interior of the room).

This method of installation is peculiarly adapted for existing hospitals, the feeder wires running around the sides of the building at a level just below the windows and drops going in through holes in the walls. The method has the advantage of very little interference with the interior of the building. If care is used, little or no plaster patching need be done. Each opening for a drop should be caulked after the tap is mounted. Use an ordinary caulking gun or the self-applicator types of caulk available in hardware stores.

Hotels pose a special problem, but are usually very easy to wire nevertheless. Practically all hotels have vertical raceways built in, one raceway rising between each pair of rooms. These raceways may be ventilating ducts,
wireways, or pipeways. They are usually "furred" into a column or a wall corner. (The term "furred," in construction work, refers to a false construction to hide a hollow space.) For example, many of the huge columns seen in large, open buildings are not as large as they look—they have been furred out to provide space for ascending and descending services.

When laying out a hotel installation, the wiring is done so that rooms are wired in "columns" vertically, not in horizontal "ranks," along a floor. The feeder lines are usually called "visers" (even though they may run down instead of up!). In nearly all cases, the outlet may be cut directly into the wall of the raceway. The feeder then drops from outlet to outlet. Where cutting the outlet into the wall is ruled out, the isolation tap can be used and a drop run exposed along a baseboard or under the molding to a terminating outlet. It is quite feasible to mix these tap-off units along a line so that one outlet is a combined type and the next the separated type. A peculiarity to note here is that there will be two rooms to each floor on each riser in most cases—watch this when figuring out line losses.

In any case, try to avoid exact periodicity in cutting taps into a line—try to keep a varying length of cable between each tap. When taps are cut in at exactly equal spacings, the small discontinuities caused tend to pile up an error at one frequency, which may result in a "suckout"—heavy attenuation occurring at one frequency or one small band of frequencies.

In this connection, the author recalls a case where some thousands of feet of RG-11 type cable had been run in the forming rolls during manufacture at a time when the forming rolls had picked up a quantity of some foreign matter. This resulted in a slight thickening of the cable's polyethylene dielectric, occurring regularly spaced at a length equal to the circumference of the rolls. This cable exhibited an attenuation of 56 db per thousand feet as compared to a normal attenuation of 38 db—but only at 69 mc. The net result was an impossibly distorted channel-4 picture. This was many years ago—and present-day manufacturers take precautions against such occurrences—but it shows the danger of periodic discontinuities. Practically all manufacturers of coaxial cables today sell, at a slightly higher price, cable that has been "swept." It has been inspected by measuring the results of feeding signals from a sweep generator through it, thus exposing excessive losses at specific frequencies.

The sweeping technique, which is possible for a well-equipped service shop, is illustrated in block-diagram form in Fig. 6. The test is performed by first setting up the equipment as illustrated, but leaving the cable out, and using more attenuation in the variable attenuator than the expected cable loss. Thus a reference pattern can be developed on the scope that is really the combined response curve of the generator and amplifier. This may be recorded on trace A. Now the cable is inserted as shown in Fig. 6 and attenuation is reduced with the variable attenuator until the scope trace returns to the previously recorded height at any given frequency point. The increased attenuation taken out is the loss of the cable, at the frequency involved. Since the curve will change shape, this check may have to be performed at various frequencies, which can be identified by markers. These curves will invariably show a ripple across the tap. As long as the ripple does not exceed 3 db, it can be ignored. Fig. 5 shows some typical curves across a single channel. The amount or depth of these ripples can be estimated closely by noting the amount of attenuation that must be taken out to bring the dip in the curve up to the average level. Two things need to be watched. The amplifier used must have more gain than the normal losses of the cable and care must be taken that the amplifier is not overloaded.

Speaking of amplifiers, certain precautions are to be observed in installing them, the first of which involves safety. These units develop heat and care must be taken that such heat cannot accumulate to cause a fire or amplifier damage. When equipment cabinets are used, they must be louvered or ventilated in some way to keep amplifier temperatures in the normal range.

The a. c. supply should be taken from lines not subject to sudden heavy loads that may produce excessive line-voltage variations. If installation must be made in areas of heavy vibration, such as occur in some elevator shafts (primarily those for freight elevators), shock-mount the amplifiers, using springs—not rubber. Springs of the type used on screen doors may be cut up and applied as in the old-fashioned telephone mountings.

Don't allow coaxial cables to flap or rub against surfaces. Perforation of the outer jacket allows moisture to creep in next to the braid, with consequent oxidation of this braid. This kind of rot can cause severe headaches for service personnel, since the cable slowly increases its losses. The process may take months, and the trouble is extremely hard to find. For the same reason, don't use coaxial cable that shows obvious signs of abuse.

One final word. Keep your instruments—field-strength meter, sweep generators, and marker generators—in calibration.

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Fig. 1. Fire stops (A) hamper vertical running of cables. However, closet space (B) can be used to hide wiring, with outlet on room wall of closet.

Fig. 2. Wiring outlets for adjacent rooms back-to-back cuts line lengths.

Fig. 3. Separate units for isolation and matching can reduce line lengths.

Fig. 4. If suitable wiring space is not available in the structure, external under-the-eave wiring can be used.

Fig. 5. To check cable by the sweep method, compare response of generator and amplifier (upper left) with that observed when cable is added to setup.

Fig. 6. This set-up for sweep-checking transmission line exposes undesired deviations in cable frequency response.
All-American Service
A presentation in Washington, D.C. on November 21, ten men stepped out of the ranks of TV service and into the limelight to accept trophies and 5000 checks. They were receiving General Electric’s 1958 All-American Awards from general manager Irvine D. Daniels of the G-E receiving tube department. Senator John Sparkman, of Alabama, one of the judges who helped select them, was speaker at the ceremony. Others on the award committee were Bennett Cerf, publisher and TV panelist, and Charles E. Shearer, 1957-58 president of the National Junior Chamber of Commerce.

The winners make an interesting comparison with the group chosen for 1957. The first list showed more men honored for single exploits, often involving their roles as hams in floods, plane crashes, and other emergencies. The 1958 group is stronger in men who have made marks in less dramatic, long-range projects reflecting civic and business responsibility. Many are active in service associations:

This year’s list of ten television and electronic technicians honored by General Electric for unusual community services in 1958 reflects some interesting changes in emphasis as compared to the award winners who were similarly honored for 1957.

Technician Awards: 1958

EDWIN B. HAINES, Bloomington, Minn. (Osseo Radio & TV), was outstanding in a home-town, youth sports program involving over 2000 youngsters in several sports. A Boy Scout leader, he is also active in the Centennial, Lions Club, and Civic League.

ALBERT P. KAZUKONIS, Brockton, Mass. (Brockton TV), instructs Boy Scouts and other youth in radio fundamentals, contributing time and materials. He is active in promoting better business ethics.

STANLEY EVERETT, Alhambra, Calif. (Everett’s TV & Radio Sales), has contributed used TV sets to Parent-Teacher Association drives; developed a radio space hat to publicize fund drives for veterans’ hospitals and other institutions; leads in civic work in Kiwanis Club, Masonic Lodge, Valley Businessmen’s Association, Valley Boulevard Associates Committee, and the Community Church.

VERNON TOWNSEND, Menomonie, Wisc. (Townsend’s Radio), provided radio communications during a tornado last June; devotes much time to civil defense emergency radio facilities and networks in Dunn County.

BRYCE R. McNEELY, Kelso, Wash. (McNeely’s Ace TV), assists in a wide range of work from child safety to soil conservation; led a volunteer group in painting the home of an aging widow; donated a lot as a children’s playground; is state v.p. of the Junior Chamber of Commerce.

THEODORE W. PICKERT, Hatfield, Pa. (Hoover’s Radio-TV Sales & Service), is a youth recreation leader; helped organize and hold office in the local Junior Chamber of Commerce; served on the Boy Scout Council; is a Heart Fund leader; and promotes good community-business relations.

VERNON E. BROOKS, Norristown, Pa. (Brooks Electric Co.), led the American Business Club in sponsoring scholarships for therapists to work with paralytics, and in a fund drive for a school for the handicapped. He is active in the Chamber of Commerce, Red Cross, Community Chest, and other bodies, provides free service to religious and charitable groups.

WAYNE E. LEMONS, Buffalo, Mo. (A-1 TV & Radio), conducted after-class electronics courses in Missouri schools and has been active in Little League baseball and Rotary.

T. E. (BUCK) ADAMS, Channing, Tex. (Adams Appliance & Hardware), donated material and labor for electrical and plumbing work in his church. “He will do anything to help a fellow man,” reports a booster, “repair a broken-down jaylphy, pen a wild cow—where there is trouble, there you will find Buck at work.”

A. GEORGE CATAVOLO, Somerville, Mass. (Elm Radio & TV Service), donates equipment, time, and service to schools, churches, and youth groups to promote electronics education and reduce delinquency. He has bought full-page newspaper ads (“Open Letter to President Eisenhower”) urging improvement in education.
Cold and Hot

By JOHN T. FRYE

MONDAY was not Barney's best day. Weekend dating usually left the Number Two Man of Mac's Service Shop pretty sleepy; so Mac was not astonished when he returned from lunch to find his assistant precariously perched on a high stool and slumped over the service bench with his tousled red head pillowed on his folded arms, sound asleep.

Mac glanced from the figure at the bench down to the tall round can he carried in his hands; then he noiselessly removed the protecting cap from the spray nozzle on top of the can and tiptoed quietly across the room. Holding the can several inches from the head of the sleeping youth, he depressed the valve. A white, disappearing cloud hissed forth and played around the nape of Barney's neck.

With a yowl of surprise the boy leaped to his feet. "Wow! What a draft! Must be getting lots colder outside," he exclaimed as he rubbed the back of his neck. "Oh, oh!" he continued as he spied the can in Mac's hands. "What are you up to?"

"That's your cold draft," Mac said with a grin as he punched the valve again. "It's General Cement's 'Spray-Koat Circuit-Cooler.'"

"So what's it good for besides going around annoying innocent people?" Barney asked with a huge yawn.

"It's actually freon gas under high pressure," Mac explained. "You use it on a circuit component you suspect of being temperature-sensitive. When this gas hits a radio part, that part gets very, very cold in a great big hurry."

"Mm-m-m-m, you're filtering through to me. That ought to be just what the doctor ordered for those radio and TV sets that display intermittent symptoms when they are first turned on. After these sets warm up a bit, the annoying condition disappears until the set is turned off and allowed to cool down completely; then it's right back. When you're trying to troubleshoot one of these little dandies, you have to act fast and catch it cutting out when it's first turned on or you're out of luck. They are great time wasters. In the past I've seen you put these sets outside in the winter or in the refrigerator in the summer to make them good and cold. Now we can put the chill on them right on the bench with that bottled north wind."

"And the good part is we can make that north wind blow exactly where we want it. We can cool off a small section of the circuit or even a single part, such as a dubious capacitor - without affecting the rest of the circuit. And don't overlook the fact that it can also be used on those sets that cut out after they get warm. You simply spray a section of the circuit at a time until the set starts to operate again. That tells you where the defective component is. When the set cuts out again, you can cool off a part at a time. When the last one is chilled, it will make the set come back on."

"Man! That's real cool!"

"There are some horse-sense precautions to observe in using the stuff. For one thing, don't play the spray on the skin at close range. It will actually freeze a chunk of the flesh in nothing flat. The salesman was telling me one of their boys was demonstrating the stuff by squirting it on the palm of his hand, and he developed a nasty 'burn' that was really a frostbite. The closer the nozzle is held to an object, the colder that object gets. You will see a sort of rim appearing on an object sometimes, but it disappears immediately. I'm told the gas leaves no residue to interfere with electronic action."

"I suppose another horse-sense precaution is to see the spray doesn't fall on a hot glass tube," Barney observed. "I'll bet you could really crack a rectifier bulb that way."

"You certainly could," Mac said as he placed the can on the shelf with the imposing array of chemicals used in service work. There was contact cleaner, corona dope, cement solvent, alcohol, carbon tetrachloride marked with skull and crossbones, acrylic spray, "Lubriplate" and silicon gel, and recorder head cleaner.

Mac picked up a high-voltage door-knob capacitor from the bench and favored it with a sour look.

"Wish I could work out a quick and accurate way of checking this cuss," he commented. "It really gave me a hard time. The set came in with no picture. Checking revealed the high voltage was only about three or four kilovolts. The first thing I did was put the ohmmeter of the v.t.i.m. that reads up to 1000 megohms across the capacitor. It showed a leak.

"A drooping high-voltage symptom is often a headache because it can be produced by so many different circuit defects. The accompanying symptoms did not help much, either. The boost voltage was low, but cutting in an outboard boost voltage supply did not restore the high voltage. Neither did changing the horizontal oscillator, horizontal output, damper tube, or high-voltage rectifier. The waveform at the grid of the output tube was as smooth as a pure sine wave. That lower in amplitude than rated, but this was not enough to cause the trouble. I checked the output transformer for shorted turns, but nothing was wrong.

"I happened to touch the transformer while I was making the last test, and it was noticeably warm. I determined to cut it entirely out of the circuit, even though this took a bit of doing. When I did so, the high voltage jumped right up. Replacing the capacitor restored everything to normal; however, it was necessary to replace the high-voltage rectifier that probably had been damaged by the heavy current drain."

"But then I started trying to find a check of this capacitor that I knew to be bad that would show it so. I had absolutely no luck. I used our ohmmeter that placed two test leads and reads up to 20 megs, but this capacitor showed no more leakage than a brand new unit. Next I tried our leakage tester that uses a neon bulb to indicate leakage resistance up to 500 megohms; this also failed to show anything wrong.

"I've finally concluded the capacitor has no leakage until a certain critical voltage is reached; then it abruptly develops a comparatively low resistance. Any attempt to test the capacitor with voltages below this critical potential must fail to show anything wrong. I was talking this over with my friend, John, who runs an experimental laboratory and also does some TV service work. He was telling me he had run into identically the same thing and had decided to see what happened to the capacitor when it was subjected to an increasing voltage. The lab has a source of d.c. voltage that can be increased from zero up to twenty thousand volts and he put this on the defective capacitor. When the voltage reached about 5000 volts, the capacitor suddenly shrunk and exploded and blew bits of itself all over the lab."

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FM MULTIPLEX
-ITS PRESENT AND FUTURE

By PAUL F. HILLE, Jr.
Polarad Electronics Corp.

SEVERAL years ago the inception of color television provided the electronic industry with a practical example of r.f. spectrum conservation. To what was generally considered to be an already crowded television frequency band, engineers managed to add a significant amount of information necessary for the effective transmission of TV programs in full color. Concepts involving modulation and demodulation in suppressed-carrier processes, band limiting, and phase considerations were employed in addition to the previously common techniques associated with conventional amplitude-modulation systems. Of special significance is the fact that this color information was incorporated (theoretically, at least) into the standard monochrome transmissions without appreciably affecting the technical quality of the latter.

The matter of spectrum conservation has been of special import to FM broadcasters for some time. Many critics of frequency-modulation transmissions have been able to argue effectively that the spread of a 50 to 15,000 cps audio band over an r.f. frequency realm some 200 kc. wide is, at best, extremely extravagant when the lack of channel space for commercial and military applications is acute. Not at all impressed by the efficacy with which an FM system distributes its modulation energy over a wide spectrum, these critics have pointed out that the relative amount of energy per sideband pair is often very low in high-deviation transmissions. Faced with mounting objections from this quarter, and also taking cognizance of the fact that many FM stations are having difficulty in marketing their programming commercially, the FCC finally allowed a limited type of non-broadcasting operation within the standard frequency-modulation band from 88 to 108 mc. The fact that these point-to-point transmissions have been taking place for the past three years without the average FM listener being aware of them attests to the technical merits of the process. Practically, these allocations have enabled many FM stations to offer long periods of high-quality classical music with few commercial interruptions while still allowing the station to sell other facilities to the industry and business at a reasonable profit. Strict engineering standards prevail, however, so that the normal broadcast aspects of FM transmissions are not adversely affected.

Fig. 1 shows the presently allocated audio spectrum of stations in the standard commercial FM band. It is important to realize that we are considering the audio-modulation spectrum of the station and not the actual 200 kc. r.f. channel allocation. In effect, it may be said that the multiplex spectrum is only available after the demodulation process at the receiver, although it will be apparent that the r.f. spectrum of the transmission will also reflect the additional information being transmitted by the fact that more sidebands are in existence in areas where none would normally be situated in standard simplex operation.

From Fig. 1 it may be observed that the audio-modulation spectrum has been defined as far as 75 kc., 55 cycles of which can be called the multiplex region. The multiplex region itself is divided into two sections, a facsimile band occupying the spectrum from 22 to 28 kc. and a subsidiary communications band from 20 to 75 kc. With respect to facsimile broadcasting,
it will suffice to indicate that either amplitude- or frequency-modulation of the subcarrier is permitted; with the AM sidebands or instantaneous subcarrier frequency not extending outside of the 6 kc. band. To protect the main channel from the raucous sounds associated with crosstalk from a facsimile transmission, the main FM carrier cannot be modulated beyond 5/6 (of ±75 kc.) by the subcarrier and its sidebands. The SCA (Subsidiary Communications Allocation) band is restricted to use as a medium for the transmission of commercial material of a non-broadcast nature, such as background music, news, stock quotations, and the

like. It is particularly important to remember that, according to law, these are private point-to-point services and it is unlawful for unauthorized persons to derive remuneration from such transmissions. Unlike the obsolete method of muting certain portions of normal simplex FM programs by means of supersonic tones, the multiplex system effectively removes the commercial service from the home listener.

Technically, the SCA band is interesting because very little was specified concerning operation therein except that the system be frequency modulated and restricted to the allocated region. Persons familiar with FM theory will realize that a relatively large number of possible modes of operation are practical within such a spectrum. As an example, consider the operations outlined in Table 1. Assume we have two modes of subcarrier modulation, the first with a peak-to-peak deviation occupying 5.5 kc. and the second with a p-p deviation of 16 kc. Although the sideband distribution of the latter extends to a maximum of 40 kc, as against 30 kc. for the former, both may be operated within the SCA band at the same time since their peak deviations add up algebraically to only about 20 kc. In other words, the spectrum allocation is based on instantaneous frequency of the subcarrier and not on the position of the last sideband in the subcarrier modulation spectrum. Because of crosstalk considerations, however, the average FM station is usually content with one, or at most two, subcarrier channels— with a guard band conveniently placed between. In addition, as Table 1 shows, it must always be remembered that the minimum sideband distribution for an FM signal can, at best, be only equal to that of an AM signal with the same modulating frequency. This is another way of saying that there must be at least one pair of sidebands spaced f distance from the carrier, where f is the audio modulating frequency.

**Crosstalk**

Before moving on to a discussion of actual circuitry in connection with multiplex systems, it is worthwhile to mention briefly some of the aspects connected with the problem of crosstalk. As far as the FCC is concerned, the crosstalk problem connected with multiplex operation is significant only with respect to its effect on the main channel. Establishing limits on this interference assures, as was previously mentioned, the high quality of reception associated with FM broadcasting. The actual specification, as applied to frequency modulation of the main carrier by the multiplex operation(s),

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**Fig. 2.** A cross-mixing amplifier used to balance two stereo channels. This circuit is essentially that which is used for the AM/FM stereo transmission system shown in Fig. 3B. It may also be used to advantage in home music systems.

**Fig. 3.** Several simplified versions of stereo transmission and reception. The method shown in (A) represents the conventional method of AM/FM stereo transmission which has been criticized on several counts. The system of (B) attempts to remedy one obvious fault of (A) in that listeners with only one mode of reception will receive only half the program information. The transmission system in (C) is obviously unsatisfactory for reasons similar to those rejecting (A). The "sum and difference" method proposes a matrix system at the transmitter itself. As a result of this important technique it is possible to obtain almost complete reception of program information by a listener with an ordinary FM receiver (D).
states that such interference must be at least 60 db below 100% modulation (the latter in FM transmission is equivalent to a deviation of ±75 kc.) in the simplex band from 50 to 15,000 cps. This means that the main channel audio output of an FM receiver with superimposed audio modulation has a magnitude of at least 60 db below the carrier, if a music program is being transmitted during the simplex operation(s). If maximum superimposed amplitude of audio modulation is used, the subcarrier component will be attenuated by at least 20 db relative to 1 kc. at the detector output, thereby considerably reducing the problem of crosstalk in following circuits. Of course, it must not be forgotten that any inherent phase distortion in the circuitry preceding the discriminator in an FM tuner will also play a part in raising the level of cross modulation and will produce effects which are far more detrimental to the multiplex channel than to the main channel. This may be readily conceived by considering the effect of the subcarrier modulation energy contained in the main channel as opposed to the secondary channel. For these reasons, most FM stations which operate a multiplex service not related in modulation content to the main channel find it necessary to eliminate the subcarrier during silent periods in the multiplex.

(Continued on page 139)

<table>
<thead>
<tr>
<th>Modulating Frequency (cps)</th>
<th>Modulation Index β</th>
<th>No. of Sideband Pairs Greater Than 5% of Unmodulated Subcarrier</th>
<th>Required Circuit Bandwidth (kc.)</th>
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<tr>
<td></td>
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<td>(Subcarrier Deviation = ±1.75 kc.)</td>
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<tr>
<td>75</td>
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<tr>
<td>15,000</td>
<td>0.12</td>
<td>1</td>
<td>30.00</td>
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</tbody>
</table>

Table 1. Sidebands and bandwidth for transmission with subcarrier having 6.4%, 28%, and 91% modulation. A ± 27.5 kc. deviation (covering the entire subcarrier band from 20 to 75 kc.) would be equivalent to 100% modulation.

Fig. 4. Block diagram of conventional FM receiver and single-channel multiplex adapter showing signal waveforms throughout the receiving system for the “sum and difference method” of stereo transmission. Most of the subcarrier is eliminated by the de-emphasis networks B and C. The waveforms are drawn for two pickup frequencies of 1 kc. and 7 kc. on stereo channels A and B respectively.

In the matter of crosstalk just discussed, there are two items of importance which were ignored. One is the effect of the de-emphasis network which follows the detector in standard FM receivers. Because of the 6 db/octave slope of this network, the subcarrier component will be attenuated by at least 20 db relative to 1 kc. at the detector output, thereby considerably reducing the problem of crosstalk in following circuits. Of course, it must not be forgotten that any inherent phase distortion in the circuitry preceding the discriminator in an FM receiver...
WHENEVER the signal obtained from one antenna proves insufficient, the possibility of using two antennas immediately suggests itself. It is generally understood that the spacing and connections of two or more antennas must be arranged in a certain way to get stronger signals. Most of our readers also know that two antennas do not give simply twice as much signal. As a matter of fact, the theoretical maximum from two antennas is considered to be 1.56 times the (voltage) signal strength from a single antenna, or 3.86 db.

Whenever two antennas are brought near each other, they will affect each other's impedance and pickup characteristics as well. As they are spaced farther apart, this interaction will be less. However, if they are spaced too far apart, it becomes difficult to connect them together properly, and losses in the connecting lines eventually nullify any advantage of using two antennas.

The simplest case of stacking involves the use of two identical antennas, spaced one above the other and connected by quarter wavelength matching stubs, as shown in Fig. 1A. Although half-wave dipoles are shown here, all of the data applies just as well to the stacking of yagis, conicals, or any other antenna types. Every antenna configuration has a characteristic impedance which is made up of a variety of different factors such as radiation resistance, inter-element mutual impedance, and others. For our purposes, only the sum total—the characteristic impedance at the antenna terminals—is important. In the example of Fig. 1, this characteristic antenna impedance is called $R_a$ for the upper and $R_b$ for the lower antenna. In the case of simple dipoles, this would be about 73 ohms for each; but most TV antennas tend toward a 300-ohm characteristic impedance. Before any stacking arrangements are considered, this impedance must be known: manufacturer's data sheets should be consulted if any doubt exists. The second impedance that must be known is the characteristic impedance of the transmission line. For most TV installations, conventional 300-ohm twin-lead is used.

Fig. 1B shows the electrical equivalent of the antenna stacking arrangement of Fig. 1A. Each antenna is represented as a voltage source and a resistance ($R_a$ and $R_b$) and each quarter wavelength (1/4) matching stub is shown as a transformer. The primary of each transformer is connected to the antenna impedance. The two secondaries are connected in parallel to the terminals ($T$) of the transmission line. We know that the impedance looking into the transmission line at $T$, should be 300 ohms. Therefore, the impedance looking out of each matching stub transformer must be 600 ohms, so that the parallel combination is correct.

Fig. 2 shows the configuration of a matching stub that is one-quarter wavelength long. The same operation is obtained with 3/4, 5/4, etc. wavelengths—any odd multiple of a quarter wave. At one end is the antenna impedance $R_a$ and at the other the desired impedance $R$, which should be connected across the transmission line. If we assume that we wish to match two 300-ohm TV antennas to a 300-ohm transmission line—a usual case—then each matching stub must transform the 300-ohm antenna impedance $R_a$ into a 600-ohm impedance $R$. This is accomplished by making the characteristic impedance of the matching stub itself a value between the 300- and the 600-ohm end impedances. To be precise, the matching-stub impedance $R$ must be the square root of the product of
the two end impedances, as shown by the first formula in Fig. 2. For our example, this turns out to be 424 ohms.

Just as the characteristic impedance of a parallel-wire transmission line is determined by the diameter of the conductors and their spacing, so is the matching-stub impedance. This relationship is given by the second formula for $R_s$ shown in Fig. 2. For this example, $R_s$ is 424 ohms. This must therefore equal $276 \log 2D/d$ where $D$ is the center-to-center separation and $d$ is the diameter of each conductor. The larger the diameter of conductors used, the greater will be the required separation $D$ to obtain a given impedance for $R_s$. Conversely, the lower the impedance $R_s$, the closer the two conductors would be for a given tubing diameter. Since available wire or tubing would be made up of the stub, $R_s$ and $d$ would be known at the start, and the formula would be solved for $D$, the separation between conductors.

The wavelength in free air is the same for matching stubs and for antenna separations. However, if the matching stubs are made up of insulated twin-lead, wavelength measurements become shorter. Any insulating material, such as polyethylene, slows radio waves down; therefore, the wavelength will be shorter than in free space. For simplicity, then, stacking bars should be made up of bare rods or tubing.

In Fig. 1A it appears as if the spacing $S$ between antennas is less than a half wavelength. Actually, appreciable spacings up to a half wavelength will increase the signal strength. The maximum gain possible with good impedance matching is shown in Fig. 1C for various spacing values. Note that half-wave spacing gives the best gain.

If we wish to illustrate how two typical 300-ohm antennas can be stacked to give up to an additional 3.6 db of gain, consider the ease where it is desired to improve reception on channel 4. (Since matching elements are resonant affairs, good broadband operation becomes feasible as antennas are stacked. More will be said about this later.) We must first determine what a quarter wavelength is for channel 4. A wavelength in free air is determined by the formula $\lambda = \frac{c}{f}$, where $\lambda$ is the wavelength in meters and $f$ is the frequency in megacycles and wavelength is in feet.

