MARCH, 1960

ELECTRONICS WORLD

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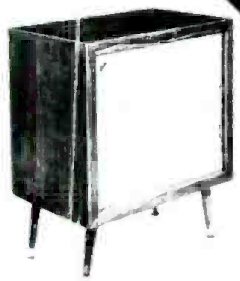

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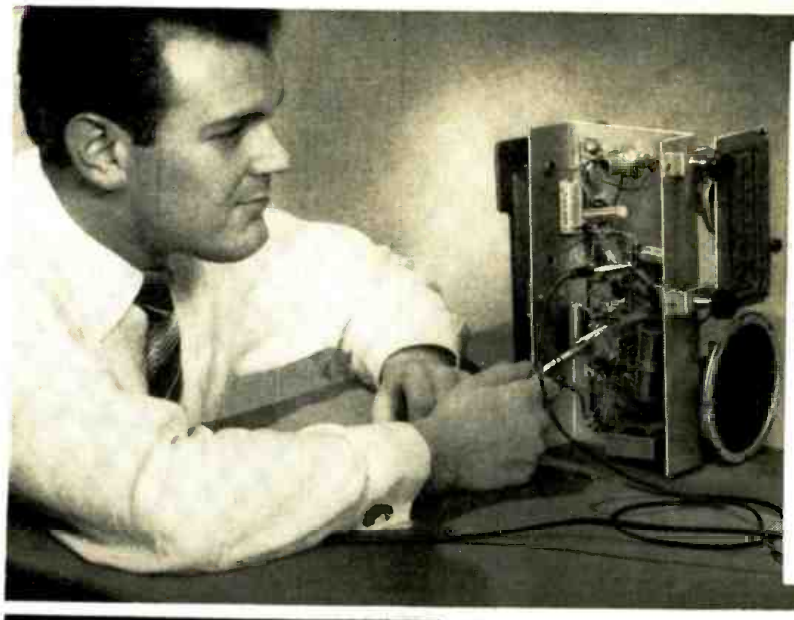

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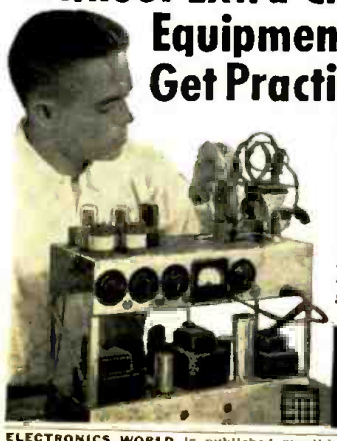

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CONTENTS

ELECTRONICS—GENERAL

The Sixties—An "Electronic Decade"? (Editorial) ..... *W. A. Stocklin* 8
Spot News ..... *Washington Correspondent* 30
Thermoplastic Recording 47
Recent Developments in Electronics 54
Parametric Amplifier Tracks Space Probes 88
Calendar of Events 117

HIGH FIDELITY AND AUDIO

More About Wide-Stage Stereo ..... *Paul W. Klipsch* 50
Room Acoustics for Stereo—Sound Absorbers & Special Speakers (Part 3) ..... *Abraham B. Cohen* 57
Portable Transistorized FM Receiver ..... *Donald L. Stoner* 61
Stereo Microphone Techniques ..... *Herman Burstein* 66
The "Stereo Classic" Hi-Fi Amplifier (ELECTRONICS WORLD Lab Tested) 68
Hi-Fi—Audio Product Review 74
Certified Record Revue ..... *Bert Whyte* 84
New Audio Test Report (ELECTRONICS WORLD Lab Tested) 114
Sound on Tape ..... *Bert Whyte* 134

TELEVISION-RADIO

"Line-Cord" Antennas: Fact and Fiction ..... *Sidney C. Silver* 41
New TV Designs for 1960 ..... *Walter H. Buchsbaum* 44
Know Your Electronic Chemicals (Part 2) ..... *Walter H. Buchsbaum* 48
Mac's Service Shop ..... *John T. Frye* 53
An Odd Sort of "Tube" Problem ..... *George D. Philpott* 64
"Controlled-Heat" Soldering ..... *Kenneth Bramham* 65
Transistor Radio Circuits (Part 5) 82
Service Industry News 102

TEST EQUIPMENT

A Practical Transistor Tester ..... *Roy A. McCarthy, K6EAW* 80
New Tube Tester Data 92
Simple Audio-Distortion Tester ..... *C. L. Henry* 120

COMMUNICATIONS AND AMATEUR

Scatter Radio Communications ..... *Robert B. Stecker* 37
Cover Story 40
Transistorized Citizens Band Converter ..... *Sol Leise, 4W0385* 70

ELECTRONIC CONSTRUCTION

FM Wireless Microphone ..... *D. E. Thomas & J. M. Klein* 42
Signal-Powered Audio Compressor ..... *Ed C. Miller* 56
Utility High-Voltage Supply ..... *Alvin B. Kaufman* 96
Custom Dials for Your Equipment ..... *Gene Brizendine* 98

DEPARTMENTS

Letters from Our Readers 10
Within the Industry 22
Technical Books 132
Manufacturers' Literature 136
What's New in Radio 142

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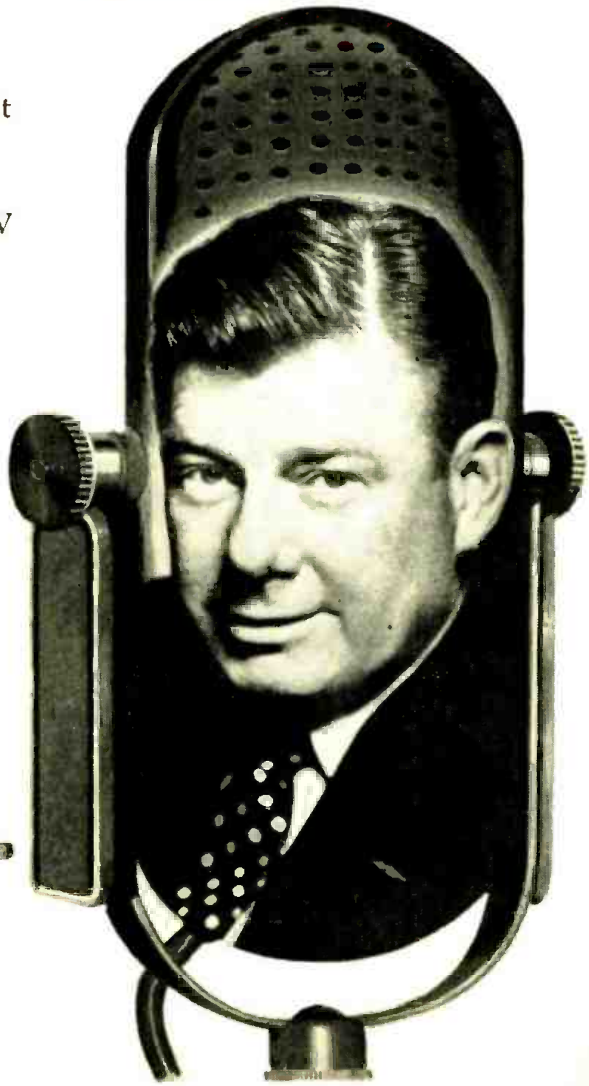

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What Does F.C.C. Mean To You?

What is the F.C.C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F.C.C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses – commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams" – people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelephone license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally required to complete the course and get your license is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand – choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

HERE'S PROOF that Grantham Students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Ron Taylor, 29 S. Franklin St., Chambersburg, Pa.	1st	12
Beri Moore, P.O. Box 169, Opp, Alabama	1st	15
Donald R. Titus, 270 Park Terrace, Hartford 6, Conn.	1st	12
Robin O. Okinishi, P.O. Box 375, Hanapepe, Kauai, Hawaii	1st	12
Billy R. Kirby, Route #3, Smithfield, N. C.	1st	9
J. H. Reeves, 10621 Ruthelen, Los Angeles 47, Calif.	1st	12
Donald H. Ford, Hyannis Rd. (Cape Cod), Barnstable, Mass.	1st	12
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12

FOUR COMPLETE SCHOOLS

To better serve our many students throughout the entire country, Grantham Schools of Electronics maintains four separate Divisions – Hollywood, Calif.; Seattle, Wash.; Kansas City, Mo.; and Washington, D.C. – all offering the same courses in F.C.C. license preparation, either home study or resident classes.

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...for the Record

By **W. A. STOCKLIN**
Editor

THE SIXTIES—AN "ELECTRONIC DECADE"?

WITH 1960 slated to be the first year in which the gross national product crosses the half-trillion mark (up from $478,000,000,000 in 1959), the electronics industry is expected to rack up a new record in all categories—with educated estimates naming $10-billion as the most likely figure.

All segments of the electronics industry shared in the 1959 upswing—according to the Business and Defense Services Administration of the U. S. Department of Commerce. Radio and television receiver shipments were up 27 per-cent; consumer products, as a whole, were up even more substantially; commercial, industrial, military, and government shipments were up over 20 per-cent; and while electron tube output increased 12 per-cent, semiconductor output increased a fantastic 75 per-cent!

While the 1959 growth is expected to continue into 1960, the rate will be somewhat slower—approximating the present growth trend of 13 to 14 per-cent. Employment in the industries producing electronic products reached record levels in 1959 and should increase still further in 1960, according to the Department of Commerce.

Commercial and industrial electronic equipment showed an 18 per-cent increase in 1959, reflecting the impact of capital expenditures deferred in 1958, the increased use of labor-saving and more efficient electronic equipment in business and industry, and the increased requirement for equipment used in research and development progress.

It is estimated that the demand for such commercial and industrial electronic equipment will continue to increase with gains of at least 10 per-cent over 1959. Products in this category include radio communications equipment; broadcast equipment; electronic computers; electronic navigation aids; electronic data processing machines; automatic controls; and test, measuring, and monitoring equipment.

An interesting sidelight in connection with such industrial equipment sales is the fact that the electronic industry itself is one of its own best customers for such products.