Since the metal bars of which the matching transformers will be constructed reduce wavelength to some extent, a better formula to use, which will take the reduction into account with sufficient accuracy for most cases, is $\lambda = \frac{c}{f} - p$. The formula for a quarter wavelength, then, is $\lambda = \frac{c}{2f}$. The midfrequency of the channel-4 bandwidth (66-72 mc.) is 69 mc. Thus 234/69 is 3.4 feet.

Having thus determined the length of the two parallel metal rods or wires, we must decide how far apart they must be spaced to obtain the desired impedance match. Let us assume that metal rods with a cross-sectional diameter ($d$) of half an inch are being used. $R_s$ and $R_e$ are each 300 ohms. The impedance of the line is also 300 ohms. Therefore $R_s$ must be 600 ohms, since 600 in parallel with 600 is 300 ohms, which is the line impedance we wish to match. Thus, from the first formula in Fig. 2, the impedance of the stub ($R_s$) must be the square root of 600 x 300. This is 424 ohms.

With $R_s$ and $d$ known (11/2-inch diameter tubing is assumed), we can solve the second formula for the spacing ($D$) between the centers of the two conductors. This comes out to 3.58 inches. Log tables or the log scales of a slide-rule can be used. For those who wish to avoid encounters with logarithms, the spacing just worked out will cover that multitude of cases where 300-ohm antennas are being matched to 300-ohm lines, i.e., where the matching impedance $R_s$ is equal to 424 ohms.

Where $R_s$ and $R_e$ are 72 ohms and $R_s$ is 600 ohms, as is the case with other antennas, $R_s$ is 208 ohms. To obtain this impedance, spacing $D$ should be 1.42 inches. Since there should be no particular problem in working out $R_s$, for any application, spacing $D$, using 1/2-inch diameter tubing, is given for several values of $R_s$: for 200 ohms, 1.3 inches; for 300 ohms, 1.7 inches; for 400 ohms, 2.1 inches. If 1/2-inch tubing is used, $D$ will be: for 200 ohms, 1 inch; for 300 ohms, 1.5 inches; for 400 ohms, 2.3 inches.

Coming back to our attempt to obtain maximum gain for channel 4, we must have the elements we wish to stack two antennas. Length for each quarter-wave bar is 3.4 feet. For spacing $S$ between the antennas: at best they should be half a wave apart. The free-air half-wave spacing is 7.1 feet. However, the combined length of the two 3.4-foot quarter-wave sections is only 6.8 feet.

Since this discrepancy represents an error of less than 6 per cent, reducing the spacing between antennas by this small amount to accommodate the size of the stubs will not produce any significant loss of efficiency. If every last drop of gain is considered important, each length of tubing in the stub can be made 1/4 of a wavelength, and the stub can be connected at an angle, as shown in Fig. 1A. If the small compromise is tolerable, however, two lengths of 8.8-foot tubing can be used between the two antennas and the antenna line can be connected at their midpoint, since the signal from two antennas is still too weak. The obvious solution would be to add a third one. In actual practice, the use of three antennas is rare, but four can be matched conveniently and with good results. The most widely used method of stacking, and also the simplest, is shown in Fig. 3. Here we have doubled up on the two antennas shown in Fig. 1 and, as shown in the table of Fig. 3, the gain increase is again less than doubling the size of two antennas with half-wave spacing giving 3.66 db, four antennas give 6 db. Again a reduction in spacing results in less gain.

The impedance matching problem is treated here in the same way as for the double stack. Consider first the impedance which should appear at the transmission-line terminals $T_1$ in Fig. 3. To get 300 ohms at this point, each set of matching stubs $3$ and $4$ must present 300 ohms; but we have shown in Fig. 1 that the impedance which is present at each of these terminal points (Continued on page 142)
The All-Transistor Portable Car Radio: 1959

By W. C. SAHM
Delco Radio Div., General Motors Corp.

Two separate tuning systems make this unit more like a portable out of the car—and more like an auto radio in it.

Fig. 1. (left) In the car, the radio fits into the glove compartment, out of sight.

Fig. 2. (below) In the portable mode, this year’s version is smaller than last year’s.

What’s new in automobile radios this year? The fully transistorized car receiver that may double as a compact portable has been around since the 1958 autos began rolling along the nation’s highways. With some refinements, it is still the big news for 1959.

As evidence of its acceptance, the auto portable made by Delco Radio is being used in three of the General Motors lines. Buick has joined Oldsmobile and Pontiac in featuring it as an optional extra. Principal changes involve separate mechanical and electrical tuning arrangements for use in or out of the car. From this major shift, several advantages that did not exist a year ago accrue. (See “Delco's Portable Auto Radio,” page 44, December, 1957.)

Since a permeability-tuning system is recognized as the preferred one for satisfactory auto-radio operation, the first versions of the auto portable were somewhat larger and heavier than this year’s model to accommodate such a front end. With its separate, variable-capacitor tuning system, the new version makes the neat, streamlined package the young lady holds in Fig. 2. Helping to keep the receiver compact in its portable mode of operation is the fact that, like most transistorized portables, it does not include an r.f. stage. The latter, quite helpful for automotive use, is now consigned to the sub-chassis that remains in the car at all times, to be switched in and out automatically as needed. Shown at the lower left in Fig. 3, this r.f. stage is brought into play through the multi-contact connector mounted to the rear of the receiver when the latter is slipped into place in the vehicle.

With the single tuning system used last year, in-car station selection was limited to the simple tuning dial of the
portable. This would not be acceptable to many automobile owners who are accustomed to such features as illuminated, slide-rule dials of generous size and convenient push-button selection of favored stations. The 1959 model thus can provide five push-buttons along with a good-sized manual-tuning dial that remains in the car. A simpler tuning knob, driving the variable capacitor, is built into the portable body.

The independent tuning systems provide another convenience. There is no longer any need to have the portable still accessible when it is plugged into the car. For this reason, the 1959 model is placed in a rack inside the glove compartment (see Fig. 2) instead of fitting into a hole in the instrument panel, as was the case last year. With the glove compartment closed, the radio is out of sight altogether. With the glove compartment locked, the portable is safe.

A number of design changes have been made in the radio’s circuits, as well as in its size and physical appearance. The portable itself is a six-transistor radio powered by four 1.5-volt mercury cells. When being used in the automobile, two more transistors—an r.f. amplifier (lower right in Fig. 3)—are added to make an eight-transistor circuit.

The six transistors in the portable mode provide the same power output as was obtained with nine transistors in the 1958 version. This reduction was made possible by eliminating the a.g.c. amplifier and using only an a.g.c. detector diode, by combining the functions of the oscillator and the mixer stages into one converter stage, and by placing the r.f. amplifier in the car, instead of in the portable.

As the portable is plugged into its rack in the glove compartment, the ten-contact female connector in the portable and the male connector in the rack meet to provide all of the necessary switching to change from portable operation to in-car operation. These connectors (the horizontal strips toward the bottom of Fig. 3) accomplish several jobs simultaneously. They disconnect the capacitively tuned oscillator and antenna circuits, the mercury-cell battery supply, the small portable speaker, and the portable volume control with its “on-off” switch. The push-button tuning unit in the car is only one of many features now provided. Power is supplied by the car battery. In place of the portable antenna, a slug-tuned automobile antenna circuit and the r.f. amplifier (DS-19) are used to provide a higher level of input signal to the converter stage. The converter circuit itself is also changed by the connector. The capacitively tuned oscillator circuit is replaced by a slug-tuned circuit. In order that the radio have sufficient power output for easy listening at highway speeds, the connector replaces the portable speaker with an added power amplifier (DS-301, following the push-pull amplifier), which gives the radio a maximum audio output of 6.5 watts, and which feeds a large oval speaker.

The result of these efforts by engineers of Delco Radio is a design that retains all of the features expected in a quality automobile receiver with no sacrifice of the advantages found in transistorized portables when the radio is used in that mode of operation.

**Fig. 3.** The 1959 version of the “double-life” Delco transistor radio. Circuits for in-auto use only are at the bottom.
The "Inverted L" Ham Antenna

By ROBERT M. SEE, W5LTD

Construction of simple antenna and matching network that provides a good compromise in height, cost, and coverage.

AFTER moving into a new home it was hoped that a satisfactory solution could be found to the problem of installing an amateur antenna without detracting from the appearance of the neighborhood landscaping. This, of course, ruled out any type of feed line which would hang suspended and flapping in the Oklahoma breeze. Naturally the buried coax feed line and all band vertical came to mind. After considerable thought (this is always the hard part), it was decided to modify the vertical radiator to include some horizontal polarization. It was believed that this might increase the field strength, on 80 and 40 meters, over that of a vertical—at least within a 300-mile radius. In other words, we didn't want our signal to skip our local friends. As a consequence, the "Inverted L" antenna—which is a compromise in height, cost, and coverage—was adopted.

The utility pole was set 5 feet into the ground and has withstood 70 mph wind gusts without guy wires. It is located on the rear of a city lot, nestled in a group of eastern red cedar trees. It takes a sharp eye to detect any discontinuity in the landscape. The XYL believes this to be the best part of the entire installation, however, the author is partial to its operation and the strong signal reports received.

Fig. 1 shows the horizontal radiation patterns on the three bands for which the antenna was designed. It would be possible to operate the antenna on 15 and 10 meters with the proper matching networks but these bands have not been investigated.

Antenna Construction

The vertical portion of the antenna is made from a 32.5-foot section of 4-inch i.d. copper water tubing. It is mounted on 4-inch ceramic stand-off insulators which are, in turn, fastened to the telephone pole. The copper tubing can be purchased in coils of varying length and was used because it is easy to handle and workable. The horizontal portion of the antenna is 32.5 feet of #12 gauge stranded copper antenna wire. It is connected through an insulator to the top of the telephone pole for mechanical strength and then bonded to the top of the copper tubing. The other end is tied through an insulator to a tree some 40 feet away. The photographs show how the tubing is mounted on the pole and connected to the matching network.

The transmission line is buried about 6 inches in the sod and runs from the house to the base of the antenna where it enters the housing for the impedance matching networks. The ground radials are made of four lengths of #12 gauge copper wire, 35 feet long. They stretch out in four directions from the base of the pole and are buried about six inches into the turf. They are securely bonded together at the pole to reduce losses and are connected to the matching network by a copper braid. In dry, sandy soil the radials should be made no less than 60 feet long and their number increased to six. It is imperative that the antenna have a good ground system, securely bonded to reduce losses.

The efficiency of this antenna on 80 meters is better than that of the 33-foot and 44-foot verticals because the high current (and high radiation) portion of the antenna has been raised.
Almost any length of wire or antenna configuration can be made to look like 50 ohms or any other transmission line impedance. This is the job of the impedance matching network. Since an r.f. bridge wasn't available, the impedance of the antenna was measured with a "Q" meter and a calibrated s.w.r. meter. The results are given here as a matter of information only: 14.2 mc., Z = 850–j100 ohms; 7.2 mc., Z = 5000–j100 ohms; 3.8 mc., Z = 26 + j0 ohms.

As can be seen from the circuit diagram of Fig. 2 and the photographs, bandswitching was handled by three separate switches. If the builder substitutes a ganged switch and a different parts layout, it is suggested that the coils be placed at right angles to each other to reduce mutual coupling.

All components were mounted on a plywood board which is slightly smaller than the inside dimensions of the RF-D type mailbox. The finished unit is slipped into the mailbox which provides excellent protection from the weather.

In the author's unit, C3 was made up of a 50 µfd. unit and a 30 µfd. variable capacitor in parallel since the variable was on hand. The actual capacity needed is 70 µfd. The 400 µfd. mica capacitor used as part of C3 should be of the high-current type. The one used here is a surplus Songamo Type A2LH (2500 volts). The switches should also be able to withstand high current if high power is to be used because they will carry the full antenna current. The switches shown in the photographs were taken from an army surplus antenna tuning unit.

R5 and RFC were added to the circuit to bleed off any static charge which might develop during thunderstorms. The knife switch mounted on the utility pole is used to switch the antenna and protect the station equipment when the station is not on the air during heavy electrical storms. This matching network has handled a 400-watt transmitter for a year and shows no signs of heating or arcing of components.

Calibration

As mentioned earlier, it is not necessary for anyone who plans to duplicate this antenna to do any design work to assure a good impedance match. It is necessary, though, to have a standing-wave indicator in the line while making the adjustments for low s.w.r. on each band. Start your adjustments with the switches set on the 20-meter band. While watching the s.w.r. indicator, rotate C1 until the lowest reading is indicated. Small variables in the antenna installation may make it necessary to change the taps on the coils one or two turns. If this becomes necessary (it is if the s.w.r. indicator cannot be made to read a low value) the C1 setting should be re-adjusted for a low reading after the taps are changed. When the s.w.r. has been made as low as possible on 20 meters the procedure is repeated on 40 and 80 meters while adjusting C2 and C3 respectively.

In addition to matching the 50-ohm line impedance to the antenna input resistance this network also corrects for reactance in the antenna and thereby affords easier loading to the transmitter. Fig. 3 shows how the s.w.r. varies over the band in the author's installation. As can be seen, the lowest s.w.r. was made to fall in the center of the band because both c.w. and phone operation were to be used. If the builder plans only c.w. or phone operation he may shift this low s.w.r. on 80 and 40 by making his adjustments on the frequency to be used.

In conclusion, it might be well to add that if you are the "bandhopping" type of operator, remember that you will have to visit the base of the antenna to switch bands. However, even this small obstacle can be looked upon as a "blessing" when you consider that in this age of automation most of us could use a little exercise!

Although this antenna cannot compete with a good beam, it has proved to be the answer to a serious problem at W5LTD. We have a sneaking suspicion that it will be in use for many years to come since it has provided excellent contacts all over the globe. We believe you will like it as well.
OPENING the case of a transistor provides an educational experience that cannot be duplicated in any other way. With the case open, a person can get a first-hand perspective of the actual emitter and collector dot size, the germanium wafer thickness, and the methods of assembly used by the manufacturer.

Of course, we can read about these things but reading lacks the visual impact and stimulation that are so effective in bringing about a quick understanding of transistor construction.

Obviously, transistors that have burned out are the ones to open and examine since they are no longer useful. However, the low cost of transistors now justifies opening even a new transistor. Fusion-alloy transistors sell for under a dollar and grown-junction types for as little as $1.50. These two transistor types, distinctively different in their manufacture, are representative of the bulk of present transistor production.

Except for a very limited production destined for consumption within the Bell Telephone System, the point-contact transistor is virtually "extinct." Another type, the surface-barrier transistor, is a fairly recent addition.

Even more sophisticated transistors—the tetrode and diffused-junction varieties—are now seeing use mainly in advanced electronic circuits for specialized applications where expense is no object. So, except for the surface-barrier transistor, let's forget about these latter types and talk about opening up some of the more interesting and available transistors.

Raytheon CK721, CK722

When one of these transistors is opened you may be in for a surprise. While early CK722 transistors were encapsulated in a plastic case that could be removed either by dissolving in solvent or heating and pulling off the case (careful, though, or the junction may be pulled out too), newer units are very different.

The metal case for the newer-type CK722 is really no more than a shell around the subminiature transistor inside. This inside transistor has a case like the 2N130A series of Raytheon transistors.

To take a CK722 apart, peel off the thin outside case with ordinary side cutters or needle-nose pliers. Beneath this cover lies a cement filler or coating that can be pushed off easily with the heated end of a gun-type soldering iron.

With the "gunk" removed, the inside transistor case is visible. This 2N130A-type case may be opened by heating the bottom of the shell with a soldering iron and simultaneously pulling gently with pliers. Fig. 1 is a cross-section view of the CK722 package.

Now that the cover is off, the complete transistor assembly can be seen. The germanium has a beautiful lustrous finish that is characteristic of etched germanium.

The emitter and collector dots are seen on either side of the germanium wafer. Somewhat more detail is visible with the aid of a magnifying glass. The larger dot forms the collector junction and the smaller one the emitter.

These emitter and collector dots are indium metal that, under heat, fuses into the n-type germanium forming regions of p-type germanium that are actually the emitter and collector. Germanium can be either p or n depending upon the type and relative concentrations of impurities. Arsenic added to the germanium makes it n-type and indium added to the n-type arsenic-doped germanium changes it to p-type.

All Raytheon transistors, including
the silicon types, are made by this fusion process.

**G-E 2N43, 2N107, 2N135**

Like the CK722, these transistors are fused or alloy types but they are hermetically sealed in a welded housing. The germanium base is electrically attached to the case which acts as a heat sink. This type of construction gives the 2N135 a medium-power rating.

The welded hermetic case introduces no soldering fluxes or gasses that could possibly shorten the life of the transistor.

A cloudy jelly-like material, probably a glyptal type, coats the junction. It can be removed with a small brush.

Slight modifications of the dot size and base thickness produce different characteristics. In the 2N135, for example, the dots are made smaller and the n-type germanium thickness between the alloyed p-type layers is made thinner. All this results in superior high-frequency performance.

To open this transistor case, snap away the welded flange with cutters and the round cover lifts easily. Inside, the germanium wafer mounts on an angle bracket that is spot-welded to the header. Heavy lead strips connect the emitter and collector dots to the posts coming into the case through the glass seals.

Fig. 4 shows the general construction of General Electric diffused alloyed transistors.

**G-E 2N78, 2N170**

The 2N170 is a good example of an inexpensive grown-junction transistor. Grown- and fused-junction transistors are radically different.

Fused junctions are made by growing a large n-type crystal, cutting it into hundreds of wafers and then fusing p-type impurities into the germanium.

By another method the emitter, base, and collector can be produced within the crystal as it is grown. It can then be cut into hundreds of smaller slices each containing an n-p-n junction. These are known as grown junctions. Thus far the grown-junction transistors are made mainly with n-p-n junctions.

Using this method, the base thickness can be controlled to very close tolerances. For this reason, grown-junction transistors are particularly suited for high-frequency circuits. In fact, the first high-frequency junction transistors were all grown-junction types. However, alloy-junction transistors have now caught up to the grown-junction in this respect.

The grown-junction is already a transistor and it only remains to mount it in a suitable case. The ends of the junction-containing strip of germanium are attached to end tabs. These tabs are the collector and emitter connections.

Since the extremely thin base zone has no distinctive appearance, the base wire is moved along the germanium strip until an electrical measurement indicates the base has been found. The base lead is then welded in place.

*General Electric* transistors of this type have a characteristically tall rectangular case with rounded corners plus a seal-off tube and bottom-welded flange. The metal header, because of its upside-down dishpan construction, is extremely rigid.

There are quite a few small parts and tabs used in the construction of this transistor type. The germanium strip is secured to tabs extending from the collector and emitter support posts. A metal strip runs parallel to the germanium and allows the base lead to be welded any place along the entire length of the germanium. This is necessary because, in some transistors, the base region may be at an extreme end of the germanium strip.

Like the 2N107, this case is also opened by cutting around the bottom flange. The cover then lifts off easily without damaging the transistor. There is no "jelly" covering of the junction in this type. Fig. 3 shows the construction.

The transistor can be operated with the cover removed for a very effective demonstration. Too, experiments to show moisture contamination and photoelectric effects can be carried out with the cover removed. Fig. 2 shows a simple circuit for demonstrating the photoelectric effect on any exposed transistor junction. Be sure to use a negative collector voltage for p-n-p transistors and positive for the n-p-n.

**Sylvania 2N34, 2N35**

The 2N34 and 2N35, appearance-wise, are identical both inside and outside; however, the 2N34 is a p-n-p unit and the 2N35 is an n-p-n transistor. Most n-p-n units are grown-junction, but the 2N35 is an exception. It is a true alloy-junction transistor.

This results in similar characteristics for the two units except for the reversed polarity for bias and supply voltage. Consequently, a 2N34 and 2N35 pair is ideally suited for complementary symmetry circuits.

To open these transistors, unsolder the case at the bottom and pull off the cover. Fig. 5 illustrates the internal assembly.

**Sylvania 2N68, 2N95, 2N101, 2N102**

The 2N68 is more difficult to open. First, cut off the leads and chuck the case in a metal lathe. By cutting away the soldered seal and part of the aluminum cooling fins, the transistor assembly will drop out, together with a small amount of white powder. Presumably, this white powder is dessicant.

The 2N68 transistor assembly is relatively large and easily observed. For that reason, the 2N68 insides give a very good display of diffused-junction transistor construction. Furthermore, the 2N68 geometry is pretty repre-

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![Figure 1](image1.png)

**Fig. 1.** Raytheon CK721, CK722 transistor.

![Figure 2](image2.png)

**Fig. 2.** Demonstration of the photoelectric effect on an exposed junction is shown. It is noted that the smaller the slice, the more effective the demonstration.

![Figure 3](image3.png)

**Fig. 3.** Mounting for G-E rate-grown "n-p-n" transistors such as 2N78, 2N170, and others.

![Figure 4](image4.png)

**Fig. 4.** General Electric's mounting for diffused-junction types 2N43, 2N107, 2N135.
The base is a square of germanium, roughly the thickness of aluminum foil, made rigid and supported by a metal ring. This ring, in turn, mounts to the base lead coming through the header. The collector makes connection to the heavy copper case, which carries away heat from the junction.

**Western Electric 2N27**

This is a germanium grown-junction transistor with an interesting holder for the germanium bar. See Fig. 7. The supports at each end make a marvelously exact-fitted connection to the germanium. The base connection is a tiny wire welded to the base region. This type of base connection is characteristic of all grown-junction transistors.

The base connection, smaller than a fuse wire, usually is the part that burns out from an accidental short to the collector or some other high current input pulse. This base connection may be completely missing on some burned out grown-junction transistors.

**Texas Instruments 903, 904**

These are grown-junction silicon transistors. Internally, the construction is similar to the 2N27 just discussed, however, the silicon bar is soldered to the looped-around emitter and collector leads as shown in Fig. 8.

Silicon transistors are very expensive because of the extreme difficulties in growing the silicon. Silicon has a high melting point and must be heated in a crucible or pot fabricated of material having a melting point slightly higher that than of the silicon itself. Too, silicon is very active chemically and must be grown in an inert atmosphere. The difficulties in handling silicon are tremendous.

One company in the Boston area, where plenty of know-how about these things exists, worked about a year on its first silicon melt.

**Amperex 2N279, 2N280**

Amperex transistors are sealed in a tiny glass tube and look very much like a subminiature vacuum tube. The glass tube is painted black. To see the p-n-p fused junction inside, just scrape off the outside paint. See Fig. 9.

The cavity around the transistor junction is filled with an obscuring semi-opaque material; nevertheless, the junction is still visible.

This method of fabrication makes the Amperex transistor ideal for classroom demonstration. Anyone can look inside, yet the junction is still protected from moisture and handling by the glass hermetic case. Light falling on the junction has a photoelectric effect and this also makes the 2N279 very interesting in demonstrations.

**Philco Surface-Barrier SB-100**

While all the other transistors have contained two types of semiconducting material, produced during the crystal-growth or by fusion-alloy processes, the surface-barrier transistor contains only n-type germanium.

The emitter and collector are produced by plating indium metal onto the surface of the germanium. The thickness of germanium between emitter and collector is made very small by an electrolytic machining process that produces two dimples in the germanium.

Fig. 10 shows a cross-sectional view of this type of transistor. There are no emitter or collector dots; otherwise, it looks much like a fused-junction transistor.

If the transistor is opened and the protective jelly removed, two very tiny dimples with almost invisible lead wires running to them can be seen. The emitter and collector are plated in these dimples and the leads welded to them. The larger dimple, as seen with a magnifying glass, is the collector.

These emitter and collector leads, like the grown-junction base lead, are very easily burned out.

Don't throw away any defective transistors that come your way. Open them and look inside first. It is an educational experience that can not be duplicated by any amount of reading or poring at diagrams!
New Frequency Scanning Radar

Large mobile unit uses single antenna for distance, bearing, and altitude data.

Scope at extreme left shows range and bearing data; while other display shows altitude. At right, entire indicator console has been pulled out on rollers to provide easy servicing.

A NEW frequency scanning radar which detects airborne targets at extreme range and for the first time simultaneously computes distance, bearing, and altitude, was unveiled by the Army. Called "Frescanar," the radar which was developed by Hughes Aircraft Co. is the eyes of the "Missile Monitor," an Army air defense guided missile fire distribution system for mobile use with a field army. The entire system consists of one equipment van, one power truck, and one antenna trailer. The equipment van houses all radar gear except the antenna.

In principle, a frequency scanning radar is one that is able to cause the searching radar beam to be moved rapidly without actually moving the antenna physically. This is done by applying a succession of frequencies to a special antenna whose directivity is made sensitive to the applied frequency. By changing the frequencies at electronic speeds, the radar beam is caused to move far more rapidly than is possible by actual physical movement of the antenna. This beam is then able to monitor numerous high-speed aerial targets at many altitudes and bearings.

The special antenna is protected from the wind and weather by a radome of fabricated rubberized nylon—vulcanized to two layers of neoprene-coated fabric—weighing about 600 pounds. The radome is inflated by two air blowers and kept that way by slight pressure from one blower.

Five basic advantages claimed for the new radar system over conventional radars are:

1. Range performance. "Frescanar" concentrates all available power in sharp pencil beams of energy flashing on and off in a fan-shaped array to pinpoint targets at great distance with extreme accuracy.

2. Single antenna and operator. Conventional systems need two or more radars, operators, and master consoles to achieve similar results. The new radar needs only one of each, sharply reducing weight, bulk, and personnel to make transportation with other Army field units easier. Use of transistors further cuts size and increases ruggedness for movement.

3. Triple function. The frequency scanning radar computes range, bearing, and altitude at the same time.

4. Greater speed. All three types of data—range, bearing, and altitude—are transmitted to missile batteries, helping them to direct missiles on targets much more rapidly.

5. Sees more targets clearer. The electronic beam scans rapidly and greatly increases the number of targets which can be tracked at the same time, providing better separation of closely spaced targets with minimum of ground clutter, and pinpoints targets faster.

All the units in the over-all fire control system are interconnected and can communicate with each other even with part of the system destroyed or inoperative. Thus a fragmented system could still operate.

Plastic balloon, resting on mobile trailer bed, protects antenna.

Target is first detected, the data is processed to missile batteries, which are then fired automatically.

January, 1959
Problems in

Horizontal Blanking

By JESSE DINES
Author of “Servicing TV Sync Systems”

Blanking networks, increasingly used, prevent many retrace faults. Learn about these circuits. Add them where needed.

WITHOUT much fanfare, there has been a trend toward incorporation of circuits to remove horizontal retrace lines in TV receivers. Their widespread use in color sets is not hard to understand. However, suppression of the horizontal return trace in monochrome sets was virtually non-existent until recent years. One may wonder why this is so at a time when features of marginal value are being dropped by receiver designers. What troubles, for example, might result if the return trace is not suppressed? Fig. 1 shows two of the difficulties which are possible when, for one reason or another, there is electron-beam conduction in the picture tube during the brief interval of the return trace.

In Fig. 1A, horizontal foldover exists at the left side of the picture and extends over to the extreme right. This particular defect results when the retrace time of the saw-tooth current flowing through the horizontal yoke windings is too slow. In Fig. 1B, a faint, vertical white line appears at the left of the picture. (The fine tuning control was adjusted to accentuate the symptom.) This particular defect was caused by a fault in the horizontal sweep circuit. If the steep, downward slope of the horizontal-sweep sawtooth (the portion representing the return trace) has its shape severely distorted by any defect, such a band may be the result.

Sometimes a bright vertical line or band that is “wavy” appears in the raster at certain times, as when station breaks occur. Excessive retrace time or radiation from the sweep circuit during this period can cause such abnormal picture symptoms. This article explains the reasons for these abnormalities, as well as how to eliminate them.

Horizontal Foldover

To understand what causes foldover due to slow retrace time, examine the horizontal sync and blanking portion of the composite video signal (Fig. 2). Note that the front porch (1.3 microseconds) is narrower than the back porch (3.6 µsec.). This is done to give the retrace more time to end before total blanking time (10 µsec.) ends. This is shown more specifically in Fig. 3 which indicates (A) the composite video signal, (B) horizontal sweep voltage showing trace and retrace portions, and (C) a portion of the raster which is scanned. Proportions have been distorted to highlight certain details at the raster edges.

Consider the normal circumstances first. A raster line is scanned from point 1 to point 4 (beginning of the horizontal sync pulse as shown in Fig. 3B). The time from points 1-2 and 3-4 are blanked out, since horizontal blanking takes place at this time. The raster line produced is shown in Fig. 3C. Retrace begins at point 4 and ends at point 5 which corresponds to point 1, the beginning of trace, for the next scanned line.
As long as the retrace ends before blanking time ends (point X in Fig. 3A), the retrace line will not extend into the video portion of the composite video signal. If the retrace does extend beyond point X, some of the video will be “repeated” and horizontal foldover will occur at the left side of the picture.

The combined duration of the sync pulse plus the duration of the back porch (refer back to Fig. 2) is equal to 5.1 ± 3.6 or 8.7 usec. This means that, in order not to have foldover, receiver retrace time should certainly be no greater than this 8.7-µsec interval. Actually, it is better to make this period shorter than 8.7-µsec because retrace usually begins at point 4 in (Fig. 3) and not at point 4. This results from the inherent delay of the sync pulses through r.f., i.f., and particularly the sync-separator circuits of the receiver before the pulses can trigger the horizontal oscillator.

In Fig. 3B, if retrace starts at point 4 it ends at point 5’ which, although slightly beyond point 5, is still within acceptable limits to prevent foldover. However, if the retrace interval is too great, retrace will terminate at point 5” and foldover will occur.

**Reducing Flyback Time**

In receivers without blanking circuits, problems like the one just discussed can often be handled by shortening the flyback period. The retrace time depends on inherent operation of the horizontal sweep (flyback) circuit. Although it is beyond the scope of this article to discuss flyback circuit operation, certain facts will help us understand how retrace is produced. Fig. 4 shows three pertinent waveforms of the flyback circuit. Waveform (A) is the signal fed to the horizontal output tube grid. At point “A”, the tube is cut off and the flyback circuit goes into self-oscillation. The oscillatory tank circuit is formed primarily by the inductances and distributed stray capacitances of the flyback transformer, horizontal yoke windings, width coil, and all of their connecting leads.

The oscillations are damped as indicated by the yoke voltage waveform shown in Fig. 4B. The period of the first negative-half oscillation determines the retrace current through the yoke. See the yoke current waveform shown in Fig. 4C. Thus, the higher the frequency, the shorter the period and the quicker the retrace; conversely, the lower the frequency, the longer the retrace period. Since we want the shortest possible retrace time, the inherent resonant frequency of the flyback circuit must be as high as possible.

A frequency of 70 kc. or higher (even as high as 90 kc.) is necessary to produce the correct retrace time. At a frequency of 70 kc., the period of one-half cycle for retrace is ¾ x 1/(70 x 10³) or approximately 7 usec. At 90 kc., the retrace time is only 5.5 usec., which is still better.

How can we keep the resonant frequency of the flyback circuit as high as possible in order to keep the retrace period as short as possible? The answer is by reducing the stray capacitance of the circuit since frequency and capacity are inversely proportional. This, in turn, can be done by keeping the horizontal output tube and high-voltage rectifier plate leads, and other such leads, as far away as possible from the high-voltage cage or other ground points.

A yoke or flyback transformer that has lost some of its efficiency through the accumulation of moisture in its windings must be replaced since the moisture increases the distributed capacitance across the windings. Substituting the output, damper, and/or high-voltage rectifier tubes may decrease retrace time, if the latter is marginal.

In some flyback circuits there is a capacitor connected across two taps of the flyback transformer secondary, frequently across the width coil. Although it serves to increase picture width, it may also increase retrace time. If this capacitor is removed to reduce the flyback interval and too much width loss results, other means can often be employed to restore this loss. These schemes include: decreasing the value of the horizontal-output tube screen-grid resistor, increasing the horizontal drive voltage by re-adjusting the drive control, and/or re-adjusting the width coil.

If such methods fail to remove foldover due to excessive retrace, then a retrace elimination circuit must be employed. Such circuits will be discussed later. Of course, the use of these circuits will also remove that portion of the video information that is folded over on the left side of the picture. However, this loss is not serious since it represents only a very small portion of the entire video signal.

**Vertical Line Distortion**

Some video amplifiers are designed to “overpeak” signal before feeding this information to the picture tube. Although this tends to sharpen picture quality, it sometimes causes overshooting of the sync and blanking pulses as shown in Fig. 5A. Overshoots “A” and “B” are in the area of picture tube cut-off; thus they have no effect on the tube’s beam current. Overshoot “C” extends into the conduction area (gray region of the composite video signal), resulting in picture-tube conduction where cut-off should normally take place.

The effect on the raster is shown in Fig. 5B, where the picture-tube electron beam is momentarily turned off every time it passes near the center of the screen, since overshoot “C” occurs at about the center of horizontal retrace time. The result is a fuzzy rope-like vertical line. To remove this line, a retrace elimination circuit should be used; otherwise, it may be necessary to redesign the video amplifier peaking circuits to remove the overshoot.

Radiation (or spray) from the horizontal sweep circuit into the video cir-

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**Fig. 3.** Relationship between video being scanned, scanning time including retrace period, and raster display.

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**Fig. 4.** Key horizontal-sweep waveforms.
circuits of the receiver can also cause a distorted sync pulse similar to the one shown in Fig. 5A. The same abnormal picture results as for overshoot. If the radiation from the horizontal sweep circuit cannot be removed by shielding or damping the circuit, a retrace elimination circuit should provide results.

In color sets, the 3.58 mc color sync signal, which appears on the back porch of the horizontal blanking pulse, can also cause one or several vertical lines in the picture when the cut-off level of the picture tube is too close to the sync pulse. This is shown in Fig. 5C.

Elimination Circuits

Fig. 6 shows some horizontal-retrace elimination circuits used in TV sets. The voltage appearing at the output-tube grid in Fig. 6A (Motorola TS-525) is fed to the picture-tube control grid through an RC network. In Fig. 6B (RCA CTCCS), a tap on the flyback transformer secondary connects to the first anode of the 21AXP22 color picture tube through a capacitor-divider network. In Fig. 6C (G-E 21T7), a separate horizontal blanking tube is used to supply positive blanking pulses to the 21EP4B cathode. The blanking tube, one half of a 12AX7, is a cathode follower whose input comes from the width coil. Note that vertical blanking pulses also feed in at the 12AX7 cathode for the purpose of removing vertical retrace lines.

Another blanking circuit that uses a cathode follower—one half of a 6BL7—is shown in Fig. 6D (G-E 15CL100). Its input to the grid comes from a tap on the flyback transformer secondary; its output, taken from the cathode, feeds three cathodes of the color picture tube. Note that a similar blanking circuit—one half of a 12BH7—is used to feed vertical blanking pulses to the picture-tube cathodes, which results in the composite blanking signal at the junction of $R_{m}$ and $R_{n}$.

Adding a Blanking Circuit

Any of the retrace elimination circuits just discussed may be incorporated in various receivers. However, one very simple type that can be used is shown in Fig. 7. The high side of the horizontal yoke windings is connected to the picture tube’s first anode (or screen grid). This yoke supplies this electrode with a negative-going blanking pulse. It also supplies the first anode with "B+" voltage.

To install the network, remove the yoke blanking capacitor, C, which connects across the high side of the horizontal coils. This capacitor is usually 47, 56, or 100 μfd. In its place, a piece of insulated, shielded cable is used, the distributed capacitance of which serves as the balancing capacitor. The exact length of cable used depends on the value of C desired. A wire about 8 to 12 inches long should be suitable. Try different lengths experimentally for best results as indicated by observation of the left-hand side of the raster. A piece of 75-150- or 300-ohm transmission line can also be used for this purpose but its length should run a foot or more.

Disconnect the wire that supplied "B-" or boost voltage to the first anode of the picture tube and tape the open end properly with high-voltage tape. Connect the insulated shielded cable, as shown in Fig. 7. The center conductor connects to the high side of the yoke—usually the blue lead or pin number 3. The shielded end of the cable is connected to the center tap of the horizontal coils.

Tape the cable against the neck of the picture tube to hold it in place. Do not ground the shielded end since the cable must be connected in the circuit in exactly the same way as was balancing capacitor C. If this is not done, yoke ringing will occur. This results in several vertical lines appearing at the left side of the raster which gradually diminish in intensity as they approach the center.

In some yokes, balance is achieved without a capacitor. These include units in which both horizontal windings are connected in parallel or their center tap connects to a tap on the flyback transformer. In these cases, the method just described for introducing blanking generally cannot be recommended: the capacitance of the added length of wire might actually cause imbalance and disturb the left side of the raster. Instead, separate pickup coils, as shown in Fig. 8, can be used to obtain the blanking pulse.

Fortunately, such coils are commercially available. RCA, for example, has put them on the market. Whether the pulse induced in these added windings should be applied to the grid or cathode circuit of the picture tube may be determined experimentally by trying out both connections, reversing polarity of the leads in each case, and then determining which connection provides the best results. Generally connection should be made to the CRT cathode if video signal is fed to the grid, and connection is best made at the grid if video is applied to the cathode. Detailed instructions for installing the coils are supplied by the manufacturer.

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Fig. 7. An easy-to-add blanking circuit.

Fig. 8. Some horizontal blanking circuits in color and monochrome sets.

Fig. 9. Special coils may be used to pick up the desired horizontal pulse.

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January, 1959
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January, 1959
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Completely up to date the BE-5 will power all the newest transistor circuits requiring 9 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.

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 electronic technicians. Test leads and 1½volt supply are included with the kit. Shpg. Wt. 3 lbs.

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 1, 3, 15, 20, 30, 300, 1,000 and 5,000 volts AC and DC. Measuring direct current in ranges of 0-50 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.

AUDIO VTVM KIT
This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of either AC voltages. Features a large 4½" 200ua 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: 0-0.1, 0.1, 1, 1, 10, 30, 100 and 300 volts. Db ranges cover -52 to +62 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 $79.50
IN-CIRCUIT CAPACITANCE-TESTER KIT
This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mfd, 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 electrolytic, mica or ceramic types. Does not detect leakage nor check electrolytic capacitors. Electron beam "eye" tube is used for quick indication. A 5-position function switch which controls the power to the instrument and selects the test circuits. Easy to build and easy to use. Test leads included. Shpg. Wt. 6 lbs.

MODEL AV-3 $299.50
MODEL T-4 $199.50
MODEL C-3 $195.00

January, 1959
"APACHE" HAM TRANSMITTER KIT
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 singlesideband 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 bandwidth 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

HEATHKIT

HEATHKIT MODEL TX-1
MODERN STYLING
ROTATING SLIDE RULE DIAL
COMPACT, STABLE, VFO
PROVISION FOR SSB ADAPTER

$229.50

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

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 pre-assembled and wired in a scaled 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.

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 11 5/8" H. x 9 5/8" W. x 16" D. Shpg. Wt. 107 lbs.

$199.50

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

MODEL DX-100-B

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. 28 lbs.

$64.95

MODEL DX-40

DX-20 CW TRANSMITTER KIT
This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6GQ6A tube in the final for 90 watt plate power input, pi-network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

$35.95

MODEL DX-20
"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 30 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 preassembled, 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 communication. 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.

"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 31 tubes, modulator, and dual power supply. A pair of 6L46 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.

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 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 antennas relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 3 lbs.

MODEL VF-1 $19.95
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 40 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.

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 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.

January, 1959
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 gridded cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained 3/4" solid core Philippine 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): 823/4" W. x 361/2" H. x 20" D. Center Cabinet: 471/2" W. x 361/2" H. x 20" D.

STereo System

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

STEREO SYSTEM PACKAGE

MODEL SE-1 (center unit) $149.95 Shpg. Wt. 162 lbs.
MODEL SC-1 (speaker enclosure) $39.95 each Shpg. Wt. 42 lbs.

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 17 3/4" L. x 16" W. x 9 3/4" 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 33 3/4" 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 MODEL CE-1 $43.95 each

HEATHKIT MODEL RP-3 $64.95

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 33 1/3 and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33 1/3, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond L.P. 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 console 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 console. 14" legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. 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.

"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 ½" 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.
**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 selects 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-cascade 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.

**HIGH FIDELITY FM TUNER KIT**

The Heathkit FM-3A Tuner will provide you with years of inexpensive hi-fi enjoyment. Features broadbanded 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 negligible 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.

**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 FM-3A**

$26.95

**MODEL BC-1A**

$26.95

**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 full output. Taps for 4, 8 or 16 ohm speakers. Shpg. Wt. 31 lbs.

**MODEL W-4AM**

$39.75

**DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT**

Another famous Williamson-type high fidelity circuit, the W-4AM features 5881 push-pull output tubes and a special Chicago-Standard output transformer to guarantee your 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

**20 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 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. 32 lbs.

**MODEL W-6**

$109.95

**MODEL W-5**

$59.75

**MODEL W-4AM**

$39.75

**MODEL W-3AM**

$49.75

**HEATH COMPANY**

Benton Harbor 15, Michigan
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.

"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.

"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.

"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.

"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 cases hardened steel for hard use 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 3⅝ 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 3⅝ 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.

Many more Heathkits to choose from


Send for Catalog describing over 100 easy-to-build electronic instruments in kit form. Complete specifications and detailed information on Hi-Fi—Test—Ham and Marine kits.

Save with Heathkits...the quality name in kit form electronics.
“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 8½" D. x 4½" H. Output transformer has taps at 4, 8 and 6 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.

Order direct by mail...

Save ½ or more over equivalent ready-made products by buying direct and assembling them yourself. Heathkit Style, Performance and Quality are unsurpassed!

the World's Largest Manufacturer of Electronic Instruments in Kit Form

HEATH COMPANY BENTON HARBOR 15, MICH.

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SEND FREE HEATHKIT CATALOG

POSTAGE

TOTAL

HEATHKITS are also available at your Dealer see listing on next page
**World's Fastest Message Printer**

New 3000-word-a-minute teletypewriter prints at a speed 20 times faster than most people can talk.

Formed by the charge area is made visible by application of powdered ink, permanently fixed by the application of heat.

The recording head is made up of 35 tiny wires leading into and through a triangular-shaped piece of plastic. The wires are polished flush with one corner of the triangle, which is the print head, to form a rectangle seven wires high by five wires wide. This is the matrix—72 of them in a row to form a printing line. They do not touch the paper but are maintained at a fixed distance from the paper surface. Electrical pulses selectively charge the proper combination of wires in each head to form an image of a character. It requires only a small fraction of a second to set up the right charge pattern for an entire line of type. During the recording stage, the electrical discharge from the print head to a metal plate is used as the source of charge to form the electrostatic image on the paper. By using a low negative voltage on the point electrodes, tiny, round dots are produced that form the letters. This process is referred to as “electrostatic recording.”

The machine operates from standard code tape, or it can be plugged into long-distance radio or telephone circuits to print out messages sent from across the continent or overseas. Another use of this unique printing technique will be to type out the calculations of new military electronic computers.

In mass production, the high-speed printer is expected to cost half as much as the bank of eight standard printers it can replace. And since there are no moving parts, except for the paper transport, maintenance should be cut by fifty per cent. Repair of the electronic circuits will be greatly simplified by the system’s replaceable plug-in units.
Independent TV-Radio Service Dealers:

THIS AD IS FOR YOU!

next time you call a TV-Radio Service Dealer...

ask yourself these 4 questions

1. DOES HE HAVE AN ESTABLISHED BUSINESS FACILITY?
   It takes a big investment to set up a properly equipped TV-Radio service operation. When the Service Dealer has a place of business—particularly in your community—you can be certain he's planning to stay. Your business is important to him. As an independent small businessman in your community he's going to do everything he can to satisfy you. It's the only way he can assure his own future.

2. DOES HE GUARANTEE HIS WORK AND PARTS?
   It's standard practice to guarantee work and parts to most qualified dealers doing so. Be sure to find out the duration of the guarantee so that you will know just how long you are protected. Remember, however, the guarantee covers only the parts replaced by the dealer, not materials or labor used. If some other tube or component fails during the guarantee period the dealer cannot be held responsible.

3. DOES HE CHARGE A FAIR PRICE FOR A HOME SERVICE CALL?
   Be sure the Service Dealer you choose makes a rate that will be equal to his time and transportation expenses. Like any other businessman, your Service Dealer has basic costs: . . . overhead, rent, taxes, insurance, salaries, etc. . . . expenses that must be considered when he establishes his service call charges.

4. DOES HE PROVIDE AN ITEMIZED BILL?
   He should, for his own protection as well as yours. Then you know exactly what work was done, which parts replaced and exactly how much each cost. You both know what replacements are covered by the guarantee in case of an early failure.

If the answer is yes to all four of these questions, the chances are you'll receive fast, competent, expert TV-Radio service at prices that are reasonable.

What's more, the chances are he'll be a Raytheon Bonded Electronic Technician and that's an added bonus for you. These expert technicians offer a 90 day work and parts guarantee that is backed by a Bond issued through one of America's largest insurance companies. They observe a strict 8-Point Code of Business Ethics designed to protect you. For the quick, safe, sure solution to all TV-Radio servicing problems, call a Raytheon Bonded Electronic Technician.

Raytheon Quality TV and Radio Tubes Mean Better Set Performance for You.
When a Service Dealer replaces old tubes with Raytheon tubes or new tubes with Raytheon tubes, you're sure of your TV or Radio getting operation. Produced by Raytheon, proven by performance, these fine tubes are designed into the major TV and Radio standards of quality and performance. That's why you can be sure of the tube performance you need from Raytheon tubes. And you can be sure that Raytheon's reputation is the product of Raytheon's fine craftsmanship. That's why the Raytheon Tube Distributor is the one to call.

Raytheon is running this advertisement in the January 19, 1959 editions of NEWSWEEK and TIME magazines to help you. Read it carefully. It makes four simple suggestions to set owners who should result in substantial increases in service business for qualified Independent TV-Radio Service Dealers. It clarifies the set owners' misunderstandings about the standard work and parts guarantee. Giant blow-ups of this advertisement are available from your Raytheon Tube Distributor at no cost to you. Be sure to feature one in your shop window.

January, 1959
DYNACO

STEREODYNE
PHONO PICK UP

This new, unique pickup is made in Denmark by Bang and Olufsen. It features a push-pull magnetic principle (patent pending) which permits realization of the full potentials of the most modern recording techniques. The special attributes which make the Stereodyne an outstanding stereo pickup make it equally exceptional for monophonic discs. On any type of record the Stereodyne offers smooth and natural sound—firm clean bass and sparkling treble—while its light tracking pressure insures negligible record wear.

BEST in every way . . .
- Wide frequency response
  Smooth peak free response from 30 cps to over 15 kc
- True Stereo
  Highest channel separation over entire audio spectrum
- Precision balance
  Both channels identical
  Some high compliance (5 x 10^{-10} cm/dyne) in all directions
- No hum pickup
  Balanced coil structure plus low impedance plus complete shielding eliminates hum from external fields
- High output
  7 millivolts per channel even on low level stereo discs provides gain to spare
- No magnetic pull
  Special magnetic circuit eliminates attraction to steel turntables
- Easy installation
  Compact size and standard mounting centers simplifies mounting. 4 terminals to avoid hum loops
- Low price
  Only $29.95 net including 7 mil diamond stylus (replaceable in 2 seconds)

Available from leading high fidelity dealers everywhere

DYNACO INC.
Dept. RT, 617 N. 41st St., Phila. 4, Pa.
Export Division: 25 Warren St., New York, N. Y.

Hi-Fi-Audio

Product Review

JBL-RANGER "METREGON"

James B. Lansing Sound, Inc., 3249 Casitas Ave., Los Angeles 39, Calif. has recently introduced a new stereophonic loudspeaker system, the "JBL Ranger-Metregon". The unit contains two complete two-way loudspeaker systems. Sound energy from the speakers is directed from both sides of the enclosure toward a curved refractor panel. This integrates the two separate stereo channels into a single three-dimensional audio source. This feature is said to eliminate annoying "hole-in-the-middle" effects.

Measuring six feet wide and thirty inches high, the new unit employs an integrated stereophonic reproducer developed by the company in association with Colonel Richard H. Ranger. The enclosure (C45) is available in light or dark walnut, light or dark mahogany, light oak, Salem maple, natural birch, korina, and ebony finishes. For a data sheet giving complete specifications on this new stereo speaker system, write the manufacturer direct and request additional information on the C45 enclosure.

STEREO-MONOURAL AMPLIFIER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. is now offering a dual-channel basic power amplifier in kit form as the Model KT-310. The new amplifier is rated at 18 watts per channel and may be used with a stereo preamplifier to provide two 18-watt stereo channels. It may also be used monaurally as a single 36-watt power amplifier feeding one or more speakers or as two separate 18-watt monaural amplifiers. Dual inputs are provided, each with individual volume control. Other controls include a channel-reverse switch and monaural-stereo mode selector. Speaker output impedances (available on each of the two sets of terminals) are 4, 8, 16, and 32 ohms, thus permitting parallel operation of two speaker systems with impedances of up to 16 ohms.

Input sensitivity per channel is 45 volt for full output. Response is flat at better than ±1/2 db from 35 to 30,000 cps at 18 watts. Harmonic and IM distortion are below 1%. The circuit employs seven tubes including rectifier.

A data sheet complete with perforated metal cage and detailed assembly instructions. Over-all size is 9 1/2" (10" with controls) x 5 3/4" x 13 3/4". Write the company direct for further details and price.

SOUND LEVEL METER

American Research Laboratories, Fort Atkinson, Wisconsin has developed an acoustic sound level meter to meet the requirements of the fast expanding hi-fi and audio amplifier field. The Model D-50 includes a specially compensated microphone feeding a transistor amplifier. The amplifier is a 4-stage, high-gain, one-piece printed circuit. It has flat response from 200 to 40,000 cps. Below 200 cps the response drops off at 6 db per octave. To compensate for this drop a special equalizing network is inserted between the microphone and the amplifier input. This equalization produces a substantially flat response from 80 to over 10,000 cps. For applications where a greater range is needed, such as running over-all frequency tests on hi-fi equipment, a special chart is provided that shows the instrument response from 50 to about 15,000 cps.

When used to make frequency response tests on hi-fi set ups, this meter will provide a measurement that includes the speaker enclosure and the room acoustics as part of the over-all test.

A data sheet giving full details on the unit and its applications is available on written request.

TURNOVER STEREO CARTRIDGE

Recoton Corporation, 52-35 Barnett Ave., Long Island City 4, N. Y. has released its new compatible Series RG-745 magnetic stereo turnover cartridge.
which has been designed for use on all
turntables and changers and for all
speeds and types of records.

Two models are available, the RG-
745-1SD "Piggy Back" and the RG745-
3SD. Using a diamond .7 mil stylus on
one side of the cartridge, compatible
performance may be obtained on either
stereo or monaural LP records. On the
turnover side is a 1 mil sapphire needle,
providing a standby monaural car-
tridge.

The RG745-3SD is mechanically and
electrically the same as the 1SD but
carries a .7 mil diamond on one side
and a 3 mil sapphire for 78 rpm’s on
the turnover side.

NEW "CUSTOM" LINE
Pine-ee Furniture, Inc., 4228 West
Compton Blvd., Lawndale, Calif. has
entered the hi-fi field with a line of
components plus the custom cabinets
in which to house them.

One of the first items to be placed on
the market is an AM-FM tuner which
has been tradenamed “The Silva.” The
circuit provides FM stereo multiplex
facilities in addition to covering AM
and FM broadcasts. Sensitivity is 77
µv for 20 db quieting on FM and 3 µv,
at 60% modulation for .5 volt output
6 db signal-to-noise ratio. Tuning range
is 540 to 1600 kc. and 88 to 108 mc.
Frequency response is 20 to 20,000
cps ± 3 db on FM and 20 to 10,000
cps on AM. The tuner requires a total
of eight tubes and draws 40 watts. A
new a.f.c. circuit combined with a low-
drift oscillator provides a 16 db correc-
tion which captures and holds a station
precisely to a tolerance of ± 1 kc.

The companion stereo preamp serves
as a master control and preamplifier
for both stereo and monaural repro-
duction. The preamp includes two
separate and distinct hi-fi channels on
a single chassis plus four stereo out-
puts and eight equalization settings for
all types of recording programming.
There are 12 inputs for all signal
sources including ceramic phono, mag-

WHAT MAKES THE TD's
TOPS?

...finer for stereo...finer for mono

If you move in circles where component
hi-fi is a byword, you’ve no doubt heard
about the Thorens TD-124 transcription
turntable and its fabulous performance.
But for late-comers we’d like to point up
just a few of the really big features (non-
technical readers may skip remarks in
parentheses): • Extra heavy table for con-
stant speed (10 lb rim-concentrated table
insures low wow and flutter; higher mo-
ment of inertia than any similar table).
• Exact speed (± 3/4%) adjustment on all
speeds—16⅔², 33⅓², 45, 78—with built-
in illuminated strobe for setting after
stylus is on record). • Easy on records
(unique two-table design permits starts
after you’ve placed stylius, permits ¾
rev. starts, makes cueing easy). • Ex-
tremely low rumble (mirror-finish main-
bearing, nylon-seated ball-thrust-bearing
reduce both vertical and horizontal rum-
bles to a new low, so important for stereo).
• 2-way motor rumble reduction (both
an extra-large idler and an ultra-compli-
ant belt-drive keep motor vibration and
speed variations from table). Driving
parts electronically balanced. No costly
base necessary (only $9.00). 50/60 cy-
cles, 100/250 volt operation.