Industrial equipment accounted for $1,500,000,000 in 1959—an increase of $170,000,000 over 1958, with further increases projected not only for 1960 but for the entire decade.

According to the EIA, December 31st closed out a decade during which the electronics industry achieved an unbroken succession of new "all-time highs" in total factory sales for every year. The industry's total 1959 business at the factory level has been estimated at $9.2-billion or more than three and one-half times the total for the first year of the decade and an increase of nearly 16 per-cent over the previous high of $7.94-billion established in 1958.

There are now more than 760,000 persons employed in electronic manufacturing, more than double the number in the business at the beginning of the decade.

In the entertainment segment of the industry, high-fidelity and FM receiving equipment is expected to provide a new market stimulus. The sales of FM sets in 1959 doubled over 1958 and are expected to continue upward in 1960, with more FM stations on the air and more stations offering simulcast programs, etc. Stepped up promotional programs for stereo phonographs and for pre-recorded magnetic tapes—in both reel and cartridge forms—is expected to spark the projected rise in audio equipment sales.

If current predictions work out, as expected on the basis of present business projections, the year 1960 and the decade ahead should be a lush period for all of us in the electronics industry. Happy Sixties!

CB MARINE FREQUENCIES

AT THE recent New York Motor Boat Show, a group of about 40 representatives of CB equipment manufacturers, electronics publications, and a representative of the FCC discussed the use of the Citizens Band by boatsmen. After various views, including our own (see our editorial "Citizens Band Calling Frequency" in our February issue) were presented, the following specific recommendations were agreed upon: Boatsmen should be encouraged to use CB Channel 13 (27.115 mc.) for pleasure-craft contacts. A second channel recommended for pleasure-craft use was Channel 9 (27.065 mc.). This channel was also suggested for use by commercial marine interests. As we have said many times in the past, none of the CB channels may be used for ham-type operation or for idle conversations; there must be a *need* for the contact.

The manufacturers present agreed to do all they could to encourage the use of these specific frequencies by boatsmen. This is certainly a step in the right direction and, with a little voluntary cooperation all around, this should result in more effective use of the Citizens Band by mariners. —30—

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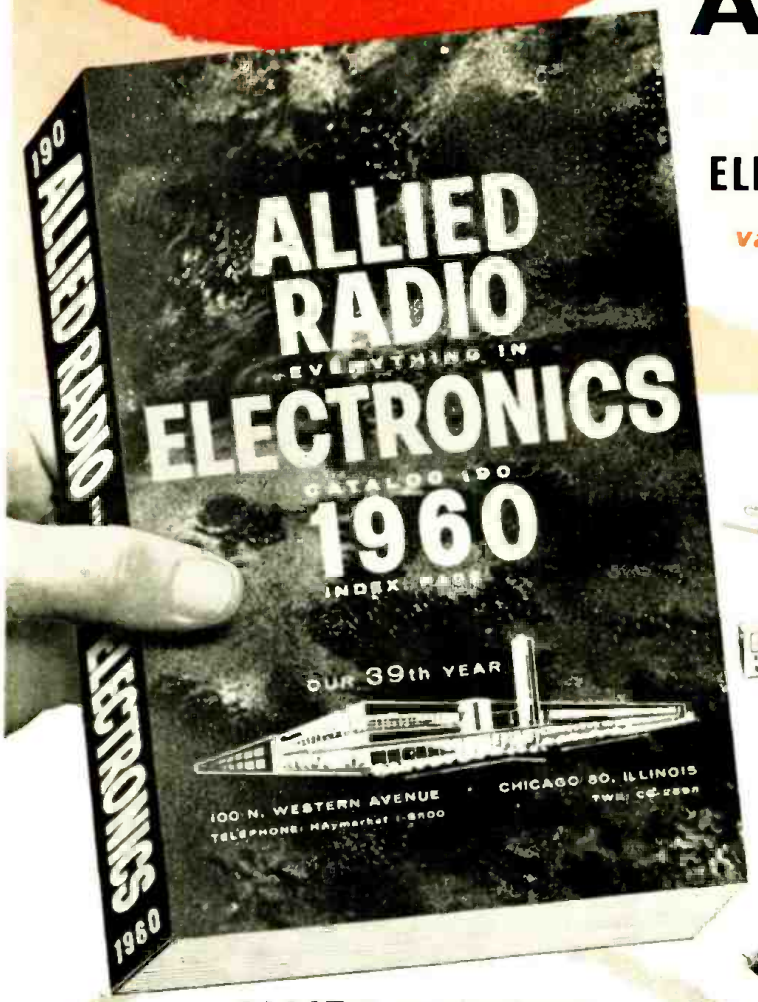

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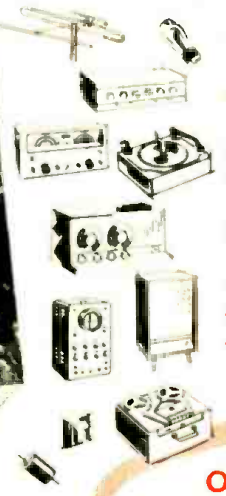

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HAM PHONE PATCHES

To the Editors:

Every remark you made, both pro and con, regarding the ham and his phone patch activities/facilities are concurred with at and by my station and myself.