These are just a few of the TD-124’s
features. Ask your dealer to tell you the
whole story on the fabulous TD-124.

Now two budget-priced
TD turntables

These 4-speed turntables have same basic
adjustable-speed precision-drive as famous
TD-124 but you save two ways: (1) they come
already equipped with stereo-wired professional
arm without overhang making them ideal
changer replacements. (2) Some TD features
have been eliminated to save you money. But
they still top the performance of every similar
turntable and player on the market. TD-184
has semi-automatic operation. TD-134 is man-
ually operated. Precision metal stroboscope
(50/60 cycles) furnished with each unit.
100/250 volt operation. Wooden base only $6.00.
Grommes

PREMIERE SOUND

P.A. sound, sparkling clear and natural high fidelity which exceeds broadcast specifications. Created and engineered for the highest quality installations. This new sound amplifier series combines rugged durability, smooth versatile operation and true natural fidelity. Available in undistorted 20, 30 and 50 watt models. Ask your sound dealer for a Grommes Premiere Sound demonstration or for complete details, write...

TANDBERG STEREO CONSOLE

Tandberg of America Inc., 10 E. 52nd St., New York 22, N. Y. has just released a new stereo console which features a built-in intercom system.

The Model 10 console will play back stereo discs and stereo tapes as well as serving as the central sound system for the entire home. Provision is made for the connection of remote speakers to provide coverage of the living area. The built-in intercom feature permits hook-ups between the console speakers and remote speakers which may be located anywhere in the home.

The AM-FM radio set in the console features a short-wave tuner with four bands and 12-watt amplifier. There are four Tandberg speakers in the unit—two 8" and two tweeters with crossover and dividing network. The console is equipped with the company's Model 3-Stereo-FT tape unit with 4-track head and increased range of frequency response as well as a threesecond record changer. Power amplification for the second stereo channel is obtained through the Model 241 preamp.

The console is available in teak, mahogany, walnut, or blonde cabinets with brass-tipped tapered legs.

NORTRONICS STEREO AMPS

The Nortronics Company, Inc., 1015 S. Sixth St., Minneapolis 4, Minn. has announced the development of two new amplifiers designed especially for stereo playback and recording.

The Model PL-100 playback amplifier is a single-channel amplifier with ample gain to match any stereo tape head or stereo phono cartridge. It can also be used as a preamp to drive a more powerful amplifier. An equalization control allows the frequency response to be varied 15 db at 10,000 cps. This unit is housed in a modern-looking gold and black cabinet. It is rated at 3 watts.

The RA-100 recording amplifier is especially adapted to converting tape microphones which may also be used for tape head or magnetic phono cartridge input for recording, copying, or dubbing. It is housed in a companion cabinet to the PL-100.

For full details on either or both of these new amplifiers, write the manufacturer direct.

G-S STEREO CHANGER

Glaser-Steers Corporation, 20 Main St., Belleville 9, N. J. is now offering a new version of its "Seventy-Seven" record changer which has been redesigned for stereo applications. According to the company, rumble, wow, and flutter have been virtually eliminated by improved motor design. Features of the unit include a stereomonaual switch on the changer deck, quick-change cartridge holders, double-channel muting switch and RC network to eliminate noise during change cycle and at shut-off, service receptacle for automatic amplifier shut-off, automatic and full manual operation at 16½, 33⅓, 45, and 78 rpm, four-pole, hum-shielded motor with dynamically balanced rotor, acoustically damped tonearm, variable stylus pressure, and jam-proof mechanism.

The base measures 13¾" wide, 12" deep with 3" below motorboard and 5½" above board. A wood base, mounting board, and automatic 45 rpm spindle are available as accessories at additional cost.

SMALL "DUCTED-PORT" ENCLOSURE

Argos Products Company, Genoa, Illinois has recently introduced a new small-size speaker enclosure that is especially suited to stereo system applications.

The Model TS-1 will accommodate an 8" woofer and tweeter. It utilizes
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Send Us Your List Of Components For A Package Quotation

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AIREX RADIO CORPORATION 64-R Cortlandt St., N. Y. 7, CO 7-2137

two ducted ports (one on each end) for improved bass response. Although small enough to be used on a bookshelf (24" wide x 11" high x 10½" deep), the TSE-1 is designed for either table or floor use (standing vertically). Two of these units are ideal for stereo because of their small size and modest cost. The enclosure is covered with heavily ribbed pyroxylin fabric and uses a new decorator pattern grille cloth. It is being offered in either dark mahogany color or blonde. Internal volume of the enclosure is 2165 cubic inches.

G-E STEREO AMPLIFIERS

The Specialty Electronic Components Dept., General Electric Company, W. Genesee St., Auburn, N. Y. has announced the availability of two new "Stereo Classic" stereophonic hi-fi amplifiers, the Model MS-4000 and MS-2000.

The former is a 40-watt model with two integrated 20-watt channels while the latter features two integrated 14-watt channels to provide 28 watts. Each model has two power amplifiers and two preamp control units on a single chassis. Both were designed to handle stereo disc material as well as stereo and monaural tape and broadcast, and monaural disc program material.

Each amplifier incorporates an unusual and effective balance control which allows the listener to adjust the sound volume from both speakers for best stereo perspective. This adjustment is comparatively fine near the center point of the control, gradually raising the output from one speaker by one decibel while fading the other. As the knob is turned to its limit, the "faded" speaker is dropped to zero output. The other four of the seven knob controls are integrated dual types for simultaneous adjustment of both stereo channels. These knobs control volume, bass, treble, and contour.

Other features of these units include channel reversing to switch either channel to either speaker, rumble filter effective on all inputs, an independent switch position and input for monaural cartridges, low hum and noise, and better than 40 db channel separation.

Further information on these new stereo amplifier/control units is available from the company.

LOW-HUM AUDIO TUBE

The Electron Tube Division of Radio Corporation of America, Harrison, N. J., has introduced a new triode-pentode tube which has been especially designed for high-fidelity audio applications where low hum and noise are primary design criteria.

The RCA-7199 plus a pair of the new 7027 high-pervenance beam power tubes for LOWEST hum...noise...microphonics in a high-µ dual triode . . .

THE Ampex EEC83 A PLUG-IN REPLACEMENT FOR THE 12AX7

MICROPHONICS:

Negligible in amplifiers requiring an input voltage of at least 50 mv for an output of 5 watts. No special precautions against microphonics necessary even though the tube is mounted in the near vicinity of a loudspeaker with 5% acoustical efficiency.

HUM AND NOISE LEVEL:

Better than —60 db relative to 50 mv when the grid circuit impedance is no greater than 0.5 megohms (at 60 cps), the center tap of the heater is grounded and the cathode resistor is by-passed by a capacitor of at least 100 mfd.

OTHER Ampex TUBES FOR HIGH-FIDELITY AUDIO APPLICATIONS:

EL84/6BQ5 9-pin power pentode; 17 W PP
6C47/EL34 High-power pentode; 100 W PP
E866/6J6 Low-noise high-µ pentode
ECC81/12AT7 Low-noise medium-µ dual triode
ECC82/12AU7 Low-noise low-µ dual triode
GZ44 Cathode-type rectifier, 250 ma.
EZ81/6V4 9-pin rectifier; cathode, 90 ma.
EZ81/6AA4 9-pin rectifier; cathode, 150 ma.
RATED BEST!
by national consumers' publication!

Rated "SUPERIOR" To Tweeters
COSTING $150.00 and MORE!

REALISTIC in brand name, REALISTIC in price, REALISTIC in its smooth performance up to and beyond the range of human hearing, the fabulous Electrostat-3 is nationally recognized and "tops" among tweeters. Like all Realistic components—speakers, tuners, amplifiers, turntables—the Electrostat-3 is designed by Radio Shack audio engineers and sold only by Radio Shack by mail-order or through its three stores. Realistic products bring music lovers "wired hi-fi" at or below its kit prices and without sacrifice of any essential physical or electrical function!

IMPROVES EVEN THE FINEST SPEAKER SYSTEMS!

Designed to fill a void in the reproduction of high fidelity sound, the Electrostat-3 will extend the range of any speaker or speaker system to beyond 25,000 cycles. Its unbelievably wide sound dispersion angle opens a new world of acoustic brilliance!

EASY TO CONNECT AND USE!

The Electrostat-3 comes complete with simplified installation instructions for any speaker or system. All that is necessary is to plug in the AC power cord, connect an 8 or 16 ohm crossover network (see Electrostat-3 kit at left) and enjoy the finest high frequency response ever heard! An 8 ohm, 5000 cycle crossover network is recommended for the AR-1, AR-2 and KLH-6, and a 1600, 5000 cycle network for the KLH-4 and the Electrostat-3.

REALISTIC in brand name, REALISTIC in price, REALISTIC in its smooth performance up to and beyond the range of human hearing, the fabulous Electrostat-3 is nationally recognized and "tops" among tweeters. Like all Realistic components—speakers, tuners, amplifiers, turntables—the Electrostat-3 is designed by Radio Shack audio engineers and sold only by Radio Shack by mail-order or through its three stores. Realistic products bring music lovers "wired hi-fi" at or below its kit prices and without sacrifice of any essential physical or electrical function!
REALISTIC DELTA-7 SPEAKER
Ideally suited for use with the highly recommended Realistic Electrostat - for full range coverage 30-25,000 cycles. Hand rubbed mahogany or oak cabinet 24½ x 13½ x 11” deep. 160.
$8 Down
$7 Monthly
$79.95

REALISTIC 15-WATT AMPLIFIER
Full 15 watts — 18-30,000 cps ± 1 db @ 1 watt 20-20,000 cps ± 1 db @ full output. Wired for stereo. Solid metal case 9% x 6% x 8½”. Reg. $66.95.
$5 Down, $5 Monthly
$39.95

REALISTIC FM-AM TUNER
Loose noise cascade FM front end; sensitivity 2 uv for 30 db quieting. Ultra quiet AM. Freq. resp. 20-20,000 cps ± 1 db. List $95.
$6 Down, $6 Monthly
$57.00

REALISTIC FM-II TUNER
Sensitivity: 3 uv. for 30 db quieting. Freq. resp. 20-20,000 ± 1 db. Gold cabinet. 9½ x 4½ x 6¼”. List $61.95.
$5 Down, $5 Monthly
$39.50

REALISTIC “SOLO” SPEAKER
Genuine mahogany finish on 4 sides make it ideal for stereo twins. Dual-cone 50.14,000 cps. in solid, tuned enclosure with duct type vent. Matches 4-8 ohms. 14½ x 11 x 10½”.
$15.95

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Electrostat 3    lbs  36C0137  $97.75
Delta7 Speaker 45 lbs. RX-10665Y  $79.95
Solo Speaker 12 lbs. RX-5060  $55.95
15-watt Amplifier 15 lbs. 33C0013  $95.95
FM-AM TUNER 15 lbs. 36C0233  $95.00
FM TUNER FM-15 9½ lbs. 36C0802  $95.00

☐ Radio Shack 1959 Hi-Fi Buying Guide

Name
Address
City
Zone
State

January, 1959
STEREO High Fidelity...build your own at great savings

Stereo Preamp Control Center Kit
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; all can be permanently connected and controlled from single switch. 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; cathode follower output and special recorder outputs; hum-free (DC on all tube filaments). Exclusive printed-circuit switches and boards. Custom styled case, 4½ x 13 x 8". Shpg. wt., 17½ lbs.
Model Y-776. Net only $62.50
Easy Terms: Only $32.50 Down

60-Watt Stereo Basic Amplifier Kit
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 from 10 cps to 42,000 cps, Phenomenal 0.05% 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 8½". (Less cover) 36 lbs.
Model Y-777. Net only $84.50
Easy Terms: Only $8.45 Down
Model Y-779. Gray metal cover. 4 lbs. Net...$6.50

EXCLUSIVE PRINTED CIRCUITRY
KNIGHT-KITS incorporate the latest technical advances; many include exclusive printed-circuit switches, as well as printed circuitry. You save time and you can't go wrong.

EXCLUSIVE CUSTOM STYLING
KNIGHT-KIT hi-fi components, as easy to look at as they are to assemble, are professionally designed to take their place alongside the finest of home furnishings. You'll be proud of your finished work.

Top-Value 12-Watt Complete Amplifier Kit...Best Buy in Hi-Fi

 nunca 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, 30-18,000 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-out EL84 output tubes; virtually hum-free performance. Handsomely styled to look well anywhere; size with cover, 5 x 9½ x 7½ lbs.
Model Y-784. 12-Watt Amplifier Kit, less cover. Net only $19.95
Model Y-783. Attractive French-gray cover for above. 3 lbs. Net only $3.95

EASY TERMS ON KNIGHT-KIT ORDERS AS LOW AS $20
the kits with the GUARANTEED specifications

SEE ALLIED'S 1959 CATALOG FOR COMPLETE DETAILS
For full descriptions of the KNIGHT-KITS below, see the 452-page 1959 ALLIED Catalog. If you haven't a copy, send for it today—use coupon on following page.

There's a money-saving knight-kit for every quality Hi-Fi need

* MONEY-BACK GUARANTEE
Every KNIGHT-KIT meets or exceeds published specifications, or we refund your money in full.

Universal Stereo Control Kit
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 7½ x 4½. 3½ lbs.
Model Y-776. Net only $9.95

Deluxe Hi-Fi Preamplifier Kit
Quality audio control center; 15 combinations of equalization; 8 inputs including tape head; DC on all tube filaments; printed-circuit switches and boards. Custom-styled. 12½ lbs.
Model Y-754. Not only $39.95

18-Watt Hi-Fi Amplifier Kit
Superb hi-fi specifications; deluxe custom styling. Includes 8 inputs for every desired signal source; full equalization; printed-circuit switches and boards for easy assembly. Shpg. wt., 15 lbs.
Model Y-797. Net only $33.95

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.
Model Y-762. Net only $76.95

25-Watt Hi-Fi Basic Amplifier Kit
Williamson-type circuit. Response, ±0.5 db, 9-70,000 cps at half power. Includes balance control; calibrated damping control; posted output transformer. Shpg. wt., 23 lbs.
Model Y-783. Not only $44.50

Hi-Fi Basic FM Tuner Kit
Authentic Hi-Fi FM response. Includes AFC, flywheel tuning; pre-aligned RF and IF coils, 4 microvolt sensitivity guaranteed. Printed-circuit board for easy assembly. Custom-styled case.
Shpg. wt., 12 lbs.
Model Y-751. Not only $38.95

2-Way "Ducted Port" Hi-Fi Speaker System Kit
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 28 x 14". Shpg. wt., 30 lbs.
Model Y-789. Not only $49.95

Deluxe "Ducted Port" 3-Way Speaker System Kit
Model D2-262. Not only $73.45

Amateur Communications Receiver Kit
IT'S THE BEST • BUILD IT YOURSELF AND SAVE!
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-standby-rec, 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 5-meter.) 23 lbs.
Model Y-726. Not only $104.50
Easy Terms: Only $10.45 Down
Y-727. S-Meter Kit for above. 1 lb. Net $10.75
Y-728. 4" speaker in matching cabinet. ½ lbs. Net $7.50

POPULAR AMATEUR knight-kit VALUES!

50-Watt CW Transmitter Kit
Model Y-255. Not only $38.95

Self-Powered VFO Kit
With built-in power supply. High stability; excellent keying; full TVI suppression. Planetary vernier drive. Calibrated for 80, 40, 20, 15 and 10 meters; output on 80 and 40 meters. Shpg. wt., 11 lbs.
Model Y-725. Not only $29.50

Z-Bridge Kit
Accurately measures SWR from 1 mc to 150 mc. Also measures antenna impedance. Has coax input and output. Invaluable for attaining peak antenna efficiency. Shpg. wt., 1½ lbs.
Model Y-253. Not only $5.85

100-kc Crystal Calibrator Kit
Crystal frequency standard for any receiver, at very low cost. Gives marker every 100 kc up to 35 mc. Trimmer for zero-beating with WWV. With crystal. Shpg. wt., 1 lb.
Model Y-256. Not only $10.95

O R D E R  F R O M  A L L I E D  R A D I O  •  1 0 0  N .  W E S T E R N  A V E .  •  C H I C A G O  8 0 ,  I L L.
Fun to build... with performance you'll proudly demonstrate KNIGHT-KITS are the first choice of hobbyists, experimenters and students because they're truly "convenience-engineered" for easiest assembly, absolute dependability and finest performance. You'll have more building fun, you'll have more enjoyable performance, you'll save more with KNIGHT-KITS.

"Space Spanner" Receiver Kit
Thrilling 2-band receiver, easy to build, fun to operate—a terrific value. Bandswitch selects exciting short-wave, including foreign broadcasts, amateur, aircraft, police and marine radio (6.5 to 17 mc), and standard broadcast. Highly sensitive regenerative circuit. Built-in 4" PM speaker and beam-power output for strong volume. Has headphone jacks and switch to cut out speaker. Easy to assemble from step-by-step instructions. Handsome cabinet, 7 x 10½ x 6". AC or DC operation. Shpg. wt., 7½ lbs. Model Y-259. Net only... $18.95

"Span-Master" 4-Band World-Wide Receiver Kit
Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself! At the flip of the bandswitch, you tune in the world—continuous 4-band coverage from Broadcast to 30 mc—fascinating foreign broadcasts, ships-at-sea, aircraft, police and marine radio, amateur reception on 80, 40, 20, 15 and 10 meters—all this wonderful short-wave, plus enjoyable foreign broadcast reception. Features sensitive regenerative circuit, easy bandspread tuning; built-in 4" Alnico V speaker; headphone terminals; speaker cutout switch. Controls: Main Tuning, Bandspread, Bandswitch, Volume, Coarse and Fine Regulation. Easy to build from marvelous instruction manual. Handsome cabinet, 6½ x 13½ x 8½". For 110-125 v. AC. Shpg. wt., 7 lbs. Model Y-258. Net only... $24.95

"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
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"Ranger III-PC" AC-DC Radio Kit
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You'll be proud of the performance of this easy-to-build clock-radio. Provides wonderful broadcast band reception. Includes Telexchron clock with sleep-switch timer plus automatic radio wake-up/alarm switch. Radio automatically shuts off at night and wakes you in morning; also turns on appliances automatically. Module plug-in circuits on printed-circuit board for quick, easy assembly. Beautiful blue and white plastic cabinet. 8 x 9½ x 5½". For 60 cycle AC only. Shpg. wt., 5 lbs. Model Y-737. Net only... $24.95

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Tiny 1-transistor radio for local broadcast reception. Works for months from single penlight cell supply. Handsome plastic case. Fascinating to build. (Requires headphones and antenna.) 8 oz. Model Y-787. Net only... $2.45

"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/Receiver, smartly styled speaker. With connecting coil. AC or DC. Shpg. wt., 8 lbs. Model Y-739. Net only... $27.50

"Ranger" AC-DC Radio Kit

12-In-1 Electronic Lab Kit
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2-Transistor Pocket Radio Kit
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$11.50

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Photoelectronic Relay Kit
Ultra-sensitive relay at very low cost. Fine for automatic control of lights, door openers, as a burglar alarm, etc. Shop wt., 5½ lbs. Model Y-702. Not only...
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Y-703. Light Source only...
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Top buy in a quality VTVM. Entire chassis is printed-circuit board—easy to assemble. Balanced-bridge, push-pull circuit; 1½ film-type resistors. 200 μa movement; 4½ meter; includes zero center scale and direct-reading db scale. Polarity reversing switch. Input Res. 11 mgs. DC and AC rms. 0-15-30-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-400-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-10-100-10000 mgs; db. —10 to —45. Includes battery and test leads. For 110-125v., 50-60 cycles. Shpg. wt., 6 lbs. Model Y-125. Not only...
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452-PAGE
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<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Model No.</th>
<th>Price</th>
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</table>

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Industrial Tubes
(Continued from page 40)

radio engineering field. In the process of developing insulators for the high-frequency conductors used in radio transmission, the insulators became very hot despite the fact that they were poor electrical and thermal conductors. Investigation revealed what proved to be the basic theory behind dielectric heating.

To simplify the explanation, we will translate the high-frequency conductor into a parallel-plate capacitor with the insulator as the dielectric material between the plates. When voltage is applied to the plates of the capacitor, the electrons in the insulating material are attracted towards the positive plate while the atomic nuclei are attracted toward the negative plate. Both reactions occur simultaneously and are accompanied by an energy conversion which is manifested as heat. If the voltage polarity applied to the plates is reversed, the electrons and nuclei will also reverse direction and produce more heat. As the frequency of polarity reversal increases, so will the amount of heat produced.

Unlike induction heating, dielectric heating reaches all parts of a homogeneous material equally. In fact, because heat can escape faster from the surface of a work piece, it is possible to have higher temperatures at the center. One case is reported where the center of a 1-inch thick plywood board was actually cooler while the surface was unmarked. This characteristic involves both advantages and disadvantages; the thorough, rapid heating is a definite advantage while the necessity for careful control and possible reduction of power input is a disadvantage.

We are now in a position to look at some of the uses for dielectric heating. The largest areas of application are moisture removal, wood gluing and laminating, plastics processing and sealing, and food processing. Although the materials handled in these areas are obviously different, they all have one characteristic in common: each and every one of them is a poor thermal conductor. In fact, it is the ability to heat materials which are poor thermal conductors that makes dielectric heating such an important industrial tool.

For instance, consider the problem raised when wood pulp is shipped from the mill to the paper plant. Since wood pulp consists of wood fibers in a water solution, a significant percentage of the shipping costs is for haulage water. Naturally a solution to this problem would be to eliminate the water before shipment and put it back in at the paper plant. But how? The conventional equipment to handle this job would be both enormous and expensive.

On the other hand, a 20-kilowatt dielectric heater (size about 6 x 4 x 4 feet) will remove one pound of water per minute at room temperature with a power input of only 40 kilowatts per hour. In addition, the dielectric heater raises the temperature of the water at a much faster rate than the wood fibers, thus the fibers remain relatively cool and unharmed. Conventional methods do not have that safety feature.

One of the most attractive features about dielectric heating is its relatively low-power requirements. Not

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**Table 2.** Power and frequency ranges of industrial equipment discussed in text.

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>FREQUENCY RANGE</th>
<th>APPROX. POWER</th>
<th>APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction Heating</td>
<td>10-500 kc, more</td>
<td>25 kw.</td>
<td>Small soldering and welding units</td>
</tr>
<tr>
<td>Dielectric Heating</td>
<td>1-500 mc, more</td>
<td>2 kw.</td>
<td>Restaurant ovens (&quot;Radarange&quot;)</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>20-30 kc, 400 kc</td>
<td>1 kw.</td>
<td>Clothes and dish washers, small industrial cleaners</td>
</tr>
</tbody>
</table>

**Table 3.** Listing of heating times and power requirements for solder operations.

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>HEATING TIME (sec.)</th>
<th>POWER REQUIRED (kw.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Soldering</td>
<td>at 370°F (per in² area)</td>
<td></td>
</tr>
<tr>
<td>steel</td>
<td>brass</td>
<td>copper</td>
</tr>
<tr>
<td>20</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>40</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Silver Soldering</td>
<td>at 1300°F (per in² area)</td>
<td></td>
</tr>
<tr>
<td>steel</td>
<td>brass</td>
<td>copper</td>
</tr>
<tr>
<td>20</td>
<td>8.0</td>
<td>16.0</td>
</tr>
<tr>
<td>40</td>
<td>4.0</td>
<td>9.6</td>
</tr>
</tbody>
</table>

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*Radio & TV News*
Ultrasonics

Ultrasonics is concerned with the use of mechanical vibrations at frequencies above the audible range. The difference between audible sound and ultrasonics lies only in the ability of the human ear to respond. Many ultrasonic generators operate between 20,000 and 30,000 cps while some operate as high as 400,000 cps.

The equipment consists of an electronic generator of high-frequency energy and a transducer to convert the electronic oscillations to mechanical vibrations. The generator is simply a power oscillator and is very similar to the induction and dielectric heating generators. The transducer is a device that converts electrical energy to mechanical energy. An ordinary loud-speaker is one example of a transducer. This transducer uses air as the medium being operated on while the medium used for most ultrasonic transducers is a liquid, frequently water. The ultrasonic transducer is in direct contact with the liquid and either produces cavities in the fluid or waves, which travel through the liquid without disturbing it. As the holes or cavities in the water collapse, a turbulence is created which provides a gentle, effective scrubbing action. The scrubbing is so effective that it will even remove radioactive particles and yet it is gentle enough to clean a delicate missile control while it is still assembled.

Cleaning is the largest industrial application for ultrasonics, although ultrasonic drills and soldering irons are also used.

There are many applications for the non-violent ultrasonic waves. The largest application in this category is underwater detecting equipment, such as sonar, depth indicators, and fish finders. Other uses are for liquid level sensing, non-destructive testing, and gauging.

Of the three high-frequency industrial applications, ultrasonics has the lowest power consumption. The most popular size is 1 kilowatt and some recent applications use less than 200 watts. The lower-power equipment is portable, being not much larger than a table radio.

Conclusion

Now that we have had a brief look at some industrial uses for electronics, we can get a small idea of the immensity of the field. We can see that there are a good many uses for electronic tubes that are not directly related to consumer products, such as radio and TV receivers. The technician who wants to expand his scope would certainly do well to learn as much about these applications as he can. —Ed.
These men are getting practical training in...

Electronics
ELECTRICITY
ELECTRONICS
ON REAL
Motors • Generators
Switchboards • Controls
Modern Appliances
Automatic Electronic
Control Units

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RADIO ELECTRONICS
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TV RECEIVERS
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AM FM • FM • AM Transistors • Printed
Circuits • Test Equipment

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ASSOCIATED RADIO & TV SERVICEMEN OF ILLINOIS

ALTHOUGH not a large group in terms of numerical strength, ARTS of Illinois has made its presence felt on more than one occasion since its inception six years ago. The circumstance of its birth centers about an effort being made at that time to get service-licensing legislation approved by the Illinois state legislature.

Howard Wolfson, a small, independent service dealer in Chicago who is now ARTS chairman, had little to do with association activities up to that time. However, he had deep convictions concerning the regulation of business by government. He felt that TV service licensing, to begin with, was discriminatory. With a long tradition of unfettered operation of those engaged in service and repair, whether it be of watches, autos, washing machines, or anything else, singling out of the TV technician for control would be to make him a scapegoat. In any case, interference from government could only bring harm to the industry, which must look to other approaches for the solution to its problems.

Disturbed over the threat he felt licensing to be for TV service, Wolfson began to contact other dealers in the state, by telephone, by mail, and in person, to let them know about the proposed legislation and to sound them out on their own attitudes. The group of like-minded dealers he got to join with him at that time to work for the defeat of the bill formed the basis for ARTS.

The group stands today, along with other groups as TEAM of St. Louis, as a leader in the fight against any licensing as being repressive, restrictive, and discriminatory.

ARTS relies heavily on the power of communication. It keeps in contact with many other groups in all parts of the country on matters of mutual concern. It played a key role, for example, in the formation of the American Electronic Alliance in 1956, and again in the more recently formed Midwest Electronic Alliance. Although its stand on licensing and other basic issues has kept it from affiliating with NATESA, it has worked with many local groups in and out of that national body.

"Back-door" selling by jobbers and bait advertising have been some of its targets. In connection with the latter, it has been one of the groups that have actively cried out against ads in telephone directories by service establishments that use such gimmicks as "free estimates" and "free service calls." Publishers of the directories and the telephone companies have agreed with the complainants that such advertising is not in the public interest and have stated that they will discourage it.

On the technical side, ARTS conducted one of the first color training schools for service in the midwest in 1954. It is now conducting a similar technical series on transistors.

Elected annually in September, its officers now include Howard Wolfson, chairman; Joseph Ehlinger, vice chairman; Yuki Minaga, secretary-treasurer; George Neize, sgt-at-arms; Anthony Mallin, historian; and John Sotor, public relations. Its 30-odd members are all full-time service business men with full-fledged establishments. Located at 433 S. Wabash Ave., Chicago 5, Ill., it issues its publication, "Common Sense," on a rather individual schedule. This mimeographed paper does not have a regular publication date: it comes out whenever its members have something to say.

ARTS feels that the industry will prosper through the constant education of shop owners, technicians, and the public.

Would you like us to feature your association here? Send in the coupon!
Service-Business Problems
(Continued from page 50)

their percentages of call-backs by taking more time to check and analyze each set. Other dealers keep a close check on the stability of tubes by brands and types and standardize on those that show up best in performance and reliability.

A serious problem that confronts all dealers—large and small—is the relatively low wage scale for TV technicians employed in the independent service industry. The U. S. Department of Labor, through its Bureau of Apprenticeships, has shown a keen interest in helping to develop standards and apprenticeship-training courses for TV technicians. Most of this effort will be lost to the independent service industry unless dealers generally give serious thought to the adoption of service pricing schedules that are commensurate with the actual costs of operating in today's market.

The endless demands on the time of all people who operate small businesses make bookkeeping, cost accounting, and analysis a chore they must fit into the odd moments they can snatch between doing other things. Since accurate records are the only "road maps" a dealer can have to show him where he is headed business-wise, slipsheets and bookkeeping often grease the path to failure. Excellent bookkeeping services are now available everywhere at a very nominal cost and many dealers have turned this specialized function over to them.

Old customers, who are the mainstay of many small service businesses, often pose a serious credit problem. How to collect a service bill from a slow-pay old customer without offending him is a problem that stymies many. Since the bulk of service work of all types is handled only on a strictly COD basis, a dealer faced with a lot of old customer-credit business could profit from the use of some of the standard programs now available that nudge slow-pay accounts without offending them.

At the end of our list of service management problems, we come to the accumulation of completed service jobs which, for one reason or another, customers have not picked up or paid for. These are comparable to the "layaway" headaches the average retailer finds piled on his shelves, on which the customers have paid inadequate small deposits. Numerous plans have been developed to accommodate such delays to collect in advance for the time involved in handling the work, and to get customers to pick up the sets promptly after completion of the work. These will be covered in a future article.

This, in brief form, covers ten of the current top problems faced by managers of electronic service businesses. They are discussed in greater detail in subsequent issues.

January, 1959

---

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AS SLICK AS YOU DO THE EASY ONES...

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102

RADIO & TV NEWS

Test Bench PUZZLER: No. 4

By WAYNE E. LEMONS

The a.g.c. played hide-and-seek only with the set in the cabinet—but the cause was really simple!

This DEFECT was simple—after we found it. Most of them are. The symptoms were loss of sync and improper a.g.c. action, with a capricious addition to a sort of motorboating instability. The latter indication was much like that encountered on this KCS108 and other RCA receivers when the stability or noise-limiter control is misadjusted.

Some rough cases leave you sweating at the service business in general. This was one of them. In addition to being intermittent, it was also temperamentally, obstinately refusing to show up except when the chassis was inside its cabinet with all screws inserted and tightened!

We began by checking the a.g.c. voltage at the tuner (a convenient terminal), where practically none was found. Rotating the a.g.c. control had no effect. Next, using a socket adapter, we shorted the grid of the a.g.c. keyer tube (point I in the diagram) to the cathode. Since this zero-biased the keyer, it should have produced maximum conduction of this stage, if the keyer were operating properly, with a high negative voltage on the a.g.c. line as a result. This step did produce an approximately high negative voltage. In that case, we reasoned, the keyer was not getting proper conduction bias.

Using the socket adapter again—and holding our breath, hoping the set wouldn't decide to start working normally again—we checked voltage at the plate of the 6A8A videomplifier, point 2. The reading was below the normal 122 volts expected here. The tuner was then switched off-channel. The change in plate potential at point 2 produced by this switch was less than five volts. This could mean a high resistance in the plate circuit of this stage or inadequate grid bias.

In this circuit, which is shown here in simplified form although no important elements have been left out, the video amplifier grid is biased directly by the germanium-diode video detector. Thus a stronger signal will normally cause the grid to go more negative. Measured with a strong signal coming in, the grid voltage was about -2.5 volts. With the receiver switched off-channel, there was practically no change in this reading.

Now convinced that the diode itself was defective, we made a resistance check from the grid of the video amplifier (output of the detector, point 3) to ground. 4000 ohms was measured one way; with the ohmmeter leads reversed, the reading was 2500 ohms. Since this seemed like the trouble, the chassis was pulled from the cabinet, the diode was replaced, the set was restored to the cabinet, and turned on. It worked—for almost an hour. Then, the same symptoms appeared.

A re-check of the set brought us right back to the detector, where readings were as noted earlier. You have all the facts available to the service technician before he finally waves his hat with this dog. What do you think the trouble was? In case you're getting ideas, it was not a case of the replacement diode being as bad as the original. As the author states, it was really a simple thing. However, if you've had your share of rough jobs for the dog, you can get the answer quickly by turning to page 156.

This nightmare involved the noise canceller, video amplifier, and a.g.c. keyer.
ARMY MARS TECHNICAL BROADCASTS

Here is the January schedule for the First Army MARS SSB Technical Net whose purpose is the dissemination of technical knowledge by radio communication.

Transmissions are on Wednesday evenings, 9 P.M. (N. Y. Time, EST) on 40-meter sideband.

Jan. 7—"The Modern Approach To Front End Receiver Design" by M. M. Klein, Manager, Engineering, Research and Development, Hewlett-Packard Corp.

Jan. 14—"TRAK—Morse Code To Tele-Printer Converter" by T. Waldron, Group Leader, Information Conversion Group, TRW Laboratories.

Jan. 21—"Phone Patches" by Robert W. Gunderson, Editor, Braille Technical Press.

Jan. 28—"Measurement of Nuclear and X-Ray Radiation" by William Mino-witz, Physicist, Nuclear Products Division, Amperex Electronics Corp.

Robert C. Sprague, right, chairman of the board of the Sprague Electric Company, is shown congratulating Harry Kalker, president of its subsidiary, Sprague Products Company, on its 25th Anniversary. The firm was founded under Mr. Kalker's direction in 1933 as the distributor division of parent organization. The actual Anniversary took place in the fall of last year.

Within the Industry
(Continued from page 24)

division has been made known . . . GEORGE TALLENT has been elevated to the post of manager of quality control, semiconductors, CBS-Hytron . . . Magnetic Amplifiers, Inc. has appointed ROBERT O. BAXTER assistant treasurer . . . STEWART NELLI has been named sales manager of Technical Wire Products, Inc. . . . DAN W. BURNS and ROBERT T. CAMPION have been elected vice-presidents of The Siegle Corp. . . . WILLIAM T. WELSH has become vice-president and sales manager of Cook Electric Co. . . . A. D. BOBROW has been appointed director of automotive sales of Van Norman Industries, Inc. . . . Zenith Radio Corp. announces the appointment of HAROLD F. DRISS-COLL as advertising manager.

RSA has named CHARLES M. ODORIZZI as group executive vice-president, consumer products and services . . . Sylvania Home Electronics named G. T. STEWART manager of national distribution.

FOR HIGH PROFIT
...and Little Competition
GET INTO MOBILE-RADIO MAINTENANCE

Wherever you see the tell-tale vertical antenna . . . on cars, trucks, or trains . . . atop a building or mast . . . it's your rip-off—for these outfits require first-rate, regular, radio maintenance . . . and they pay high profit!

LAMPKIN METERS ARE THE PREFERRED TEST EQUIPMENTS!

LAMPKIN 105-B MICROMETER FREQUENCY METER

Use it for any type, Range .01 to 175 MC (to 3,000 MC by checking multipliers). Pinpoint VHF CW signal source. Weight 10 lbs. Width 13". Price $220.00 net.

 Ask for our booklet "HOW TO MAKE MONEY IN MOBILE RADIO MAINTENANCE". Do it NOW! There's no charge.

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ALL ELECTRIC
SHAVERS
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terado COMPANY

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1058 RAYMOND AVE., ST. PAUL, MINNESOTA
IN CANADA: ATLAS RADIO CORPORATION LTD., ONTARIO
in Fig. 3. Balance between channels is achieved by the control at the extreme right, $R_6$, $R_5$ in the front view. Separate bass and treble controls are used for each channel, at the author's preference, in order to maintain flexibility and experiment with intentional tone unbalance of the two channels. However, the individual may prefer single bass and treble controls. If so, he may replace $R_5$, $R_6$, $R_7$, and $R_8$ with dual 50,000-ohm pots. To properly adjust the amplifier, set all controls except "gain" at mid-range and set "gain" at a very low level. Using a tone test record (stereo if available, but monaural will do) plug in one input and adjust bass and treble for flat output (or accent highs or lows if preferred). Then plug in the other input and remove the first, adjusting the other bass and treble. Now check the volume from each channel to see if they are equal. If possible do this with a tone record input and an a.c. meter across the voice coil. If this is not feasible, judgment by listening will suffice temporarily. Adjust the balance control until the two outputs are equal. Now overall gain of the system can be adjusted with the master gain control. There is a possibility that the two sections of the pot used for this control may not have equal resistance throughout their entire ranges, resulting in system unbalance at certain gain settings. About the only solution here is to try another pot, or be content to rebalance the amplifiers at these points. Theoretically, if bass or treble is readjusted, both channels should be changed by the same amount. It has been interesting, however, to experimentally unbalance the tone controls and observe results on various records.

Note that the balance control provides full range from zero to full output for each channel. This, of course, results in a loss of over-all available gain. The author prefers this system since there is a great surplus of gain and full range is desired to experiment with effects and to demonstrate with one channel cut off. If less flexibility and more gain is desired, simply change $R_5$, $R_6$ to 100,000 ohms and add 470,000-ohm resistors in series with the low side of $R_5$, $R_6$ to ground. This will allow variation in gain of each channel of about $\pm 20\%$ and will nearly double the preamplifier gain. Such gain is unnecessary and is, in fact, useless unless a lower output cartridge and more powerful speakers are used, but it is mentioned here to clarify the design.

The Speakers

The speaker system consists of two 6- by 9-inch oval speakers in conventional bass reflex cabinets built into opposite ends of the wall, as shown in Fig. 4. Anyone using an automobile rear-seat speaker will verify that the oval speakers sound pretty good and they proved to be satisfactory in this application. The cost of sound-absorbing insulation in the speaker cabinets was saved by stapling egg cartons of the soft paper variety to the walls. If you choose small low-cost speakers, remember the amplifiers deliver 10 watts output at full volume. Keep your volume control down to a reasonable level to avoid ruining speakers which may be rated at only 5 watts.

Speaker Placement

Proper phasing of the speakers is obtained by listening for maximum sound reinforcement midway between the two speakers and reversing the leads to one of them, if necessary, to obtain this reinforcement. Improper phasing will leave a "hole" in the music at this central point. A monaural record is helpful in checking for proper speaker phasing.

Referring again to the room diagram of Fig. 4, it is now believed by some that the speakers should be aimed straight out from the wall—not at 45° angles as was once thought. The room is a 12- by 14-foot family room, panelled in knotty pine—a good reflector of the highs. An excellent stereo effect is achieved in most of the room as indicated in the diagram. A "listening test" of the system was made by several friends. Besides being highly pleased with the stereophonic sound, they commented that the panoramic effect when playing monaural records make this unit sound better than most single-channel high-fidelity systems they had previously heard.
Transistorized Midget TV

This G-E design works well on battery power.

WHAT IT believes to be the world's first battery-powered TV set that falls into the truly compact, personal-portable classification is now being demonstrated by the General Electric Company. Completely transistorized, the Liliputian receiver weighs 10 pounds and is about the size of an automatic toaster. It can be operated from house current as well as from its integral battery.

A G-E spokesman points out that the tiny set is a developmental model, not yet ready for consumer introduction. Nevertheless, it is fully operative, with sensitivity and performance claimed to equal that of a conventional full-sized TV set. It does a good job on its built-in antenna.

Only 8½ inches high, 7¼ inches wide, and 7¼ inches deep, this eye-catcher is covered in vinyl plastic and is equipped with a carrying strap. Its 22 transistors work with a picture tube that has a diagonal measurement of 8 inches. No other tubes are used in the design. Power is supplied by a rechargeable silver-cadmium battery that will provide three to four hours of continuous viewing pleasure. The set can then be recharged while it is being used on house current.

When will the set go on the market? Blocking a price low enough to be accepted by consumers right now is the current cost of transistors. However, the competitive effect of low-priced, imported transistors and other developments, one spokesman ventured, are cutting down this cost factor rapidly. As a result, 1961 may well be the year for mass production of these handy sets at reasonable prices.

January, 1959
COYNE offers LOW COST TELEVISION Training in Spare Time AT HOME

The future is YOURS in TELEVISION—RADIO COLOR TV!
A fabulous field—good pay—fascinating work—a prosperous future! Good jobs, or independence in your own business!

Coyne brings you Modern—QUALITY Television Home Training; training designed to meet Coyne standards. Includes RADIO, UHF and COLOR TV. No previous experience needed. Practical Job Guides to show you how to do actual servicing jobs—make money early in course. You pay only for your training, no costly "put together kits."

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Send Free Book and details on how to get Coyne Quality Television Home Training at low cost and easy terms.

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RAF TUBE TYPES
RCAF has published a revised and expanded edition of its illustrated catalogue on "Photosensitive Devices and Cathode-Ray Tubes."
The 32-page booklet presents technical data, basing diagrams, and brief test descriptions on more than 130 of the firm's tube types. Photographs of representative tubes are shown throughout the publication.
The booklet is available from the company's Electron Tube Division, Harrison, N. J., at a cost of 30c.

SOLDERING TOOL CATALOGUE
A new comprehensive catalogue illustrating and describing the complete line of Vulcan Electric Company's soldering tools is now available.
Specifications and prices are included, as well as technical information on screw and plug tips.
The booklet is available upon request to the company, 88 Holten St., Danvers, Mass.

COIL BOOKLET
A new specifications booklet, "Tungsten Coils for Vacuum Metallizing," has been made available by Sylvania Electric Products Inc.
Containing information on all standard vacuum metallizing coils manufactured by the company, the booklet lists each coil according to dimensions and type of metal rather than by arbitrary code number.
Copies may be obtained from the firm's Chemical and Metallurgical Division, Towanda, Pa.

NEW G-E PUBLICATION
The extension of high reliability manufacturing techniques to commercial receiving tubes is described in a new General Electric publication (ETR-1541-2).
The 24-page booklet discusses the use of gold and silver in grids, anti- lint and dust measures, testing procedures, and design and engineering considerations in connection with the firm's line of television receiving tubes.
Copies are available through the company's receiving tube department, Owensboro, Kentucky.

TWIST-PRONG CAPACITOR GUIDE
Coval Inc., Electric Corp., has released a 52-page booklet listing over 3300 manufacturers' part numbers, ratings, and sizes for twist-prong replacement capacitors used by 97 TV set manufacturers.
A simplified "registration stock number" system permits orderly shelf arrangement and fast handling of the

MANUFACTURERS' LITERATURE

RCA TUBE TYPES
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The 32-page booklet presents technical data, basing diagrams, and brief test descriptions on more than 130 of the firm's tube types. Photographs of representative tubes are shown throughout the publication.
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A simplified "registration stock number" system permits orderly shelf arrangement and fast handling of the

units in logical sequence according to rating.
Write to the company at South Plainfield, N. J. for additional information.

MICROTITAN BROCHURE
Microtran Company, Inc. announces a 4-page brochure listing many new types of transformers added to its catalogue line.
Typical schematic and circuit diagrams are also shown in conjunction with converter transformers.
The brochure is available free of charge. Write directly to the company at 115 E. Mineola Avenue, Valley Stream, N. Y.

SUPREME MASTER INDEX
Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. has published its "1938 Master Index" to all of its radio and television manuals. The Index covers 17 radio volumes and 13 TV manuals.
The 48-page booklet cross-references all material in the available radio and TV manuals. By direct reference to volume and page numbers, the task of finding needed material is greatly simplified.
Readers of our publication may obtain single copies at a special cost of 5c in stamps for postage. Write directly to the publisher of the Index for your copy.

NATIONAL CO. BROCHURE
The catalogue describes a complete line of wear-resistant, steel threaded inserts for use in aluminum or brass. Five types of captive nuts and a line of studs are catalogued.

RECEIVING TUBE CHART
A receiving tube interchangeability chart listing 122 replacements for 180 popular television and radio types is now available from General Electric Company.
The pocket-size chart (ETR-1749) is offered as a time-saver for service technicians who may be in immediate need of a tube for which they have no direct replacement on hand.
This brochure is available through the company's authorized tube distributors.

NEW "SENCORE" LITERATURE
Service Instruments Corp. has announced the availability of a new, multicolored catalogue on its line of test instruments.
The brochure includes photographs of each of the firm's products and also photographs showing the particular product in use. Complete information is included, with schematics. Write direct to the firm at 171 Official Road, Addison, Illinois.

TRANSISTOR GUIDE
Sylvania Electric Products Inc. has designed a brochure which includes complete ratings and characteristics for nearly 100 EIA registered transistors. The 20-page catalogue includes corresponding outline and socket specifications for each entry. Also incorporated is a section devoted entirely to a transistor interchangeability guide designed to assist in the identification of more than 600 transistor types.

The brochure, "Sylvania Transistors —Characteristics and Interchangeability Guide," is available at a cost of 10c. Write direct to the company at 1740 Broadway, New York 19, N. Y.

TUBE TESTER BOOKLET
Century Electronics Co., Inc. announces the availability of a new and revised printing of its booklet entitled "Operating a Successful Tube Tester Route."

The 12-page booklet includes such points as financing, buying tubes, how to sign up locations, how to service locations, financing for expansion, record keeping, etc. Copies are available free of charge.

Mail your request directly to the company at 111 Roosevelt Ave., Mineola, N. Y.

TRIPLLET CATALOGUE
The Tripllett Electrical Instrument Company, Buffalo, N. Y., has released its new catalogue, No. 37-T.

This brochure covers electronic, electrical, radio, and television test equipment.

PACKAGED ELECTRONIC CIRCUIT GUIDE
The fifth edition of the Centralab "PEC" Packaged Circuit Guide is now available. This new five-page guide is one-third larger than the previous edition and contains complete replacement information on packaged circuits used in equipment of over 200 manufacturers.

A special feature of this new brochure is a cross-reference chart showing the company's appropriate replacement for units of other manufacturers. Copies are available without charge from electronic parts distributors or from the company, a Division of Globe-Union, Inc., 801 E. Keefe Avenue, Milwaukee 1, Wisc.

Just Out

**FLIP-CHaRT**
Tung-Sol Electric Inc. announces publication of a new 30-page "flip-chart" style chart showing electrical and physical characteristics of the most important electron tubes having industrial, special purpose, and military applications.

The attractive chart, T-24, is printed on heavy duty coated stock, indexes industrial tubes by class, and gives technical information pertinent to each type within the class.

The chart may be obtained without cost from the firm's distributors as well as from the company at 95 Eighth Ave., Newark, N. J.

TRANSFORMER CATALOGUE
The 1959 edition of the "Stancor" Transformer Catalogue is now available. The 32-page, two-color brochure covers the entire line of the company's transformers for industrial, communications, television, and radio applications.

An important feature of this catalogue is a new indexing system, making it easy to locate the appropriate unit.

Copies are available at no charge from the firm's distributors or directly from the manufacturer, Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

**SILICON SOLAR CELLS**
The Semiconductor Division of Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ili., has issued a four-page brochure detailing the electrical and physical characteristics of its standard line of silicon solar cells.

Bulletin 32-58 gives complete design parameters as well as application notes on nine types of cells.

**New SUPREME 1959 TV Manual**

AMAZING BARGAIN

The new 1959 TV manual is the bargain of the year. Covers all important sets of every make in one giant volume. Your price for this mammoth manual is only 93c. This super-value defies all competition. Other annual volumes at only 93c each. Factory service material simplifies diagnosis. Includes all data needed for quicker TV servicing. Practically tells you how to find each fault and make the repair. More pages, more diagrams, more service data per dollar of cost.

TELEVISION SERVICING COURSE

Let this new course help you in TV servicing. Amazing bargain, complete only 93c, full price for all lessons. Giant in size, mammoth in scope. Topics just like a 290.60 correspondence course. Lessons on picture faults, circuits, adjustments, short-cuts, UHF alignment facts, hint and antenna printing and double-shooting, test equipment, picture analysis. Special, only 93c.

**COMPANION RADIO COURSE, Introduction to TV**

How to cover complete tube training in TV, plus other important methods. Covers fundamentals, facts finding, use of test equipment. Everything in radio, is used in TV. Ask for details. Questions. New edition. Special, only 93c.

17 RADIO VOLUMES

Supreme Publications

Sold by All Leading Parts Jobbers
SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

* Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyatron, Miniatures, Sub-miniatures, Novais, 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 82

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

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.

Production of this Model was delayed a full year pending careful study by Superior’s engineering staff of this new method of testing tubes. Don’t let the low price mislead you! We claim Model 82 will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82 the novelty is duplicate eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

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.

Model 82 comes complete, housed in portable, hand-rubbed oak cabinet with removable cover. Only $36.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

Moss Electronic, Inc. 3849 Tenth Ave., New York 34, N. Y.

See page 111 for complete details
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

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 without danger of cathode damage.

SUPERIOR’S NEW
MODEL TV-12
TRANS-CONDUCTANCE TUBE TESTER

TESTING TUBES
★ Employs improved TRANS-CONDUCTANCE circuit. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
★ NEW LINE VOLTAGE ADJUSTING SYSTEM. A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.
★ SAFETY BUTTON — protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
★ NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY. Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

TESTING TRANSISTORS
A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special “transistor only” meter scale. The Model TV-12 will accommodate all transistors including NPN’s, PNP’s, Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Model TV-12—$72.50

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

See page 111 for complete details

Moss Electronic, Inc.
3849 Tenth Ave., New York 34, N.Y.

January, 1959

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SUPERIOR'S NEW MODEL 77

SUPERIOR'S NEW MODEL 79

SUPERIOR'S NEW MODEL 79

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SUPERIOR’S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!

✓ R.F. Signal Generator for A.M. ✓ Bar Generator
✓ R.F. Signal Generator for F.M. ✓ Cross Hatch Generator
✓ Audio Frequency 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 Generator provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Generator provides a variable 360 cycle to 20,000 cycle peak wave audio signal.

The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 180 Kc., 262.5 Kc., 456 Kc., 600 Kc., 900 Kc., 1200 Kc., 1800 Kc., 2500 Kc., 3579 Kc. ± 5 Megacycles (in color burst frequency).

BAR GENERATOR: The Model TV-50A provides an actual Bar Pattern on an R.F. Receiver Screen. Pattern will consist of 4 to 10 horizontal bars or from 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Generator will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shadowing, horizontal and vertical lines interconnected to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the DOT Pattern Generator is a tool you will want to have on any color TV Receiver tube. The Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A provides complete coverage for A.M. and F.M. alignment.

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

ALL PURPOSE BRIDGE

IT’S A CONDENSER BRIDGE

with a range of 3000 microfarads to 1000 microfarads (Measures power factor and leakage too.)

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.

CAPACITY BRIDGE SECTION
4 Ranges - 50 microfarads to 1000 microfarads. Will also locate shorts and leakage up to 25 megohms. 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 phono and meter if desired.

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Say You Saw It In RADIO & TV NEWS

Mac's Service Shop
(Continued from page 56)

"Well, that's one way to test 'em," Barney observed.
"Yes, but it's not very practical. Until I find a better solution, I'm going to use the old tried and true method of substitution without fooling around with useless resistance checks."
"You spoke about the capacitor feeling warm after the set had been turned on and that checks with what a fellow was telling me about these units the other day. He claims that quite often you can see a little arc inside a bad capacitor if you look closely in a very dim light. He says the glow of the arc will show up right through the case. But enough of this talk about the hot high-voltage circuits. Come on down to the level of this little a.c.-d.c. receiver and tell me if you hear anything wrong with the tone quality."
Mac listened critically to the little receiver as he ran the volume up and down. "No," he said slowly; "should I?"
"Well, the boy who brought it in said that after it was on for a few minutes it became so mushy you could hardly understand it. I've had it on for an hour and I can't see anything wrong. Just to be on the safe side, I checked the coupling capacitors for leakage and the speaker cone for proper centering. Nothing is wrong in either department."
"How old would you say that boy was?"
"Around sixteen, but what's that got to do with the price of hay in China?"
"What would you say was the favorite program of the teenagers?"
"That disc jockey program that comes on at eleven p.m."
"That's probably the only time the kid uses this radio. Now what is different about using a radio late at night and using it during the day?"
"I give up. Mr. Bond. What is different about using a radio late at night and using it during the day?"
"Ever check the line voltage late at night?"
"Yeah-h-h! It goes away up. Let me plug this thing into the variable-voltage transformer and raise the line voltage up to about 125 volts. There we are."
It was only a minute or so until the clear sound of the radio began to blur a little and in no time at all it was distorting so badly that speech could scarcely be understood. Mac did not need to tell Barney what to do next. He removed the 50C5 tube and put in a new one. Now the radio continued to play clearly even at the elevated line voltage.
"The old story of secondary emission causing the plate current to run away," Barney said. "The only difference is that the condition does not start until the line voltage is increased. Man, you've really got to be on your toes in this racket. I suppose if I hadn't told..."
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January, 1959

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JANUARY 28-29

First International Symposium on Nuclear Fuel Elements. Sponsored by Columbia University and Sylvania-Corning Nuclear Corp. New York, N. Y. Dr. Henry H. Hausser, Secretary, 730 Fifth Ave., New York 19, N. Y.