It has been my contention that normally a long distance call would not have been made in the first place had not the ham been the go-between. The "patch" arrangement gives the third party the source for putting in a call at either end—sometimes at both ends. As you stated, a number of those who were contacted *via* the patch turn right around and make a second call *via* the land-line to confirm the airwave QSO.

AT&T, *IT&T*, and the hundreds of small telephone companies would profit tremendously by their open approval of this form of activity.

N. G. GIGNAC, YN1, USN
WA2AFX
Brooklyn, New York

To the Editors:

I was glad to read K9IVY's article on phone patches in your December, 1959 issue, and would be willing to accept all of his proposals except one. It hardly seems right to have to pay an additional monthly fee for a service that in reality would not be provided. The ham provides his own patch equipment and would use his "private line" no more than any other normal subscriber of a private line.

In my own situation, an additional fee was paid when I had the telephone company install a jack in the shack so that one of the instruments in my home would be portable, thereby providing an extension at the operating position.

NORMAN G. PRESTON, JR., K4PRQ
Minister
Woodlawn Methodist Church
Roanoke, Virginia

To the Editors:

Not very long ago, a ham phone patch was a most important thing to me, and the occasion for making one was easily comparable to a major holiday of the stature of Christmas or New Years.

My last duty station was on a fairly remote West Pacific island, exceedingly more remote in environment than distance from our beloved U.S.A. Thus, any sort of personal contact in the nature of a phone conversation with family or loved ones was indeed a cherished occurrence. There were two or three ham stations available to provide phone patch service. At the time, I had not the faintest notion that this practice might be illegal, and the consideration all concerned maintained for the stateside hams who completed phone patches cannot be put into words. They were our favorite people. I can only say that the invective I feel toward any person or agency who might outlaw this important morale builder would match in intensity my esteem for those who made it possible.

LT. WILLIAM W. ORRANGE, USMC
2nd Marine Air Wing
USMCAS
Cherry Pt., North Carolina

We are still being flooded with comments on Mr. Ehinger's important proposals on how phone patches should be made legal.—Editors.

* * *

GOVERNMENT PRINTING OFFICE

To the Editors:

I am certain that many of your readers are unaware of the many excellent electronic publications available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

These publications include Air Force manuals, Navy training course manuals, and military technical manuals. Information on available publications may be obtained by requesting a free copy of price list 82, Radio, which also covers electronics, radar, and communications.

EINAR H. MORTERUD, W5FPB
Albuquerque, New Mexico

* * *

CITIZENS BAND BEAM ANTENNA

To the Editors:

I must congratulate you on the frank presentation of your editorial in the November issue concerning Citizens Band operation. I can certainly agree with the problems involved and with the final approach to the solution only being through mutual understanding of this project.

I am a little confused, however, that in one breath you take this attitude and practically 5 pages down in the magazine appears a beam antenna for Citizens Band use. If this is going to be restricted to local use and to try and cut down the interference from the skip signals, it seems that the antenna also forms a proper part of the cooperation, and we question the endorsement and promotion of beam antennas for Citizens Band use.

It is a good article, however, and we intend to build one to actually try it out. We question one thing, however, that we would appreciate your passing on to Mr. Hartland B. Smith concerning the impedance matching, which is obviously 72 ohms. I think you will find

Channel Master
AUTOMATIC
TENN-A-LINER
model 9524
$49.95 list

Hits TV stations right on the nose! The Channel Master Automatic Tenn-A-Liner is the only rotator that aims the antenna within **one degree** of the precise transmitter location.

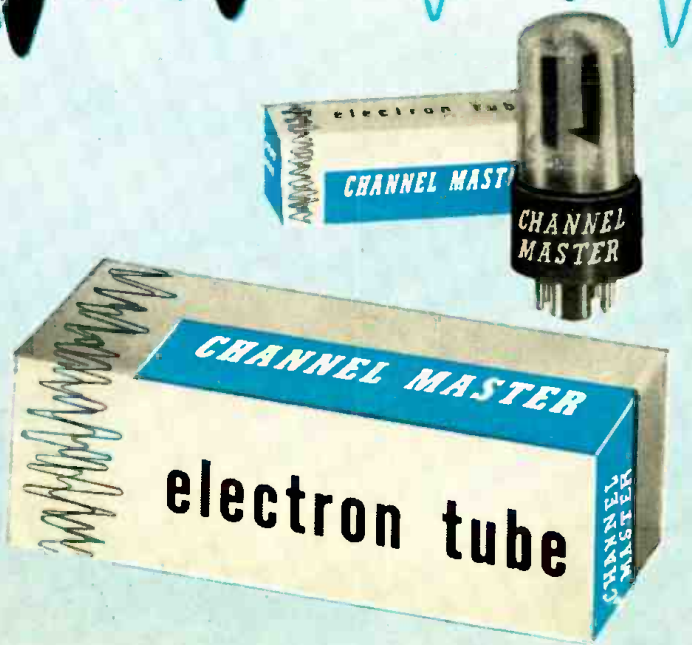
Superior parallel circuit delivers a full 29 volts to the rotator, producing higher torque that easily turns even the heaviest antennas. Fewer moving parts—all fully protected from weather extremes — contribute to long, trouble-free service.