FEBRUARY 5-8
International High Fidelity Music Festival. Shoreham Hotel, Washington, D. C. Open to pub. Contact M. Robert Rodgers, director of Festival, at 2101 16th St., N.W., Washington 9, D. C., for full details.

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January, 1959
The Heater-Cathode Leakage Problem

By MANNIE HOROWITZ
EICO

One of the baffling causes of audio circuit hum can be cured with a little thought and care.

THE quality of a high-fidelity amplifier is determined by two major criteria. The first important one is just how much of the original signal it will reproduce faithfully. The second, and equally important factor, is its freedom from unwanted interference generation. One of the primary forms of undesirable interference is hum.

This interference is most obvious when introduced into low-level amplifiers such as reluctance-cartridge phono preamplifiers or tape-head preamplifiers. Any hum originating in this stage is amplified by all succeeding stages. It is therefore more important to keep hum at a minimum in this section than in any other part of the amplifier.

Hum can be caused by several factors. Poor filtering of the "B+" power supply is the most obvious cause. An equally obvious one is pickup from stray a.c. fields such as power and heater leads as well as induction from power transformers. A more elusive, but extremely important, factor is the ground loop caused by fields set up in the metal chassis. The factor to be discussed, heater-cathode leakage, is perhaps the greatest cause of occupational headaches among tube engineers, audio engineers, and audiophiles.

The actual construction of the heater-cathode section of a vacuum tube is simple. The cathode is a thin cylindrical-shaped piece of metal. The outside is coated with an emitting material which supplies the electrons for the vacuum tube. Some of the trouble begins when this emitting material "spills over" to the inside of this cylinder.

To heat this cathode, there are several folds of insulated (usually with an aluminum oxide coating) wire placed within the cylinder (Fig. 1).

![Diagram of heater-cathode construction](image)

Fig. 1. Heater-cathode construction.

Fig. 2. (A) Heater-cathode circuit. The a.c. from heaters can appear across bias resistor if tube is leaky. (B) Circuit to get cathode current as a function of applied voltage between heater and cathode. Reversing battery polarity shows current in a reverse direction. Refer to text.

1. This wire serves the sole purpose of heating the cathode. Being placed within this cylinder, the heater wire touches the inside of the cathode in several places.

When a tube is defective, electrons can flow from the heater to the cathode or in the reverse direction from the cathode to the heater. Fig. 2A shows just what happens when there is current flowing in either direction, under the condition that one side of the heater leads is grounded.

The cathode, the heater, and the cathode bias resistor go to make up a complete diode circuit. It is undesirable that any of the a.c. on the heater goes through the cathode resistor. If there is no conduction between the heater and cathode, no a.c. can appear there. However, if there is any conduction between these electrodes in either direction, the path is closed. The variation in conduction, due to a.c. cyclical variations in the heater, will modulate the electron stream between heater and cathode in either direction. This sinusoidal voltage variation will appear as a 60-cycle voltage across the cathode bias resistor which, in turn, will be amplified by the tube.

Cause of Leakage

Heater-cathode leakage can result from several different types of tube deficiencies. If there is any emitting material inside the cathode cylinder, there may be conduction from the cathode to the heater. In a similar manner, the heater insulation may be imperfect, permitting electrons from the hot heater wire to reach the cathode.
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January, 1959
Direct conduction between elements can take place due to low resistance paths in sockets, tube bases, as well as impurities in the heater coating.

There can also be hum caused by the heater leads that extend below the level of the cathode cylinder. Being exposed, electrons may be conducted to the cathode leads, besides the other element leads or the electrodes themselves.

Possible Solutions

Whatever the cause, it is obvious that heater-cathode leakage is undesirable.

The first step toward minimizing this defect must be taken by tube manufacturers. The most popular tube used in the low-level preamplifier stage is the 12AX7. Although American manufacturers are working hard to cure this defect, there has been no complete solution as yet. Better 12AX7s are still imported from Europe. These are identified as ECC83's. However, the European imports vary in the amount of leakage among tubes of the same type and are thus not 100% reliable.

An obvious solution is to use transistors instead of tubes. Unfortunately, these are relatively noisy—a type of interference more undesirable than 60-cycle hum.

Since, at the present time, tubes must be used for best results, many preamplifiers have been designed with d.c. on the heaters. In this way, no a.c. is introduced into the first stage. Although an excellent solution, it has several important drawbacks. Unless well filtered, this system can introduce 120-cycle hum due to full-wave bridge rectification. Hum at 120 cycles is more objectionable than the 60-cycle variety. It is also undesirable because of the high cost of supplying a well-filtered heater voltage. Despite these disadvantages, a d.c. heater supply is still a common and good solution.

Another solution, equally effective, becomes obvious when the problem is given further study.

In a tube which exhibits heater-cathode leakage, the heater and the cathode make up, in the case of any other diode, a d.c. voltage can be placed between the elements, with an ammeter in the circuit (Fig. 2B). As the d.c. voltage is increased from zero to several volts, the current climbs steadily. A point is reached where there are no more electrons available at the heater to reach the cathode. This is known as the point of saturation. Here, any increase in voltage does not, at the same time, mean an increase in current (Fig. 3A).

Assume, now, that the battery is reversed. In this instance, electrons flow from the cathode to the heater—possibly due to emitting material on the inside of the cathode cylinder. The curve will follow a pattern similar to that of Fig. 3A, but in the reverse direction. The combined curve with the battery at both polarities is shown in Fig. 3B.

With this in mind, we can proceed to a solution which is frequently applied in practice. We grounded on one side, the maximum potential difference between the cathode and heater is the heater voltage at the peak of the a.c. cycle. This, of course, assumes that the cathode bias voltage in Fig. 2A is negligible. In accordance with Fig. 3B, this peak a.c. voltage variation means a high current variation.

Assume that there were a means of center-tapping the heaters, with the center arm being connected to ground. Fig. 4 shows two examples of this—one using a center-tap on the heater winding of the power transformer and the other using a pot across the heater with the center arm placed between the power transformer and ground. The voltage swing between any part of the heater and ground or cathode (cathode voltage being negligible) is then halved at peaks in the cycle. Due to the shape of the curve (Fig. 3A), halving the voltage decreases the current swing by half. Thus there is less than half the a.c. variation appearing across the cathode resistor than in the first case.

The so-called hum-bucking potentiometer in this arrangement is of further help in reducing hum. The two halves of the heaters are out-of-phase.

A careful adjustment of this control will not only cancel out hum due to this phase difference, but may introduce enough balance or unbalance to cancel hum due to extraneous pickups.

With a little thought, this method can be extended to give results comparable or even surpassing those achieved with d.c. heaters.

Fig. 3B reveals two flat regions beyond which any increase in voltage does not show any increase in current. One of these regions is in the positive half while the other is in the negative half.
Fig. 4. (A & B) Methods of center-tapping heaters to ground or zero voltage. (C) Heaters center-tapped to "B+" or "B-" for results obtained in Fig. 3B.

Suppose that the heaters were set at a high positive voltage with respect to the cathode (Fig. 4C). Let us set this voltage somewhere at the center portion of the flat part of the diode curve in Fig. 3B.

Due to heater-cathode leakage, assume a sinusoidal voltage appears between the heater and the cathode, as indicated in Fig. 3B. However, instead of varying sinusoidally around the zero volt point (as when no positive voltage is applied to the heaters) it will vary around the high voltage. Observing the curve at this point, a variation in voltage does not result in any variation in current. The a.c. voltage will produce a d.c. ripple-free current. This d.c. will go through the cathode resistor of Fig. 2A, rather than the a.c. that would ordinarily pass through this resistor. No a.c. through the resistor means no hum voltage to be amplified by the tube.

This bias voltage should be made as high as possible for best results. The limiting factor is the lowest heater-cathode breakdown voltage for any tube connected to this particular heater group. This breakdown voltage is listed in the tube manuals. The same results are achieved with the heaters set at either a high positive or high negative voltage with respect to the cathode, is obvious from Fig. 3B. As long as this voltage is on the flat portion of the curve in either direction, ripple elimination is accomplished. The added effect of cancellation from hum-bucking potentiometers is useful here as well as for the original grounded case.

All of these methods fall short when there is excessive tube leakage. Excessive leakage in any form means unwanted current through the cathode bias resistor, resulting in a change of the point of operation for the tube that is used.

As for any other function in any type of electrical apparatus, a good tube is necessary for good results. No circuit will operate properly when defective components are used.

In summary then, we have discussed some causes of the heater-cathode leakage problem along with some of the solutions. These include the use of special low-noise preamplifier tubes, the use of well-filtered d.c. on the heaters, the installation of a hum-bucking potentiometer, and the application of a d.c. biasing voltage.

January, 1959
use this check list when selecting the record changer for your stereo/mono high fidelity system

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THE recent New York High-Fidelity Show clearly established that the stereophonic disc has come of age and is certainly here to stay. In the ensuing weeks since the Show the over-all stereo disc situation has sorted itself out even more. People are beginning to realize what is necessary for good stereophonic reproduction in terms of equipment and at the same time the experience of their listening has taught them which companies are making the most representative and good type of stereophonic disc, and which are not.

Now, I make these assertions from having talked to a great many people. I must confess that since for the most part these are people in my immediate circle of friends, their tastes and interests are among similar lines to my own but they may not necessarily be a reflection of the taste of the general public. These people share my enthusiasm for the stereophonic revolution, but they contend that there has been such a mad, frantic scramble on the part of equipment manufacturers and record companies to produce the materials of the stereophonic evolution, that much common sense, good taste and honest policy has gone by the board. They contend that sometime after this fall, perhaps after Christmas, there will be a decline of interest and of sales in stereophonic equipment. They say the general public is being oversold on stereophonic sound, that the general public is having difficulty in understanding what stereophonic sound is all about and that many so-called salesmen in establishments which have never before been in the selling of anything as complicated as stereophonic sound have given out a great deal of misleading and inaccurate information which confuses the issue still further. From the record end of the matter, they point out that there is a great deal of poor stereophonic sound being produced and, in fact, allege that a surprising percentage of what is sold as a stereophonic disc is, in fact, nothing of the sort and is a phony gimmick-up sort of two-channel monaural sound.

These allegations, as I said, were quite shocking to me, and while I have not had a chance to thoroughly investigate them on the basis of an admittedly abbreviated inquiry, I would say that there is both substance and exaggeration in their claims. I think they overlook one very basic fact about stereophonic reproduction, whether it be from tape, disc, or whatever. This is, that given the most unadorned but normal ear, belonging to a person who at least has no aversion to music, and further, given a reasonably good and honest facsimile of stereophonic sound, it is not difficult to appreciate the difference and express the preference for stereophonic over monaural reproduction. When I brought up this point with my friends, they said: "Yes, you are right, but only to the extent that the average man you are talking about has been exposed to stereophonic sound while in the company of either a friend or an honest, reliable salesman, who takes the time and trouble to explain the mechanics of stereophonic sound." To one of my friends, "to successfully inculcate in any person the idea of stereophonic sound, it is even necessary to teach this person the mechanics of the equipment itself." This is a hard argument to refute, and while we could go on arguing pro and con about this all day, I think the whole matter is really bad and that I am about to start the guns that if nothing else, the normal ear and an open mind can, and do, appreciate and prefer stereophonic sound to monaural sound. These establishments which do not have the proper sales personnel who are thoroughly familiar with all the ramifications of stereophonic sound and who can easily impart this knowledge to a perspective customer, will simply fall by the wayside and cease to be a factor in stereophonic merchandising. The fact that many more different types of retail establishments are presently trying to cash in on the stereophonic boom, does not alter this fact. It is up to them to be as well equipped as the most component high-fidelity retailers, in matters of equipment and personnel.

The situation is really not new and has its analogy a few years ago when we were dealing with monaural high fidelity. A very large section of the public became aware of the differences between true component high-fidelity and the generally less satisfactory "packaged" hi-fi, and there soon sort themselves out. Up to the inception of the stereophonic disc, there were more and more members of the general public who were learning anew the old adage that you can't get something for nothing that good monaural high-fidelity systems were generally not cheap and were not usually sold by appliance dealers or any other sort of establishment which had neither the personnel nor the stock to satisfy the requirements.

Some apologists have pointed out that the present stereophonic disc boom is going to be the biggest challenge the legitimate component high-fidelity retailer has ever had to face. Their contention is that stereophonic sound, even from the cheaper packaged stereophonic systems, is infinitely better than the packaged monaural "hi-fi" systems. They say that the difference is so startling that the equipment literally sells itself, and that for this reason, packaged stereophonic equipment will be sold successfully in the appliance dealer, department store, etc. with far less trouble than had been the case with monaural high fidelity. There is undoubtedly a germ of truth in this. It would be foolish to...
say that many retail establishments which have never sold quality sound may not be successful in merchandising stereophonic equipment. If, however, my friends are even 50 percent right in their allegations concerning the adaptability of the average person to stereophonic listening, this would seem to afford the legitimate high-fidelity dealer the best opportunity to thoroughly entrenched his position as a purveyor of quality high-fidelity sound.

No good high-fidelity components retailer can long stay in business if he is not thoroughly equipped with knowledgeable personnel and the best of equipment to offer to the public. Hackett up by an aggressive and courageous advertising program he can regain, or at very least, retain his influence in the high-fidelity scheme of things. It may be a corny cliche, but it is pretty certain that you can't fool all of the people all of the time. If what my friends contend is true, I still can only see a period of "agonizing reappraisal" in which industry and the public will sort itself out in its attitudes toward stereophonic sound. If after this readjustment, some of the impetus is removed from the stereophonic boom, on the basis of our similar experience with monaural high fidelity, there will still be more than enough business to keep all segments of the industry very happy for a long time.

One final point that my friends made, in which unhappily I must concur, is that there are indeed some discs being sold as stereophonic which are nothing but tricked-up monaural. This, above all, could do the most harm to the whole stereophonic boom as even with the improvement that two channels does afford monaural sound, it has nowhere near the dramatic impact of true stereophonic sound. Naturally, if a good many of the general public is exposed to this phony stereophonic sound, word-of-mouth being what it is, this will tend to alienate many people from stereophonic sound before they have had a chance to evaluate it for themselves.

I realize this has been more of a philosophic dissertation this month than usual, and that a great deal of it may not apply directly to you. But there is no denying that the general public cannot be ignored by any group and any decisions made regarding the general public will ultimately reflect on the segments of the public more intimately concerned with matters electronic. The old saw is that "time will tell," but this reporter will go out on a limb and state that in spite of all the "signs and alarms" the stereophonic boom may stagger a bit, but will quickly recover itself and continue unabated for some time to come.

TCHAIKOVSKY
OVERTURE 1812
CAPRICCIOTTI ITALIAN
MARCHE SLAV

It goes without saying that pot-boiler though this may be, it will undoubtedly prove a best seller as a stereo disc. Naturally, any discussion of the "1812 Overture" must inevitably come in for comparison with the famous Mercury version incorporating the real cannon fire. Here, too, real cannon fire has been utilized and as played through a really big stereophonic system, the results are quite impressive but even with the blandishments of stereo, the Mercury cannons still have the greater weight and punch. Add to this the fact that the wild clangour of bells in the Mercury version is mild in comparison on this disc. However, apart from these two points the "1812" takes on a breadth and grandeur in the stereophonic process, impossible to achieve even in as good a version as Mercury monaural. The directional qualities

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were excellent with the heavy and stirring brass nicely balanced against the strings and woodwinds. The “Capriccio Italian” and “Marche Slav” are both stereo spectaculars, and though reproduced from a stereo disc have a very wide dynamic range and sounds with much brilliance which will delight the high fidelity enthusiast. The performance by Kenneth Alwyn is straight forward and competent, but hardly inspired. It makes too much of crossing all the “Ts” and dotting all the “Is” and is too fussy where he should be tenter. In spite of this, with the over-all excellence of the sound, and the fact that there was little if any diminution in level as compared to the monaural version, this is certainly to be judged one of the most exciting stereo discs yet released.

PROKOFIEV
PIER AND THE WOLF LIEUTENANT KIE SUITE
Vienna State Opera Orchestra conducted by Mario Rossi, Boris Karloff narrates the first selection. Vanguard Stereophyl VSD 2010. Price $5.95.

Yes, you are reading this caption right. It is indeed our erstwhile ghoulish friend Boris Karloff narrating the popular Prokofiev children's piece. And does he scare our little friends? But of course not. As probably many of you know, friend "Frankenstein" is the is a gentle man who speaks with an excellent English accent, albeit with a slight hiphop, and who is generally regarded as one of the more cultivated men in Hollywood. He affords an easy, well-modulated delivery and indulges in no phony histrionics. He is an appealing version and with the other excellent features of the disc, this is sure to be a popular item. Rossi conducts the work with considerable authority, but for my taste, at least, is a bit on the slow side.

The stereo sound is excellent, with good instrumental separation, excellent directional effects, and with no apparent "hole in the middle." On the other side of the disc the work "Lt. Kije" gets taken to its unprententious and although I prefer the recent Reiner version with the Chicago Symphony, this must be judged as a good and successful recording.

Here the enthusiasm on orchestral sonorities and some of the effects in brass and percussion are quite startling, especially in the stereo medium. Overall level was down a few decibels from its monaural counterpart, but this is not serious. The disc tracked well and there were no spurious modulations as a result of poor cutting.

LISZT FOUR HUNGARIAN RHAPSODIES FOR ORCHESTRA
Vienna State Opera Orchestra conducted by Anatole Fistoulari, Vanguard Stereophyl SHV 108 SD. Price $2.98.

Vanguard continues its policy of producing spectacular demonstration discs, which for advertising purposes they put at equally spectacular prices. Has come up with its first stereo demonstrator. You may not care for such ancient corn balls as the Liszt "Hungarian Rhapsodies", but from a merchandising viewpoint, the use of such war horses is justified. In any case, I think you will be quite surprised how different the “Rhapsodies” can sound when you hear them in a stereophonic system. They are imbued with new life and gaiety and it is almost as though you were hearing them for the first time.

Fistoulari is a good man for this sort of thing and his readings have plenty of verve and space. Speaking of this one close-up recording with excellent orchestral definition but at the same time, clever utilization of acoustics have resulted in a very spacious, airy, stereo sound. Instrumental separation was very good, as well as the directional effects. Dynamic range was reasonably wide, and

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again, the over-all level was only slightly below that of a monaural disc. At the $2.98 price, and with the excellence of the performance and sound, this is sure to be much used for the purpose for which it was intended, namely a good introduction and demonstration of Vanguard stereophonic sound.

**HAYDN**
SYMPHONY NO. 94, 99

This disc will be in reiteration to those who say that the music of the classic masters gains very little in the stereo medium. It is true that the larger and more colorful orchestration of the modern scores certainly is productive of more excitement in stereophonic sound, but after all, there is more to music than mere excitement. In the case of Haydn, we do not have the flamboyance of a lot of brass and percussion, but there is a much more literal recreation of the Haydn orchestra in stereo than there is in monaural. The sense of direction is in no way diminished, the instrumental separation is just as pronounced, and above all, the rounded spacious fullness, the sense of live presence which characterizes an on-the-spot performance, is certainly audible discernible. The strings and woodwinds which play so important a part in these Haydn scores are exceptionally smooth, beautifully proportioned, and afford a sense of realism never possible in any monaural version I have ever heard. Krips turns in completely sympathetic performances of both symphonies, a bit slower paced, perhaps, than most other versions, but this is all to the good in expositional terms. Each section is given its proper values in relation to the others and the whole is a logical and handsomely wrought musical edifice. As always, Krips manages to elicit superb string playing from the Vienna Philharmonic and we must also acknowledge a debt to the orchestra for the wonderful pure-toned sonority of the woodwinds. If the bulk of stereophonic discs have thus far been a bit too spicy for your particular musical appetite, the quiet beauty of these two Haydn symphonies should prove to you that stereophonic sound can be palatable for all forms of music.

**ALBANIZ**
IBERIA, NAVARRA
FULLI.
THREE CORNERED HAT: DANCES INTERLUDE AND DANCE FROM LA VIDA BREVA

This album is sold under the generic title of "Spain!", and as you can see by the contents, the title is certainly justified. The music is, of course, a natural for stereophonic reproduction with its dazzling orchestral colors. Albéniz is virtuoso music and since Reiner has transformed the Chicago Symphony into one of the most virtuoso orchestras now extant, they sail through these difficult scores with consummate ease. Probably the most effective piece here is the "Iberia Suite," with the "En Corus Christi de Sevilla" a stunning example of the ultra sonorities that can be produced by stereophonic sound. The over-all sound is of the high quality we have come to expect from Reiner and the Chicago group, aided as always by a impeccable acoustics of Chicago's orchestra hall. However, the quality of stereo from this Victor disc leaves something to be desired. It is noticeably down in level from its monaural counterpart, and I encountered some of that annoying "swish-swash" modulation which is indicative of cutting difficulties and/or pressing difficulties.
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with the disc. It is conceivable that this occurred in only a small percentage of the discs and perhaps the ones that you buy will not be so afflicted. If you have a stereo system which is quiet enough to withstand a healthy boost in the volume control, you will find this disc one of the most spectacular examples of stereophonic reproduction.

I wouldn't swear to this, but my own feeling is that one can get so enamoured with the fabulous acoustics of Orchestra Hall that there is a tendency to strike out in new musical directions in order to produce these incredible and fascinating sonorities. Having recorded stereo in this hall myself, I can understand this fascination and can only say "Bravo" for this new facet of Reiner and hope that we shall have a great deal more of the same.

HARTOK
CONCERTO FOR ORCHESTRA

Here is more of Fritz Reiner and the Chicago Symphony in stereophonic sound and once again, it is with the type of repertoire that shows off everything to best advantage. Those of you who have had stereophonic tape machines will remember this as one of Victor's very early stereophonic tape releases. Now transferred to stereo disc, it has lost relatively little in the process and must be considered one of the most successful of Victor's transfers from their early stereo tape material. This is all the more remarkable because, as far as I know, this recording was made in the old two-channel stereo recording process which the company employed prior to its threecchannel "shadow-image" technique. There is an excellent directivity to the sound and in spite of the fact that it is two-channel, the "hole-in-the-middle" problem has been rather well solved. Instrumental separation was excellent and even at that early stage of the stereo game Victor had learned to utilise those wonderful Orchestra Hall acoustics to promote an uncanny sensation of depth in their recording.

With the virtuosity of the Chicago players at his bidding, this is an extraordinary musical experience. This stereo disc has a minor deficiency in level and a modicum of some of the other faults that can befall a stereo disc, but all in all, they are not so serious as to bother anyone but the most hypercritical and audio fanatics. In time there will be better recordings and possibly better performances of this wonderful work, but it will take a mighty strong combination of both to supplant this recording as a very choice item. —30—

Level Indicator for Hi-Fi

ONE of the most annoying problems in hi-fi stereo operation is obtaining perfect balance between the left and right channels. This problem is particularly difficult when some of the audio equipment is in one room and the speakers are in another. One would most likely find himself walking back and forth several times before balance is obtained. It isn't a question of obtaining a setting for one record or tape and then assuming that it will hold true for other recordings since balance between channels varies considerably from one tape or disc to another.

Actually any type of a.f. voltmeter can be used across the output terminals of the power amplifiers to solve this problem. However, expensive units are not a necessity. One of the most reasonable on the market today, and one that we have just checked out, is the Lafayette Radio Model TM-40. This is an extremely low-cost unit which combines in a single housing two separate meters, each with its own range control. The meters can be used across any voice coil terminals—4, 8 or 16 ohms. Zero db reading on each meter is obtained at 1.2 volts. The range controls, which are basically sensitivity controls, provide means of adjustment should higher output voltages be attained. They also permit the meters to be adjusted for equal readings with equal sound outputs from both speakers. Since balancing is basically the only requirement in this type of installation, absolute accuracy is not important in that only relative level of the two channels is required.

Should one want to make a frequency check of his hi-fi system, the meters should be used with the level control at mid-position. Frequency accuracy is within +1 db (from 30 to 20,000 cps) at this point. However, with the level control at maximum position, the accuracy drops off considerably. It is down —10 db at 30 cps.

These meters also have many other applications. They can be used to indicate levels when recording on tape or disc or they can be used to check balance at outputs of preamplifiers, tuners, or even at individual amplifier stages.

Wiring diagram of the single meter indicator. The stereo unit uses two similar assemblies. Only exception in circuit diagram is that in the stereo unit the 8000 ohm shunt across the meter is omitted. —30—

TM-40 stereo balance meter. Lafayette Radio also has available Model TM-20 which incorporates one instead of two meters. Two of these single units can be used for stereo but by itself it is applicable to monophonic operation. Particularly to check recording level.
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A method of "customizing" dials with markings not found on standard dial plates and decals.

In the construction of amateur, hi-fi, and special commercial electronic equipment, the need frequently arises for dials with calibrations and markings not found on standard dial plates and decals. This need is commonly met by using a hand-drawn or type-written dial plate. This is usually neither artistic nor workmanlike and customers often object to the black-line-on-white format which results.

Experience has shown that a white-line-on-black special dial, with a protective cover disc of plastic, looks workmanlike if skillfully made, and meets with customer approval. A method for making these "photoplastic" dials will be outlined here.

Using any good grade of white drawing paper, lay out the dial, to several times the finished scale, using blue pencil for the layout lines that are not to appear on the finished dial and black India ink for line work wanted in the end product. Apply lettering by any desired method. Guided lettering, such as LeRoy, is fairly good; stick-up lettering, using any one of the prepared "Trans-Adhesive" letters, such as Ar-type, Zip-A-Tone, or Monsen type (obtainable at most artists' supply stores) will usually look better. In a pinch, letters and numbers cut from slick-paper magazine pages and fastened in place with rubber cement, can be used. The appearance of a finished dial pattern is shown in Fig. 1. Layout lines in this diagram have been retouched so that they will reproduce. In actual practice, the blue layout lines "drop out" in copying.

From this dial pattern, make a negative photostat. If the dial is a "one shot" proposition, make the photostat to the desired finished size. If many dials are to be made, or maximum quality is desired, make it the same size as the original. Appearance of the negative photostat is shown in Fig. 2. Note that the guide lines have "dropped out" here because photostat paper sees blue as white. Unwanted lines can be removed from the negative photostat by touching up with black India ink.

When multiple prints are to be made of the same dial, the negative photostat is copied on lithographers' film to final size, producing a photographic negative from which any number of contact prints can be made quickly and cheaply. Prints made on glossy paper and with adequate contrast, have a much better appearance than those made on photostat paper and usually last longer.

Fig. 2. Negative photostat of original dial pattern. Blue layout lines disappear as they do not photograph.

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Fig. 3. (Upper section) Kodalith transparency made from a photostat negative. Magnification 1/2. (Lower section) Here are the final glossy prints that have been made by means of a contact print from transparency.

Fig. 4. Finished appearance of a special dial made according to the above description. A protective cover made of a disc of clear plastic is used. A center hole in the plastic disc is made large enough to clear shaft of the operating control.
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January, 1959

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THE EICOTUBE TESTER DATA

NEW ECO MODEL 625 **

These new test readings will help you keep the roll chart of your EICO tube checker up to date.

<table>
<thead>
<tr>
<th>Tube</th>
<th>Top</th>
<th>Middle</th>
<th>Bottom</th>
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</thead>
<tbody>
<tr>
<td>1AF5</td>
<td>100</td>
<td>1</td>
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<td>1AF5</td>
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<td>(Good = 100)</td>
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<td></td>
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<tr>
<td>1DN5</td>
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<td>1DN5</td>
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<td>1.4</td>
<td>1</td>
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<tr>
<td>1G5</td>
<td>65</td>
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<td>10</td>
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<tr>
<td>1J6</td>
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<td>1K3</td>
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<td>3DK6</td>
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<td>(Good = 500)</td>
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<td>6BN9*</td>
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<td>3.3</td>
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</table>

* Center-Tapped Filament.
** Complete up-to-date roll charts are now available for EICO tube testers 825 (chart 825-06) and 856 (chart 846-08). For further information, write directly to Electronic Instrument Company, 33-66 Northern Boulevard, Long Island City 1, New York.
Electronic Terminology

By JOHN J. GILL

HERE'S another chance to try your hand at solving a puzzle while the oil dope dries! All of these terms should be thoroughly familiar to the practicing technician so try whipping through this. If you run into any snags, the answer can be found on page 156.

ACROSS
1. Bridge for measuring resistance.
6. A hot cathode will —— electronics.
8. Beam, as in CR tube.
10. Coil with strong field.
11. Element No. 27. (Abbr.)
14. The higher audio frequencies.
20. No. 2 in color code.
21. North Dakota. (Abbr.)
23. Relaxation oscillator. (Abbr.)
24. Seventh word in phonetic alphabet.
26. Type of circuit. (Abbr.)
27. Code sign.
29. Metallic conductor.
30. Look.
31. Fifty-one (Roman Numeral).
32. I saw. (Latin).
33. Type of modulation.
37. Federal radio-TV regulatory body. (Abbr.)
39. Electrodynamics. (Abbr.)
40. Broadcasting room.
42. Direct current. (Abbr.)
44. Control on color TV.
46. Resistance box.
49. In distance.
52. One of the baseball leagues. (Abbr.)
53. Reply to call.
55. Inductance (symbol).
56. Sends back information from satellite.
57. Not c.w.

DOWN
1. Used for measuring electric losses.
2. Type of speaker.
3. Carbon tetrachloride (slag).
4. Unit of resistance.
5. Unit of energy.
6. Tuning indicator.
7. A temperature determining device.
9. Signal interactor. (Abbr.)
11. Center of transformer.
12. Part of airplane wing.
15. Electrodynamics. (Abbr.)
16. A list of radio stations.
17. Denotes weak signal on TV.
18. To discharge filter capacitors through a resistor.
19. Ham organization. (Abbr.)
22. Voltage fed to output stage.
25. Meter for checking frequency.
28. Wide-range reproduction.
29. D.C.
34. Frequency used in superhet. (Abbr.)
36. Amplification factor.
38. Business organization. (Abbr.)
41. Current (symbol).
43. Measure of loss due to mismatch of impedance line.
44. Undesirable effect in TV picture.
45. Electronic equipment testing group. (Abbr.)
46. Another code sign.
47. Return signal.
48. Point of compass. (Abbr.)
50. Coin sending device.
51. E =
54. Not a sinner. (Abbr.)

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January, 1959
POINT-CONTACT DIODES

Erie Resistor Corp. of Erie, Pa. has announced a new line of miniature germanium point-contact diodes which has been especially developed for general purpose and computer applications.

The new units are encapsulated in hermetically sealed glass cases measuring 256 inch long by 0.16 inch diameter with a minimum lead length of 0.14 inch. The units are color coded in accordance with EIA standards.

The general-purpose diodes feature high electrical stability and outstanding recovery characteristics while the computer-type diodes offer superior temperature characteristics in addition to these features, according to the company.

For full details on these eleven new miniature point-contact diodes, write the manufacturer direct.

SUBMINIATURE DELAY LINES

Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, California is currently offering a new line of seven lumped-constant delay lines which are suitable for transistor and printed-circuit applications.

These delay lines consist of subminiature powdered-iron toroidal inductors and temperature compensating ceramic disc capacitors in a lumped-constant configuration which is phase- and frequency-compensated for optimum pulse response.

The units are packaged in a 1" x 1" metal tube with glass-to-metal end seals to bring out the pigtail-type leads. The seven units in the series provide characteristics ranging from 1 microsecond delay at .03 sec. rise, and 500 ohms impedance; to .7 sec. delay, 23 sec. rise, and 1600 ohms impedance. The entire group of seven delay lines is available in kit form.

Write the manufacturer for any additional information required.

"CONDUCT-A-LITE"

Yates Manufacturing Co., 340 W. Huron St., Chicago 10, Ill. has just introduced a new instrument especially developed for the service technician and others who work with electronic equipment.

The unit consists of a 6" conductor rod, a 4" curved conductor section, a 1/4" clip-on mirror (similar to a dental mirror), and a 2-cell "Conduct-A-Lite." The entire instrument is housed in a shirt-pocket-sized plastic kit and is powered by two standard penlite batteries.

It can be used for the inspection of recessed surfaces, cavities, tubes, and the underside of component parts in a chassis. For full details on this service tool, write the manufacturer direct for information and prices.

"TEL-A-TURN"

Rogers Manufacturing Company, 214 S. Main St., Lindsey, Ohio is now marketing a new TV service cradle—the "Tel-A-Turn."

Designed by a practicing service technician to speed troubleshooting and repair jobs, the new device will hold popular size chassis measuring from 9" to 23". Full rotation and locking in any position are additional features of the device.

The unit includes a switch with indicator light on a cheater cord for safety and easy energizing and deenergizing of work. An adjustable swivel lamp permits direct lighting of the section being serviced. There is a built-in PM speaker with clipped leads to eliminate speaker removal from the customer's set.

The entire cradle moves on 2 1/2" ball-bearing, rubber casters for noiseless mobility.

The manufacturer will supply a
colorful data sheet on this device to those making a direct request.

"CITIZENS BANDER"
International Crystal Manufacturing Co. of Oklahoma City, Okla., is now marketing a 27 mc. transmitter-receiver for operation in the new Citizens band.

The "Citizens Bander" meets all FCC requirements for equipment operating in this band. It is crystal-controlled with a tolerance of .005% and a maximum input of 5 watts. In addition, it has a double conversion superhet receiver and is operable on 115 volt a.c. It is also available for 6- or 12-volt d.c. operation. It can cover all 22 channels in the new Citizens Band and has a full 2-watt low-distortion audio output.

Range of the new unit is up to ten miles. License is granted without examination or code test. Form 505, properly executed and forwarded to the FCC in Washington, will produce the necessary authorization.

COIL WINDING MACHINES
Industrial Winding Machinery Corporation, Suite 3410, 120 Wall St., New York 5, N. Y. is now offering a line of coil winding machines manufactured by Willy Annäus and imported from West Germany.

Among the units being offered is the Model WG 300 which is designed for single or multiple winding. Continuous adjustment of traverse pitch from .002" to .049" is available in two stages with the machine running or at rest. The wire can be positioned by a roller button or by a fork guide depending on the gauge of the wire being wound. The support for the wire guides moves in a sintered metal bearing and is of substantial cross-section to prevent any vibration which might lead to uneven winding.

The standard machine is designed for a maximum traverse width of 4.92" which has been found adequate for most normal requirements. Longer windings are available on special order. Winding speeds of 6500 and 3800 rpm; 1500, 750, and 350 rpm; 3750, 2700, 1200, and 850 rpm; and 3750, 2700, 750, and 350 rpm are available, all infinitely variable. Layer winding assemblies range from .006" to .044" diameter minimum to .066" to .079" diameter maximum.

For a data sheet on the Model WG 300 or other units in this line, write the U. S. distributor direct, outlining your coil winding requirements.

REPLACEMENT "PEC'S"
Centralab, a division of Globe-Union, Inc., 560 E. Keefer, Milwaukee 1, Wis., has announced the availability of eight new "PEC" packaged circuits for re-

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replacement applications in Philco, RCA, Motorola, Packard Bell, and G-E sets. Full information on the new units, PC-336 through PC-343, is included in the company's Bulletin No. 42-578, which is currently available from distributors or the manufacturer direct.

HIGH CURRENT RECTIFIERS

International Rectifier Corporation, 1521 E. Grand Ave., El Segundo, Calif., is now offering a new silicon radio-TV rectifier which features forward current ratings up to 750 ma. to meet the requirements of TV sets having higher than 500 ma. rectification needs.

Featuring electrolytic construction, the new "Unistac TV-500" eliminates the need for special sockets, drilling, or conversion kits. To provide optimum reliability at elevated temperatures, the unit employs a silicon diode mounted on a finned heat exchanger designed to assure maximum convection cooling.

One of these units in a half-wave circuit will deliver 750 ma. and 130 volts d.c. with an input voltage of 117 volts r.m.s. Two units in a half-wave voltage doubler circuit will deliver 750 ma. and 240 volts d.c. with an input voltage of 117 volts r.m.s.

The new rectifier is now available at parts distributors throughout the country.

SHALLOW LEVER SWITCH

Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, III., has added a new series to its line of lever-action switches.

The Series 12000, small in size, is mounted by means of a single fastener and requires only one-fourth the depth of conventional key switches behind the panel. The new "Lev-R" switches are available in 2- and 3-position types, locking and non-locking, and a 3-position type, locking one side and non-locking other side.

Features include relatively long springs without any "forms" at point of flexing to insure suitable spring action for long life; soft, easy action with real detent "feel" on locking types; springs assembled into a conventional slack assembly and insulated from each other; silver contacts rated at 3 amps, non-inductive load. Palladium contacts for low-current, low-voltage applications and special circuits are also available.

ATR'S UNIVERSAL INVERTER

American Television & Radio Co. is now offering a new "universal" inverter which will operate from 6- or 12-volt car batteries, a boat storage battery, or a home electric plant.

Especially designed to operate standard 60-cycle a.c. tape recorders, television sets, dictating machines, p.a. systems, record players, electric razors, and various household appliances, this new ATR line is available in output wattages ranging from 80 to 600 watts. In addition, the new units are completely shielded to eliminate r.f. interference, are instant starting, provide frequency stability, and include a built-in power factor corrector utilizing a simple toggle switch.

Complete descriptive material on this new line is available from the company at 300 E. 4th Street, St. Paul 1, Minn.

REPLACEMENT RECTIFIERS

The Semiconductor Products Department of General Electric Company, Syracuse, N. Y., has revised its line of snap-in germanium rectifiers to permit their direct substitution for selenium rectifiers in television sets.

This new development permits one 400 ma. half-wave rectifier (1N1010B) and one 400 ma. double rectifier (1N1016B) to supplant the entire line of five replacement types. This germanium TV rectifier line was revised to help technicians reduce the number of electron tubes in their stock which must be carried on service calls.

Both units deliver 400 ma. d.c. output current into a load at 70 degrees C or 158 degrees F. Both are rated at a peak inverse voltage of 380 volts and an r.m.s. input voltage of 130 volts. Neither device need be derated since there is a complete absence of aging characteristics.

TRANSISTRON'S "REF-AMP"

Transistor Electronic Corporation, Wakefield, Mass., has developed a new device which combines, in a single package, a voltage reference zero diode and an amplifying transistor.

Known as the "Ref-Amp," this unit provides a combined temperature coefficient as low as 002% per degree C over a temperature range of -55 degrees C to +100 degrees C. Regulator circuits, normally requiring ten or more components, may now be developed with only one "Ref-Amp," one "Regulator," and four resistors.

According to the company, this reduction in components increases reliability, doubles loop gain, and reduces
Currently the coil forms are available in three materials: paper base phenolic for the coil winding (#2560), "Polypenco" (#2561), and "Kel-F" for coil winding (#2562). The company will supply complete data on request.

Complete details on the new phone patch are included in Bulletin TE-558-10 which is available from leading distributors or from the manufacturer direct.

SENSITIVE MIDGET RELAY

Kurman Electric Co., 191 Newel St., Brooklyn 22, N. Y., is now offering the Series 231D, low-cost, dust-protected midget relay to the trade.

This lightweight unit is designed especially for plate circuit, photolec-
tric, and remote control applications where space economy and current drain are major design criteria. Sensitivity is as low as 6 mw., s.p.d.t., with a maximum coil dissipation of 2½ watts. Contacts can carry 2-amps, 115-volt a.c. or 28-volt d.c. Some of the features of this relay include adjustable contacts, high-speed operation (down to 1 millisecond), and high-speed keying. Coils can be wound up to 13,000 ohms for a.c. or d.c.

The company will supply further details as required.

---

SHEETED COIL FORM
Cambridge Thermionic Corporation, 445 Concord Ave., Cambridge 38, Mass., is now in production on a new horizon-
tally mounted r.f. shielded coil form that is ideally suited for printed circuit work.

The new unit is a completely shielded coil form assembly using internal powdered iron components of unique design. It is ideal for i.f. strip work where ease of tuning, compactness, and dependability under rigorous serv-
ice conditions are required, according to the company.

The assembly can be chassis mounted for conventional circuitry by means of a #2-56 screw or it can be mounted for printed circuit wiring by four pins. Required mounting holes are on 400" by 300" centers. The mounted assembly is ½" wide by ½" high. A positive compression-type tuning core lock is provided.

The new unit has "Triggermatic" control which provides 90 watts in the first trigger position and 125 watts in the second position. Also included are a pre-focussed spotlight and a newly designed copper, iron-plated tip which is said to give greater heat transfer and longer life.

The kit comes complete with gun, a supply of solder, a brush for cleaning connections, and one of the firm's soldering aids. Model 8200K is now available at distributors, craft shops, and hardware outlets.

PHONE PATCH
Ryapp Incorporated, 7800 W. Addi-
son St., Chicago 34, Ill., has recently introduced a new device for patching a telephone line into a radio trans-
mit-receive system so that two-way conver-
sation is afforded between the tele-
phone party and a remote station.

The Model TE-1 employs a hybrid transformer in a balanced-bridge circuit to permit automatic voice control of the transmit-receive functions. It is

easily attached to popular communica-
tion equipment by means of their ex-
ternal connections.

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135
Interesting, Pictorial FREE BOOKLET

Service Industry News

EFFORTS to order our own lives will characterize us all as long as we are members of the human race. However, an outside event comes along every once in a while to remind us that we must also do some adapting to our environment. With the service industry still divided on what to do about test-them-yourself, drug-store tube checkers, just such an outside event may strengthen the arguments of those whose stand is: "If you can beat 'em, join 'em."

Raytheon Manufacturing Co. recently announced its Tube Mart, which is planned for the service dealer. It consists of a combined tube tester, to be operated by the set owner himself, and a tube rack. Tube Marts are designed to be placed in any type of location, but only under the control of legitimate service dealers. They will be available to such dealers through regular Raytheon distributors. There is space on each Tube Mart for dealer-imprinted leaflets that direct tube purchasers to him for service required beyond simple tube replacement. In addition to the promotional value, it is hoped that dealer control of these testers will put back in his pockets the profits he has been losing on tube sales through purely non-technical outlets.

The adoption of this technique for selling tubes by even this single manufacturer could have considerable impact on service-industry attitudes toward self-testers. In addition, we have learned that other leading tube makers are considering programs similar to the Raytheon plan. Many of them are concerned with the fact that uncontrolled testers of the sort now in use are being employed to market tubes of questionable quality. They hope to win the support of the service industry in keeping the public oriented toward name-brand tubes.

New State Group

A new star recently took its place in the constellation of statewide service associations. Preliminary steps were taken recently to form the North Carolina Federation of Electronic Associations which is to be incorporated as a not-for-profit organization.

At the organizational meeting held in Greensboro, N. C., Garland Hoke, president of the Durham association, was elected president of the NCFEA; Joe Woods of the Greensboro group was named vice president; Charles Mac Broom of the Durham association was selected to serve as secretary; and Edmund Barbour of the Fayetteville local was elected treasurer. Elected directors included: Ken LaRue of Charlotte, Herbert H. Griffin of Lenoir, and R. B. Corn of Raleigh. Present address of the NCFEA is: Garland E. Hoke, President, P. O. Box 222, East Durham Station, Durham, N. C.

The Big IDEA

The annual convention of the Indiana Electronic Service Association, held early in the fall, brought together an imposing group of service-association leaders from many sections of the country. The three-day affair was climax by a short meeting of the directors of the Midwest Electronic Alliance followed by an all-day, informal discussion of national service problems and possible solutions.

The purpose of the informal conference, which drew association leaders from many parts of the country, was to hear the details of a proposed plan developed jointly by the Texas Electronics Association and the Television Service Association of Michigan. The program presented at the Indianapolis meeting is to be handled by a representative group of association officers and called the Committee for Independent Dealers' Electronic Activities (IDEA). It was especially emphasized that the informal cooperation that will occur in this new development is not intended to serve as a vehicle for the formation of another national service association.

In explaining the purpose of IDEA, Karl Heinzman, president of TSA of Michigan and a member of the committee, said: "The service dealer must be recognized as an important small business man, as such, he should have a voice in the very things that affect his destiny."

"The mushrooming of set manufacturers' service facilities across the country, together with parts warranties and 'free service policies,' and, in many cases, open attacks against the local independents by the set manufacturers, are producing near-irreparable harm to the business of the independent service dealer."

"With the rapid growth of the service industry, it is now essential to have better communications between the manufacturer and the independent service dealer. More than ever before, the independent service dealer is in need of a spokesman to present his side of the picture to the manufacturer, the public, and the legislatures, both state and federal."

IDEA is and will function as a committee—not as an association—empowered to speak for state and local independent associations and represent the...
service dealer on a united, national front."

It is felt by members of the committee that there are now more than 30,000 full-time service businesses in operation across the country, each with an investment of at least $10,000. In addition, there is believed to be another forty thousand or more servicing dealers and competent part-timers whose investments are less than that.

The steady down-grading of the independent service dealer's required price structure through manufacturers' "free service" deals and other sales gimmicks is placing these investments in serious jeopardy, it is claimed.

The idea of the IDEA is not new nor intended to become a national association, the acting chairman, Tilman Babb of Wilshire Television, Dallas, Texas, and an official in the Texas Electronics Association, pointed out that the IDEA program would fail if it is permitted to get entangled with association politics. He said it is designed to be, and must be, a team effort in which individual service dealers can participate along with national, state, and local associations, for the sake of united action on an important issue.

"The independent service dealer is now fighting with his back to the wall," Mr. Babb said. The objectives of IDEA are simple, straightforward, right to the point. Those objectives are to put the brakes on all forces that are undermining the independent service industry. Associations are mighty important in helping to create a healthy business atmosphere for service dealers in the local communities where our businesses are located. IDEA will not encroach on the prerogatives of service associations at any level—local, state or national. IDEA is a program in which every service dealer can freely cooperate, regardless of his association affiliations, because it will be fighting against the forces that are subtly undermining his business."

Association officials who participated in the informal discussions at the Indianapolis meeting included Horace Childers, Tilman Babb, and Marvin Tappe of the Texas Electronics Association; Karl Heinzman, Harold Chase, Jack Barton, and Pat Laforet of the Television Service Association of Michigan; Victor Reitter, Frank J. Molnar of NATESA; Robert Steer of the Television Service Association (TELSA) of Connecticut; John Hemak of the Minnesota Television Service Engineers; Carl Stallius and Vern LaPlante of the Electronic Technicians Association of Toledo; Howard Wolfsen of the Associated Radio & Television Servicemen of Chicago; John Graham of the ARTSD News of Columbus, O.; W. C. Pecht, of TEAM, St. Louis, Mo.; Charles A. Conwell, Frank Teskey, and Robert A. Sickels of the Indiana Electronic Service Association.

In the wake of the meeting in the capital city of Indiana and the formation of the IDEA Committee, it is said that there has been a rapid spread of
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transmission. Appropriate muting circuits (of the squelch type) in the subscriber's receiver may then eliminate any random noise components which might become apparent during these periods.

The last mentioned point represents the second important consideration with regard to crosstalk from the simplex channel into the multiplex channel. While crosstalk may seem to be an important factor in the multiplex transmissions where the information being broadcast on the two channels is not related, this problem becomes less significant in the case of stereophonic broadcasts. Since the material on both the simplex and multiplex channels is closely related, both harmonically and rhythmically, one can tolerate a far greater amount of crosstalk between channels without seriously impairing the usefulness of the transmission. One possible alternative to the problem of retaining the marketability of presently operating multiplex services has been the proposal that stereo transmissions be made with an AM subcarrier rather than with the FM subcarrier method now authorized in the SCA band. This restriction would then guarantee that commercial programming would not be received in any useful form by the home listener with an AM stereo multiplex adapter.

With respect to the cross modulation picture in general, it may be said that practical operation of FM stations with non-related primary and secondary channel services has given indication that the -60 db main-channel interference limitation is readily achieved with subcarrier deviations under ±10 kc. at 15% main-carrier modulation by the subcarrier. For as the multiplex channel itself is concerned, the empirical results seem to be somewhat less favorable in many cases. Crosstalk from the main channel into the secondary channel may average around 40 db below maximum output level of

![Fig. 5. Illustrating separation of simplex audio and subcarrier information in the multiplex adapter. (A) Shows an audio signal of the output of the FM tuner discriminator when no subcarrier is being transmitted. When the subcarrier is transmitted, it emerges on top of the audio signal as shown in (B). Proper separation of the crosstalk from the main channel audio is shown in (C). Amplitude distortion of the composite signal (B) may result in subcarrier “drop-out” as in (D).](image-url)
the subcarrier receiver, with over-all distortion levels running a few percent. These figures represent results obtained with a carefully aligned receiver system and with subcarrier deviation and alignment values of ±10 kc, and 15% respectively. The significance of proper receiver alignment will be discussed in following installment of this series.

**Stereo Transmission Systems**

Before considering some of the transmission systems that might be adopted for stereo broadcasting with FM multiplex, it would be well to evaluate the practices in use at the present time. Many broadcasting organizations which have both an AM and FM outlet have been transmitting stereophonic material by the AM/FM method shown in Fig. 3A. This technique can give surprisingly good results in primary signal areas if certain precautions are taken at both the transmitter and receiver. For one, it is desirable to use an AM-tuner of the type rather than the superheterodyne receivers now in general use. Almost all conventional superhet are far too narrow for FM bandpass characteristics in order to achieve the highest possible gain per stage. On the transmitter side, many AM stations tend to lean quite heavily on volume compressors in order to extend their effective signal area. Use of such compressors are quite detrimental to optimum stereo transmission, since their counterparts in FM transmitters—the modulation (deviation) limiters—do not ordinarily possess the same dynamic characteristics. The common misconception concerning bandwidth allocations of AM transmitters will not be discussed here, except to indicate that most large AM broadcasting stations transmit an audio spectrum which comes favorably with their FM transmissions.

The transmission system shown in Fig. 3A and its equivalents which may employ two separate AM or FM stations (or even two multiplex channels on one FM transmitter) to accomplish the same end, has been criticized on one major count—that the listener with a single standard receiver can, at best, receive only half of the information being transmitted. Naturally most stereophonic recordings do not have absolute separation of the two stereo channels (except for special effects) so that in most cases the omission can be considered negligible. However, this is no reason why the listener with one receiver should not be entitled to receive as well-balanced a program as does the listener with two tuners. One of the ways that this fault may be partially overcome is through the method described in Fig. 3B. Here the two stereo channels are cross mixed in an amplifier system similar to that shown in Fig. 2 so that the effective separation of the stereo channels is reduced. This means that there is always some material from Channel A (normally the FM channel) present in Channel B (normally the AM channel) even though the stereo tape or disc being transmitted there is no pickup at all on Channel B. This holds true in the reverse case as well. Although this system may go a long way toward satisfying the listener with only one receiver, it tends to cancel the illusion of depth which, after all, is the reason for transmitting stereo in the first place. By recording AM/FM stereo transmission on tape and then comparing the channel separation of the-off-air transmission on those on the original tape or disc, the pickup has observed many instances of such manipulations by broadcast stations. It is, of course, possible, up to a point, to use the cross-mixing amplifier configuration of Fig. 2 to return these transmissions to their original state.

As would be expected, multiplex operations may lend themselves to the same kind of transmissions as have just been outlined, i.e., one stereo channel may be fed to the main FM carrier and the other to a subcarrier system. See Fig. 3C. This method again suffers from the same fault previously explained in that the listener with a “normal” FM receiver is not able to receive the subcarrier modulation component.

A fourth system, based on analogue computer techniques, has been proposed where the single-receiver listener is assured of a well-balanced stereo band. Even the listener who chooses to use the stereo information in this system is basically simple in operation although the methods used may not be familiar to the average audiophile. In a matrix amplifier (similar to that shown in Fig. 2) the two stereo channels (live, disc, or tape) are combined to create two signals which represent the vector sum and difference in the two stereo pickups. Algebraically, these signals may be represented as (A + B) and (A - B), the letters representing the two stereo channels. The former component is fed to the main carrier modulator and the latter to the subcarrier system. Since the home receiver cannot decode the subcarrier signal, he receives only the main channel information; however, in this case he enjoys a composite signal derived from equal portions of the two stereo channels. Although he may not have as perfect a signal as he might normally obtain as a result of careful mixing and blending in the recording studio or concert hall (microphone placement, etc.), for optimum stereo reproduction does not necessarily coincide with the placement for best monaural listening), he is far better off than with just one half of the transmitted information, which he would be receiving with the previously discussed systems of stereo transmission.

Concerning the resolution of the matrixed signals into their original A and B components, this is readily accomplished by simple means in the multiplex adapter. See Fig. 4. By suitable detection of the subcarrier we may obtain the difference signal (A -
This component, although not normally usable in the ordinary sense, may be added to the main-channel signal \((A + B)\) to give: \((A + B) + (A + B) = 2A\). Similarly, the difference component may be subtracted from the main-channel signal to give: \((A + B) - (A + B) = 2B\). The factor \((2)\) is a relative term and need not enter into the basic considerations. Although the recombination process may seem complex, it will be shown that for a frequency-modulated subcarrier system it is possible to design a simple detector circuit which will provide both polarities of difference signal to enable a relatively straightforward resolution of the two stereo channels.