For these and other reasons, you can recommend and install the Automatic Tenn-A-Liner with full confidence of customer satisfaction.

from the top of the roof...to the back of the set...

CHANNEL MASTER

works wonders in sight and sound



Premium tube features at no extra cost. Channel Master Electron Tubes are designed for use in television, AM/FM radio, and high fidelity systems. They offer the same outstanding performance, quality, and value you've come to expect from all products bearing the Channel Master name.

Rigid manufacturing controls assure consistent performance characteristics, exact tolerances, long life, low noise, and maximum gain. Channel Master Electron Tubes are engineered to provide the best possible results.

For happier customers, fewer callbacks, higher profits ... put Channel Master tubes in the sets you service.

CHANNEL MASTER CORP. ELLENVILLE, N. Y.

TV ANTENNAS • ACCESSORIES • TRANSISTOR RADIOS
STEREOPHONIC HIGH FIDELITY COMPONENTS

that most of the Citizens Band rigs on the air are either *Heathkit* CB-1, or home-made units which require 50 ohms, and we would like to have the information for the use of this beam with a 50-ohm matching impedance.

We certainly must compliment you on the fine magazine that you are now putting out.

FLETCHER HARRIS, JR.
Galveston, Texas

We certainly do not advocate the use of a beam antenna for DX operation on the Citizens Band. The idea of the beam is simply to obtain more reliable communications over distances of 20 miles or so with low-power equipment.

Regarding the impedance of the beam, the amount of mismatch that would be produced by connecting a 50-ohm transmitter to a 75-ohm circuit is not too serious, besides which the 50-ohm figure given by some manufacturers is merely a nominal value. The actual output impedance may be somewhat different from this.

For those who want to reduce the input impedance of the beam, we would suggest they try the following: Reduce the distance between the boom and the point where the hook-up wire connects to the driven element from 11⅞ inches to about 10 inches.—Editors.

* * *

HUNGARIAN COLOR ORGAN

To the Editors:

Referring to the letter of Mr. L. de Bodroghy in your April, 1959 "Letters from our Readers" column concerning the Photorhythmicon. I believe that nothing fundamentally new could have been found in the system described in 1948 since corresponding systems have been known before.

For example, an exactly similar device has been amply described, and during the year 1942 was publicly operated in the theater "Arizona" in Budapest under the name "Color Orchestra." Its original model was constructed by me, then a member of the research staff of *Tungsram Works Ltd.*

PROFESSOR I. P. VALKO
Technical University
Budapest, Hungary

Thanks to Professor Valko for his interesting comments, and also for sending us copies of the British and Brazilian patents referred to by Reader de Bodroghy. There appears to be some error in the British patent number indicated since patent No. 21173/48 describes "Improvements in and relating to Short-wave Aerials."—Editors.

* * *

MICRONS AND MICRO-INCHES

To the Editors:

It has been called to my attention that tape recorder manufacturers have been describing tape-head gap widths in terms of "microns," while meaning *micro-inches*, as in "90 microns width (.000090 in.)."