Before discussing the basic considerations involved in designing a multiplex adapter, brief mention should be made of bandwidth requirements of the “sum and difference” method of stereo transmission. Consider the situation which exists when a subject is placed exactly between two stereo pickup microphones. The sum channel would contain an audio component made up of the vector sums of the two microphone outputs which would be equal. Depending on the fidelity of this process, the transmission would be a good description of the program content, as it were. The difference channel meanwhile would transmit the vector subtraction of the two microphone outputs which, in this case, would be zero. This means that the entire informational content of the program is being transmitted by the sum channel and the integrity of the transmission would depend wholly on the fidelity of the main FM carrier system which broadcasts this component. Notice that in practical applications there is no situation where the sum channel would contain zero information as long as there was a significant component of difference signal.

Although the illustration just given represents a specific situation, it serves to make one point clear. It can now be realized that if the difference channel were to be limited in audio bandwidth there might conceivably be a reduction in directional resolution of a stereo transmission, but never a reduction of the characteristic content of the basic program material. If it is further considered that the high-frequency crosstalk in typical stereo disc recordings may run as high as 5 db at 10 kc, it becomes understandable that band limitation in the difference channel might easily be condoned or even desirable from certain standpoints. Of course, the “crosstalk” in a good two-channel tape recording or a live broadcast from a “dead” studio might be considerably less; however, the acoustic considerations evolving from practical situations and also the inability of the ear to resolve direction at low frequencies still casts serious doubt on the justification for full bandwidth transmission of the subcarrier channel in the “sum and difference” system of FM multiplex.

(Concluded next month)
Right Way to Stack Antennas (Continued from page 61)

marked 7, is 300 ohms. As was demonstrated for the single stub, the matching stub 10 through stub 300 ohms into 600 must have a characteristic impedance of 424 ohms itself. We have shown how this matching-stub impedance is determined by the diameter and spacing of the conductors. In other words, the same matching-stub impedance can be used for stubs 1, 2, 3, and 4! The difference between the primary stubs (1 and 2) and the secondary stubs (3 and 4) is that the latter could not possibly be a quarter wavelength long since the separation between the connecting points will be about a half wave long. A half-wavelength line does not provide the desired impedance transformation. It is thus necessary to make each of the secondary stubs 3 and 4 three-quarters wavelength long. The extra length can be taken care of by bending the bars themselves or by bringing them back towards the antenna supporting mast.

It is possible to use other systems for devising the stubs, including one in which half-wave elements are used. However, determination of values becomes more involved, and the values for D and d become such that special construction requirements must be considered.

Whenever antennas are stacked for additional gain, the accompanying changes in bandwidth and directivity cannot be neglected. These side effects may be helpful in some locations but in others they can be harmful. One important result of stacking is the reduction in antenna bandwidth. Since the matching stubs must be designed for a single frequency, optimum impedance match really is limited to a relatively narrow frequency band. As the impedance match gets worse above and below the design frequency, reflections occur which reduce signal strength and can even cause ghosts to appear. The more antennas that are stacked together, the greater will be the bandwidth reduction. As a general rule, it is safe to say that a given antenna which has uniform gain over the low TV band will have good gain only over a single channel when four such antennas are stacked. In the case of the high TV band and the u.h.f. band, the percentage of bandwidth reduction is the same. However, since each channel occupies a smaller percentage of the carrier frequency, the apparent bandwidth reduction due to stacking is less pronounced.

Another effect of stacking is the narrowing of the main lobes in the antenna's sensitivity pattern. The increase in antenna gain is accompanied by a distortion of the beam into a narrower angle, and this requires that the antenna be oriented more exactly. This change in directivity is most pronounced in the vertical plane.

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A NEW experimental radio broadcasting system that provides stereophonic sound through a single receiver and dual speakers on the regular AM broadcast band has been demonstrated to broadcasters by the Radio Corp. of America. With the system, only a single AM broadcast station is employed to give the stereo effect.

The operation of the AM stereo system is as follows. Two separate sound channels, picked up by two separate microphones or from a stereo tape or disc at the studio, are transmitted on the regular broadcast frequency. A standard AM signal is made up of a carrier wave and two symmetrical sidebands equally spaced above and below the carrier wave. In the stereo system demonstrated by RCA, each of the stereo channels is carried by one of these sidebands.

In the special AM stereo receiver, the two sidebands are separated and fed to two speakers, left and right, to reproduce the stereo effect picked up at the studio. In the present conventional AM receiver, there would be no separation of the two sidebands, so that the program would be heard in conventional fashion without the stereo effect. Note that the conventional receiver would then be reproducing the entire program content, that is, the sum of the left and right channels, rather than the right-left difference, one of these channels. The special stereo receiver can also pick up non-stereo broadcasts and play them through either speaker or both, without any stereophonic effect.

Examination of the block diagram (not shown) of the receiver shows a common r.f. amplifier, converter, and i.f. amplifiers for both channels. After the common i.f. amplifiers, the composite signal is applied to two separate sideband selectors, detectors, a.f. amplifiers, and speakers. In this way, each sideband is handled separately so that the information on the lower sideband, for example, is fed to the left speaker and information on the upper sideband is fed to the right speaker.

For the demonstration, music from a stereo tape, broadcast over a lab-type AM stereo transmitter, was picked up by the special receiver feeding dual speakers. The receiver also picked up a regular AM broadcast from WYCA in New York to demonstrate its compatibility. It must be emphasized that this represents an experimental, laboratory demonstration of equipment that may not be available for commercial use for some time to come.
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Breakdowns occasionally occur in the video i.f. transformers used in the model RA-112 series and RA-113 series. These are likely to involve a break- down in the ceramic coupling capacitor inside the i.f. can. For example, an over is possible between the silvered ceramic tube of this component and the bare wire that fits into it. In later versions of these transformers, the wire has been coated to minimize this possibility. In any case, whatever the cause for the capacitor breakdown, it is comforting to know that replacement of the entire transformer is not necessary.

By external manipulation, the wire in the ceramic tube may be removed, thus taking the capacitor out of the circuit effectively. A substitute capacitor may then be added, also externally. The wire, shown in the bottom view of the transformer (Fig. 1), is readily accessible for removal. After this step, connect a 1.5 µfd., 400-volt capacitor (Stackpole type GA-3 or equivalent) between pins 2 and 4, as shown. This connects it between grid and plate terminals. Naturally, alignment should be checked after the change. A slight touch-up of the grid and plate coils will probably be found necessary.

EMERSON: ERRATIC COLOR
Sometimes, although colors may be reproduced on the screen, they may not be distributed to correspond with the picture content. Whether this loss of color synchronization is constant or occurs on an intermittent basis, the first possibility to consider on receiver models C-502A through C-507A is that L2 needs re-adjustment. The slight adjustment that may be required can be accomplished without test equipment during reception of a color TV broadcast. Manipulate L2 for optimum color lock. This is the position that will produce good pull-in as well as good color hold once synchronization is achieved. If a 920-kc. beat interference pattern mars the picture during color reception, this is also a possibility of a matter of adjustment. This pattern (about 3
black bars per inch along any horizontal scanning line) is at the difference frequency that occurs when the 4.5-mc audio i.f. carrier and the 3.58-mc color subcarrier are permitted to heterodyne. The 41.25-mc sound trap, \( T_s \), is used to tune out this interference. The top of \( T_s \) is adjusted carefully for maximum rejection of the beat pattern while a color broadcast is observed. Make certain that the fine-tuning control has been adjusted for best color reception.

**TVI ON CROSLEY**

If persistent interference is noted on channel 6, or sometimes on channel 7, in receivers using the J-21 series of custom chassis, it may be of internal origin. Included in this group are chassis 472, 473, 476, and 477. The interference arises in this way: the second detector acts as a harmonic generator for the i.f. signal that is fed to it. Harmonics may be radiated from this circuit back to the antenna input.

If interference results from this cause, it can usually be corrected by physically changing the ground lead from the detector. This is the lead from lug No. 2 of i.f. transformer \( T_{bc} \). As shown in Fig. 2A, the lead is removed from its old ground connection near the video amplifier and rewired to another ground lug near the 3rd i.f. amplifier Fig. 2B.

**SHORTS IN MAGNAVOX TUNERS**

Examination of 700584-6 tuners being returned for replacement, with the notation that they are "shorted," indicates that many of them could be repaired in the field quite simply. The short can occur when one of the r.f. plate coils makes contact with the low-potential end of \( R_{bc} \), the 10,000-ohm resistor feeding 140 volts to the mixer stage. When this happens \( R_{bc} \), the 2200-ohm resistor outside the tuner, burns. Simply bending the coil away slightly to clear the short and then replacing \( R_{bc} \) should be the only repair required. This is quicker and less expensive than replacing the tuner, even if it is still in warranty, as a replacement would involve an alignment check of the receiver.

January, 1959
Single Push-Pull Stage (Continued from page 49)

frequency component almost in phase. Any distortion of these components in the amplifier is cancelled by the push-pull transformer in the same way as a regular push-pull output.

Then, in the final amplifier circuit, overall feedback, from the individual speaker connections, goes back into the amplifier to linearize each channel as an entity, regardless of its division into mono and stereo (or push-pull and push-push) components.

The major form of distortion reduced by the normal push-pull output transformer is this lower frequency component. The push-pull transformer here does it, both as regards harmonic and IM components. Distortion higher up, which gets more complicated anyway, is taken care of by the feedback, as it also is in any normal amplifier.

2. Will not the loudspeakers, connected as at Fig. 4, reproduce the stereo out-of-phase?

This is a matter of phasing, at both input and output. Most three-terminal pickups are phased so that lateral motion of the stylus gives two outputs that are positive at the same time (Fig. 5). In this system, the output has to be connected so, for lateral motion, one output is positive at the instant the other is negative.

In the phonographs using this amplifier, the pickup is phased correctly for this purpose. Using the amplifier with other pickups is no problem when there are four terminals, the user can phase his pickup to suit.

If you've become used to thinking the way most systems are connected is standard, then this system will seem non-standard to you in this respect. But it really depends which you start off with as the standard. From the viewpoint of the user, the pickup, basic symmetry will require the up-and-down component to be the in-phase, or push-pull element, which agrees with this system, and makes the more generally accepted connection "non-standard".

As far as functioning is concerned, all that matters is that it be connected the right way, which only has to be done once, when setting up the system.

At the loudspeaker end, if different units are used, the opposite end of the voice coil(s) have to be connected to the ground bus of the left and right systems. But, again, once the system has been phased, everything works correctly. The thing is purely relative.

3. One reason, or advantage of push-pull operation is improved efficiency of the output stage. This is achieved by working at, or nearer, class B operation. In view of the fact that this system uses a push-pull component, can it utilize this advantage properly?

Class B is a theoretical condition, postulated on plate characteristics that make an abrupt, or discrete transition from straight lines representing constant a.c. resistance, to a cut-off condition, representing infinite resistance (Fig. 6). No tubes ever made operate just this way.

But working well "round the bend" as a single-ended tube can result in excessive curvature. And the parallel, or vertical component, goes through this amplifier as a "single-ended" operation. Let's give a little thought to what can happen in a single-ended amplifier of this type with feedback.

Assume it is biased to a point well in excess of the curvature, so a signal comes through that drives it "round the bend"—in fact well into cut-off. Feedback fails to offset the waveform inside the amplifier that is distorted in the opposite way (Fig. 7). But it can only work on parts of the waveform that get through. For the part beyond cut-off there is no feedback.

So the internal waveform becomes exaggeratedly asymmetrical the opposite way. As has been proved many times, such an asymmetrical component in a waveform is equivalent to a change in d.c. bias; in this case it will work progressively, like a "pump", until the feedback can "get to work" on the whole waveform.

In effect, the feedback will use the time constant of the coupling between drive and output stage to alter the bias just enough to allow the stage to handle the signal completely, so it can work on linearizing all of it.

But, if this were the only means, and the time constant is made long enough to represent a good bass response (which is needed for the push-pull mode), quite a bit of distortion can occur before the required point. Fortunately, however, with the circuit shown in Fig. 4, another effect can take charge meanwhile.

When the large signal first "strikes", its first positive excursion at the grid of the drive stage (Fig. 7), it won't be offset by corresponding feedback at the cathode, because the output tubes will run well into cut-off. Consequently, from the point where the output tubes
cut off, the grid voltage here will rise sharply positive, and due to grid current, will temporarily bias this stage back by a corresponding amount. With proper choice of time constants, this will pass a similar temporary bias to the output stage—positive, so the output stage can immediately handle the whole signal.

So, after the first quarter wave of a big vertical component (unless it runs the output tubes into the positive grid region now, in which case, the signal is just too much anyway), the output tubes find the right bias for the signal coming through by means of the feedback action. From then on the feedback maintains a correct balance in bias adjustment.

4. Doesn’t having the tubes handle a “double” signal—push-pull as well as push-pull—limit the maximum power of the amplifier as compared with normal push-pull operation, in spite of any self-adjusting action?

To tackle this question I went to the Mullard “Technical Handbook of Receiving Valves” to see what I could expect of a tube under these conditions.

In Class AB, self-biased push-pull, with 300 volts on the plates, they give 17 watts. A figure is not given for the same operating condition in parallel, but an inspired guess from figures given for a single tube operating at 250 volts suggests they would give around 13 watts under this condition.

Working in this circuit, if a pure signal is fed in, in-phase in both channels, so as to work the tubes in push-pull, they will give their rated 17 watts, into the rated resistance load. This will be shared between the left and right channel, after an appropriate loss in the output transformers.

Similarly, if one channel is reversed in phase, to be equal to a vertical cut, the tubes should deliver 13 watts into the same kind of load. So, when someone asks whether this mode of operation will limit the power, do they want to get 17 + 17 = 34 watts, for the same money they can normally get 17 watts?

Actually, under the hypothetical conditions represented in such tests, the amplifier should always be able to deliver somewhere between 13 and 17 watts, according to phase angle between channels.

But actual stereo programs does not possess a single frequency with known or constant phase difference between

FM COMMUNICATION EQUIPMENT

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channels. Different components will have different phase angles, at quite random distribution. But this is nothing new. The same invalidation of wattage ratings occurs with normal amplifiers.

An amplifier is never called upon, in musical program, to deliver 17 watts pure sine tone into a resistance load. It's called on to deliver a multiplicity of complex tones into a loudspeaker. If it had a resistance load, the maximum peak power of the complex wave would be just twice the average power of the theoretical sine-wave output. That's about as nearly as we can relate the measured results to practical performance.

With the combined stereo amplifier, if both loads were pure resistances, the maximum peak power delivered to the two channels combined will be somewhere between 26 watts minimum (2 x 13) and 34 watts maximum (2 x 17). Different proportions of different component frequencies may get delivered to each channel, but this is the maximum peak power of the composite, still assuming that inaudible resistance load.

5. What about crosstalk in a combined amplifier like this?

The original claim is that the separation between the channels "on the average is better than 25 db". There is something about the crosstalk question that needs clarifying here. How much separation do you actually require anyway?

The answer to this question requires qualification. It depends on what the crosstalk is. If it is pure crosstalk — left program breaking through to right, or vice versa, 10 to 12 db separation is quite adequate. But if it should happen to be distortion components of left program showing up in right, then 30 or 40 db is not so good. When you measure crosstalk, do you have simple crosstalk, or instead do you have cross-modulation?

Pickups, as well as combined amplifiers, will need more careful scrutiny from this viewpoint. There is no reason why a combined amplifier should not have a separation of better than 25 db that is pure crosstalk, due to slight imbalances and tolerances on transformer ratios, etc. Actually, a complicated mechanical structure with non-linear compliances controlling its motion is much more likely to produce the cross-intermodulation variety than a combined amplifier, in which transfer is more or less like simple break-through from one channel being handled by the amplifier to the other.

But now we are getting onto much bigger questions that open up avenues for further work. Here we can only say we know all about these stereo problems. Meanwhile, the single stereo amplifier definitely works, and provides certain economies that make it quite worth while.

We can expect to see shortly announcements of commercially available equipment using these principles.

Low-Ripple Eliminator

(Continued from page 41)

The 6.3 volt secondary winding of the power transformer was chosen as the a.c. source to provide the energy for the "A" supply. There were two principal reasons for this choice: (1) standard size components are preferred wherever possible and a 6.3 volt secondary is always available and (2) if a higher a.c. voltage source were used than was needed, the excess energy would only have to be dissipated as heat and thus wasted, not to mention the high-wattage resistors that would be required. It must be remembered that the same current would be necessary (about 1/4 ampere) irrespective of the voltage source.

If a selenium rectifier operating series-half-wave from this low-voltage secondary were to charge a 100 μfd capacitor to peak, the maximum available d.c. voltage would be 6.3 times √2 or about 8.9 volts. This, therefore, would be the value assigned to Eₘ (d.c.) in equation (2). The output voltage Eₜ (d.c.) required at the load is about 1.5 volts. The load itself, Zₜ, is 6.0 ohms. When these values are substituted in equation (2) one obtains the following:

\[ 1.5 = \frac{(6.0)(8.9)}{(6.0 + 2R + Zₜ)} \]

or, after collecting terms:

\[ Zₜ = 29.6 - 2R \]

A selenium rectifier was available which was rated at 250 ma., but its internal impedance Zₜ was about 100 ohms. This was the specification for the present application because it would require a load of 29.6 ohms, and the load would be the same whether this load was R or not. The rectifier was built to...
withstand line voltage, however, and consisted of five plates (or leaves) connected in series. A single plate, therefore, should be able to withstand about 25 volts which would certainly be safe enough for our purposes. The important thing about a single plate is that its internal impedance would also be diminished to a respectable value of about 20 ohms without in any way detracting from the current handling ability of the original rectifier stack. This value for Z, substituted in equation (3) yields a resistance of about 5 ohms for R which works out quite well. Equation (1) can now be used to determine the nearest value of C for effective suppression of the 60-cycle ripple. It turns out to be 500 μfd, which is not especially bulky at low-voltage ratings (e.g., 15 volts). Consequently, the selenium rectifier selected for the "A" supply was carefully disassembled by removing the rivet which holds the plates together. A single plate was re-assembled using the original solder lugs and insulated washers. The new assembly was held together with a 6-32 machine screw and nut, care being taken to insulate the threads of the screw from the rectifier plate. The modified rectifier is partly visible between the decks of the chassis in Fig. 1.

The precise matching of resistances with reactances is quite critical for optimum ripple suppression. For this reason it was decided to use a suitable resistance wire in order to determine the exact resistance necessary. Manganin wire (made by Wilbur E. Dufton Co., Newark, N. J.) was chosen because of its extremely low temperature coefficient. Size 32 was convenient, having a specific resistance of 4.52 ohms per foot. The radio, itself, was used instead of a dummy load during this final determination of the amount of resistance wire needed. A length of slightly more than a foot was used at first, corresponding to the nominal value of 5 ohms for R. Using the coil as an indicator, it was not difficult to tell that 4% ohms for each of the series arms and 2 1/2 ohms for the shunt minimized the hum to such a degree that it was hardly detectable. The d.e. voltage measured across the real load turned out to be 1.3 volts instead of 1.5. This was considered to be close enough, especially since the radio's performance is, after all, the best criterion of acceptability. The amount of wire required for each resistance was then wound around a suitable form. Large carbon resistors (i.e., large, physically, as well as high in ohms) served this purpose quite nicely. Fig. 2 is a bottom view of the "A" supply showing the compact arrangement of components. The hand-wound resistors just described are clearly visible in the foreground.

A schematic diagram of the complete power supply ("A" and "B") is shown in Fig. 3. The radio has been performing daily for about six months in a very satisfactory manner powered by this equipment.
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Authoritative TV FREQUENCY SPECTRUM AND INTERFERENCE CHART on VHF TV frequency spectrum. Of particular interest to the service technician, this "fold-out" shows how various TV channels are affected by common interferences caused by other broadcast signals.

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**RADIO & TV NEWS**

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Long Distance SSB Tropo-scatter Link

First single-hop system is now undergoing tests over a 640-mile distance.

RECORD completion and installation of the world's first single-hop long distance, single-sideband, troposphere-scatter communications system has been announced by the General Electric Co. The long-range system was designed and developed by Massachusetts Institute of Technology's Lincoln Laboratory and G-E for the U.S. Air Force. The new scatter hookup is undergoing tests at Fort Monmouth over an unprecedented 640-mile distance between Millstone Hill, near Boston, Mass., and Sauratown Mountain, near Winston Salem, N.C. It is a prototype of the first such over-the-horizon communications system to be used by the Air Force as the main communications between advanced Arctic bases for the military.

Six to eight years of normal development time are usually allotted for projects of this nature. However, due to urgent need for this equipment, the scatter link was completed in a record 1½ years, from drawing board to installation. The equipment was manufactured on a $10-million contract.

The main advantages of the system are its extreme reliability of communications and its ability to span long distances, which is important in inaccessible areas where erection and maintenance of repeater stations would be impossible.

In the new Air Force system, two huge super-power transmitters are used at each site. Each transmitter has a potential output of 50 kw. The transmitters send simultaneous signals to two antennas where they are focused by two giant 120-foot high parabolic reflectors and beamed skyward. The antenna gain is about 20,000 times. Thus, at full power, the equipment is transmitting one billion watts of effective radiated power.

The huge antenna reflectors at each site are precisely aimed at an identical area in the troposphere. Here the signal paths cross-cut. Although much of the power is lost at this point, some is scattered or reflected back to the receiving antennas. Since the system is two-way, each site is designed to receive and transmit simultaneously. Twenty-four separate voice and teleprinter channels are provided.

The equipment was designed for simplicity of operation and ease of maintenance. Thus, it can be operated safely by personnel with a minimum of training. Built-in safety devices assure protection from personal harm while the system is in operation.

While the first edition of this text (1942) was adequate for its period the almost unbelievable strides in the field of radio and electronics since that time has dictated the requirement of an up-dated volume. Although still under the aegis of Dr. Everitt, dean of the College of Engineering, University of Illinois, the services of five contributing authors have been enlisted to handle specialized subject material.

The text is divided into 22 chapters and an appendix and covers mathematics needed in radio and electronics, d.c. circuits, circuits with time-varying voltages, vacuum-tube and transistor principles, modified power supplies, the transmission and recording of sound, audio and video amplifiers, pulse and switching circuits, electromagnetic waves, the transmission and reception of signals by radio, AM detectors, AM radio transmitters and receivers, FM, monochrome and color TV, vacuum-tube instruments, u.h.f. and microwave circuits, radio wave propagation, radio antennas, radar, and industrial applications.

Since the use of higher mathematics has been avoided throughout the text there is no reason why the serious student shouldn't be able to use this volume as a "do-it-yourself" training manual in the field of radio and elementary electronics. Test questions at the end of each chapter encourage such usage.

"This is truly a sensational receiver ..."
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"This is the first receiver I have had to respond so well to Single Side Band."
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the West Indies, it should meet the needs of even of the most avid television DX fan or the collector of freak skip transmissions on the FM band.


This volume represents the cumulative experience of a group of Mullard engineers and physicists who have been engaged on research and development of semiconductor devices and their application for a number of years.

These eight men, along with their editor, have covered the subject thoroughly from the physics of the device and its characteristics to specific applications in a variety of circuits. The chapter on physics is on a high technical level and was included primarily for physicists. Its contents can be bypassed by the more experienced electrical engineer since the balance of the text is complete in itself.

The book covers general four-terminal networks and the transistor equivalent circuit; direct-current biasing and characteristic classification; high-frequency amplification; class C amplification; sinusoidal oscillators; amplitude modulation and demodulation; the junction transistor in nonlinear circuits; and transistor d.c. converters. An appendix covers transistor measurements of various parameters and characteristics.

The treatment of the subject is mathematical and at an engineering level. An engineering degree or at least junior standing in an engineering college is pre-requisite to an understanding of the text. For those engaged in transistor research or the application of transistors in various circuits, this report on British progress along these lines should be of real interest.

"PIN-POINT RECORD CHANGER TROUBLES IN 5 MINUTES" by Coyne Staff. Published by Coyne Electrical School, Chicago. 292 pages. Price $3.95. Spiral bound.

The success of the first volume of the "Pin-Point" series has dictated the application of the same technique to the servicing of record players and their associated amplifiers.

This volume brings all of the mechanisms made in the United States as well as the foreign makes which enjoy widespread American distribution. The material covers hi-fi turntables as well as single-, three-, and four-speed changers. There are over 400 time-saving photographs and illustrations to help the technician track down service faults as well as 58 specially developed trouble "Check Charts." Accompanying the "Check Charts" are explanations of troubleshooting short cuts based on years of actual field experience.

The text is divided into four sections covering record changer mechanisms, tone-arm servicing, amplifier servicing, and record-changer servicing. This latter section is arranged alphabetically by manufacturer for fast identification.

The spiral binding which permits the book to lie flat on the service bench is an added boon to the busy technician.


This is a handy reference book for the practicing technician or experimenter who has occasion to use an oscilloscope in his work.

It may also serve to lend encouragement to many technicians who are a little afraid of the oscilloscope, and because of this fear, they are not getting the full benefit from a piece of test equipment whose versatility is probably unmatched in the field of electronics. The scope certainly should be more widely employed than it is.

The text covers the CRT tube, oscilloscope circuitry, accessories used with scopes, how to measure waveforms, waveforms, networks and waveforms, the display of characteristics, fundamental electronic circuits, checking receiver circuits with the scope, waveforms in monochrome and color TV, and scope fault patterns. The text is illustrated but a little retouching on some of the many scope waveforms shown would have been very helpful to the user of this book.


The neophyte engineer and the serious service technician will both find the book of value since it covers a specialized field about which there is far too little published material available.

The treatment is practical and those with a good grounding in electronics and a working knowledge of mathematical operations should have no difficulty following the presentation of the material. The text covers an introductory section in which the nature of waves is discussed. Then the author moves on to consideration of transient waves and their calculation; sinusoidal waves; standing waves; transmission efficiency, and impedance matching; lines as resonators; equivalent lumped circuits; measurements and standing-wave ratio; the circular transmission-line chart; finishing up with a four-part appendix which includes transmission line data needed by the student (characteristic impedance, skin effect, proximity effect, and attenuation in standard cables).

The text can be used either as a practical handbook for communication transmission lines or as a stepping stone to work with microwave systems.


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SOLUTION TO BENCH PUZZLER NO. 4

(See page 102)

TAKING another look at that part of the circuit which is reproduced above, we realized something. While we had to use the top-of-the-chassis method to check out the diode, this measurement to ground would be valid only if the secondary of the i.f. transformer had continuity. The trouble turned out to be an intermittently poor connection to this secondary. In fact, the reading across the winding was a few thousand ohms. The repair was indeed simple: a cold solder joint in the 3rd video i.f. transformer was sweated.

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