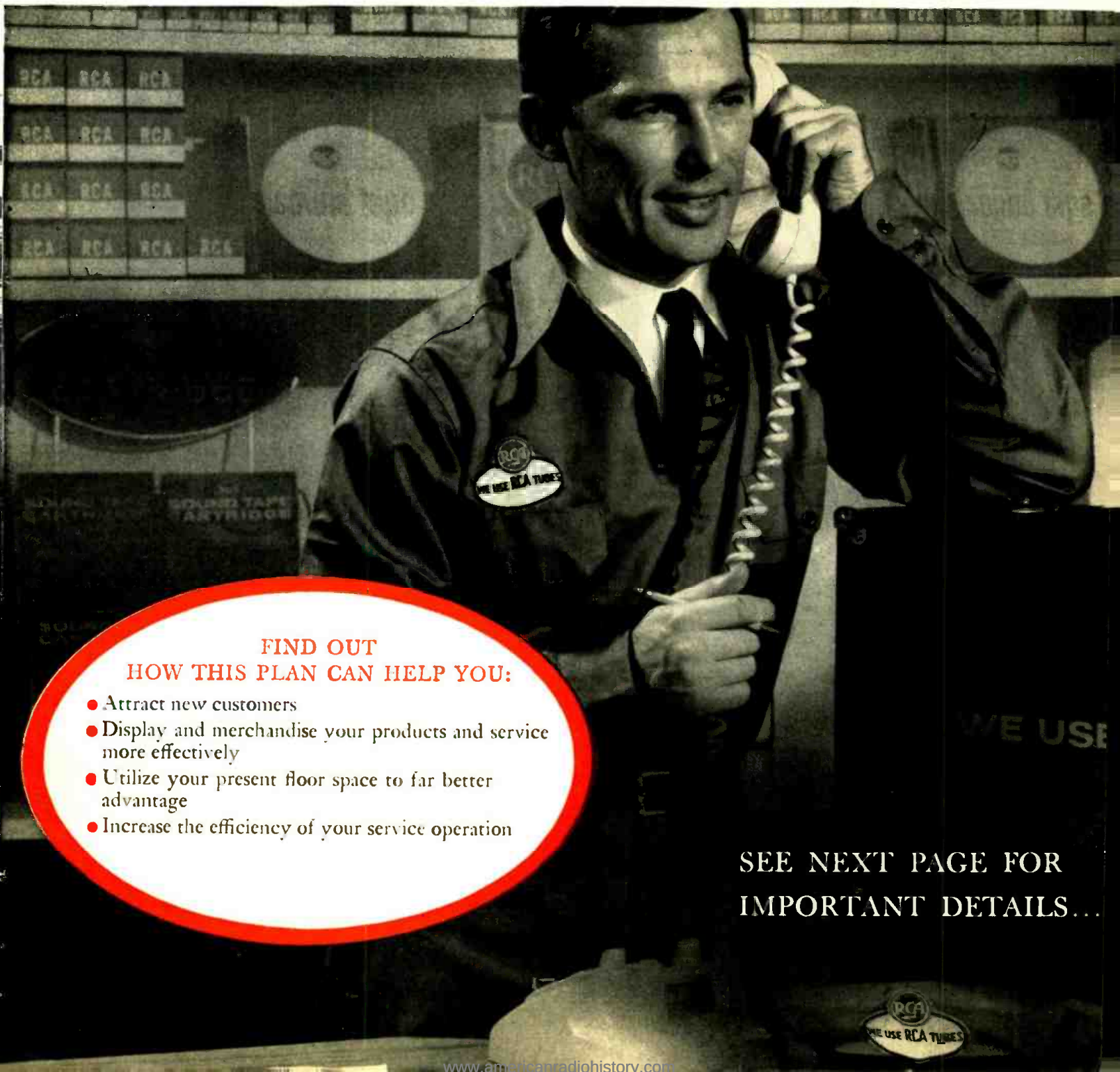
I would like to point out that a micron is a unit in the metric system equal to a millionth of a meter. 90

(*Continued on page 138*)

EXCITING NEWS FROM RCA!

Announcing a new plan to give your store

THE SUCCESSFUL LOOK



FIND OUT HOW THIS PLAN CAN HELP YOU:

- Attract new customers
- Display and merchandise your products and service more effectively
- Utilize your present floor space to far better advantage
- Increase the efficiency of your service operation

SEE NEXT PAGE FOR IMPORTANT DETAILS...

Your Store...Key to Successful Sales with the new RCA STORE IMPROVEMENT PLAN

Your skill, experience and integrity are the basic qualities that help you sell your service to the public. The appearance of your store can impress them with these facts —invite them inside to call on you with confidence.

The components shown here—and many more—are all available from your Authorized RCA Tube Distributor under the new RCA Store Improvement Plan. With minimum effort on your part, they will help you give your store *the successful look* inside and out. *No expensive store renovation is required.* No fancy, impractical blueprints are offered. Instead you are provided with carefully thought-out components that increase the business potential of any shop—big or small, old or new.

THE SUCCESSFUL LOOK—OUTSIDE

STORE FRONT

PROFESSIONALLY INSTALLED WINDOW DISPLAYS— CHANGED EVERY SEASON

With this plan, your store window becomes a strong invitation to new customers. It will be decorated and fitted with attractive seasonal displays—prepared by RCA—without any fuss or bother on your part.

RCA ILLUMINATED WINDOW VALANCES—ALSO USED AS IN-STORE MODULAR DISPLAY PANELS

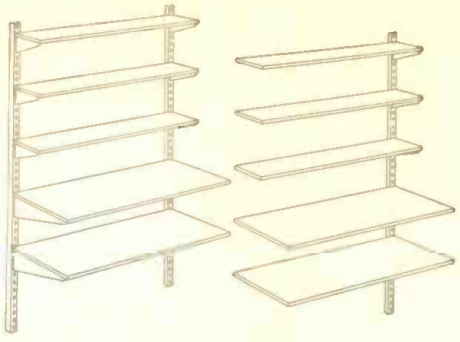
Here's a brand new idea that can be used to decorate your store window—or the interior of your shop as shown in the "Sales Area" photograph on opposite page. A choice of two- or four-foot lithographed panels, in gold-finished satin steel, gives you complete flexibility in designing your own customized illuminated window valance. Complete with hanging hardware and fluorescent lighting.

A good looking store front is your first opportunity to convert a passerby to a customer. The RCA Store Improvement Program offers you the elements to make your store front a working partner in your business.

Talk to your Authorized RCA Tube Distributor about this exciting plan right away. Ask him for your copy of RCA's new Store Improvement Guide (4F257), with a complete list of the components available and the order forms to secure them. Find out how easily and quickly you can add those few extra touches to your store to give it that Successful Look for 1960.

SALES AREA

The interior of your shop should be an important sales aid. Here, good first impressions can be reinforced, to make it easier for you to sell your products and services.



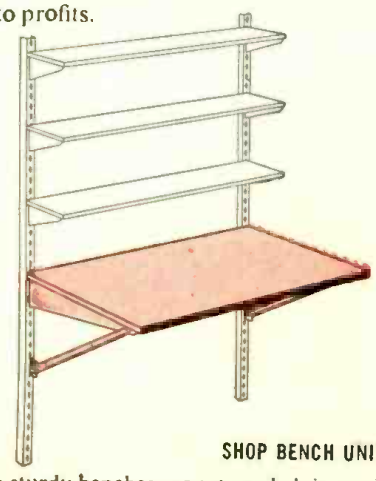
RCA DISPLAY AND STORAGE SHELVING UNITS

Attractive, sturdy shelving helps you display your merchandise more effectively for added sales. The RCA Plan offers basic four-foot shelving units, with add-on units to fit every need. Units may be set up in a variety of arrangements—and are easily disassembled and re-arranged.

THE SUCCESSFUL LOOK—INSIDE

SERVICE AREA

An efficient service area, providing faster, better organized work flow, is an important key to profits.



SHOP BENCH UNITS

These sturdy benches mount on shelving units to provide additional storage and work space, efficient work flow, better use of floor space. They save you time and money.

ADDITIONAL SALES AIDS—TO HELP BRIGHTEN YOUR PROFIT PICTURE

Eye catching sales accessories can draw attention to the services you offer. Sales-boosting accessories include illuminated clocks, signs, product display units, door bars, streamers, decals, service auto lights—even uniforms.

RCA **RADIO CORPORATION OF AMERICA**

Electron Tube Division *Harrison, N. J.*

YOU'RE AS SUCCESSFUL GENERAL ELECTRIC'S

AS YOU WANT TO BE WITH NEW PSM* METHOD!

*PROFITABLE SERVICE MANAGEMENT

Earn the good things of life for yourself and your family by following the Profit signposts on every page of General Electric's PSM* Method! The engraved Certificate which says you have completed this instruction program, will mean new success for you as a TV technician.

Says Dr. John K. Pfahl of Ohio State University, under whose direction the new General Electric program was prepared: "The electronic service dealer must be, at the same time, a technician, good businessman, and sales manager." You learn step-by-step how to realize these aims, by following General Electric's Profitable Service Management Method. You are shown how to *assure* a satisfactory profit margin, not merely hope for it—how to increase business by methods others have found unfailingly effective.

In the LP record "Sounds of Success" you will hear from the lips of experienced TV technicians just how they have built greater incomes. After completing the two volumes of instruction that make up the study course, a questionnaire is available to check your acquired knowledge, prior to receiving your Certificate.

All come handsomely packaged for your bookshelf. Check the highlights of General Electric's PSM* Method given below! Then see your G-E tube distributor! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Kentucky.*

HERE ARE SOME OF THE MANY SUBJECTS YOU WILL STUDY:

BOOK NO. 1. "SOUND BUSINESS PRACTICES"

BUSINESS FOR PROFIT: Your reasons for owning a business...How much money should you make?...How to make your business profitable.

PLANNING YOUR BUSINESS: Planning expansion...Cash planning...Shop planning.

ORGANIZING YOUR BUSINESS: Overhead costs...Pricing...What it costs you to make a service call...What it costs you to make a shop repair...Inventory control...Credit organization...Choosing a form of organization.

CONTROLLING YOUR BUSINESS: Why use records?... What records are needed...Taxation...Use an accountant.

BOOK NO. 2. "SELLING ELECTRONIC SERVICE"

ARE YOU ATTRACTING NEW CUSTOMERS?: Attracting new business...Businesslike appearance...Effective selling...Good identification...Basic market research.

PROMOTING YOUR BUSINESS: Advertising technique... Advertising campaign planning...Special offers...Seasonal planning...Customer contact.

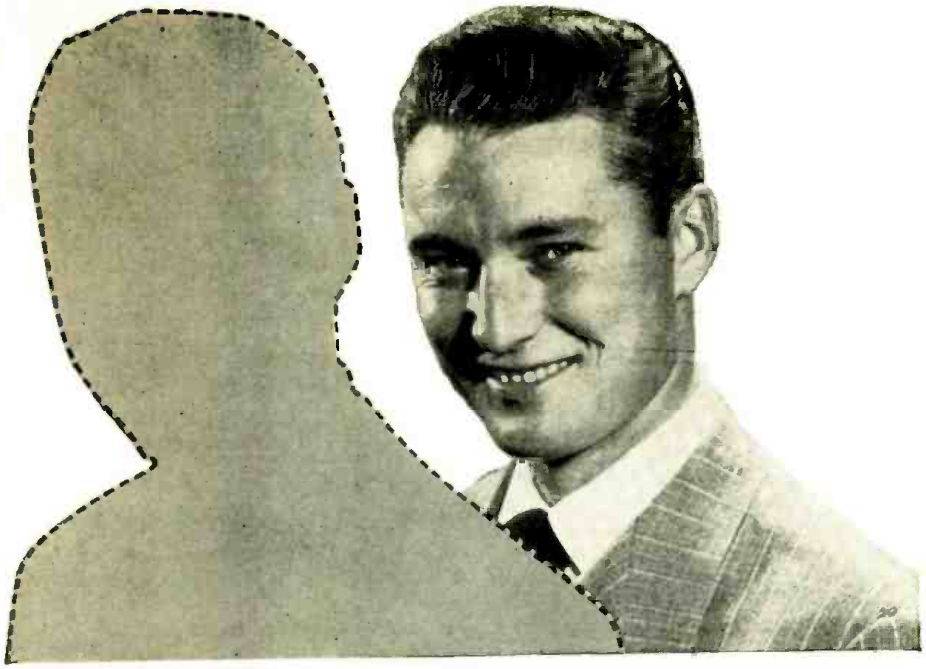
KEEPING YOUR CUSTOMERS SATISFIED: Customer relations...Customer grievances...Guaranteeing repairs...Building new customers.

Progress Is Our Most Important Product

GENERAL ELECTRIC

311-401

Compare your job, your age, your pay with that of



men who enroll at CREI

Men can stand still—or lose their jobs—even in a growing industry. They're doing it now in the fast-growing electronics industry. Companies actively seeking men with advanced technological knowledge are simultaneously firing mediocre men.

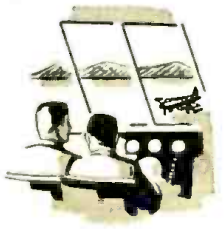
CREI students (more than 20,400 are currently enrolled) keep pace with electronics progress—and are eagerly sought by employers who offer solid opportunities for rapid advancement.

We analyzed the backgrounds of men who enrolled for CREI advanced electronics home study in a recent month. How do you compare?

- 62% were civilians. 38% were in the Armed Services.
- Of the 62% who were civilians, 35% were lab technicians, engineering aides, research assistants, electronic specialists, and similar high-rated electronics engineering men. Average pay: $435 per month (range $300 to $900). Average age: 28. Median age: 26. Previous formal electronic training varied from six months to more than a year.
- 9.4% of the civilians were technical representatives—field engineers who were school- or factory-trained to help install, maintain, service and teach the use and operation of electronic equipment. Average pay: $525 per month. Median age: 28.
- 6.5% of the civilians held college degrees, most in a field more or less related to electronics (engineering, physics, chemistry, etc.). These men were not in basic electronic work. Reason most often given for enrollment: to supplement job know-how with better understanding of electronics. The remainder of the civilians were small groups of small percentages.

Even if you compare favorably with new CREI enrollees now, how do you think your salary will compare a year from now? Five years from now?

Qualify for positions which require advanced electronics education — via CREI home study —while retaining your present job. Meet your family responsibilities while gaining knowledge of electronic engineering technology so essential for your career advancement.



CREI is now in its 33rd year. Last year marked the start of CREI Atomics, a division of CREI devised to meet the need for advanced home study education in nuclear engineering technology. Last year also marked the opening of our European Division, bringing advanced professional electronic education to Western Europe.

Since 1927 we have directed technical education of thousands —as individuals and in groups— in electronics engineering technology. We developed the first civilian pilot course for radio mechanics for the Army Signal Corps in 1941, supplied 300,000 texts to the U. S. Navy in a special course for radio technicians in the South Pacific in 1943, trained hundreds of technicians during World War II for the Signal Corps. We co-founded the National Council of Technical Schools, which first

established scholastic and business standards for the technical school field. We were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. In 1946 we instituted the group training programs now used by companies which represent the cream of the electronics and aviation industries.

What does this record of achievement mean to you as a CREI student? It means that industry and the Armed Services alike respect CREI men. It means that your CREI diploma is a door-opener. Significantly, Help Wanted ads often specify "CREI education or equivalent required." Our Placement Bureau, which helps graduates and advanced students find more desirable positions, is always available to CREI men. While no placement guarantees will be made by CREI or any other reputable institution, for many years the demand for CREI graduates and advanced students has far exceeded the supply.

CREI HOME STUDY ADVANTAGES. Technical education is accomplished on your own time, during hours chosen by you. You waste no time in travel. You have plenty of time to do your best. Your work is under the supervision of a regular staff instructor who guides your progress step by step. Courses are prepared by experts, presented in easy-to-understand form, kept up to date by periodic revision. Experience in more than three decades of home-study teaching, during which time we have corrected and commented on many hundreds of thousands of examinations, enables us to anticipate questions in our lesson material and minimize troublesome points.

CREI STUDENTS are professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. In 1958 they devoted approximately 1,572,456 hours to 104,831 lesson texts, answered (and were individually graded upon) 1,048,310 searching questions and engineering problems. They studied electronics engineering technology—transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices, and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of Vandenburg AF Base and Cape Canaveral. They are at Alamagordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines, and Trans-Canada Air Lines. They share in electronics at All America Cables and Radio, Inc., and The Martin Co. They work for USIA (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI technical education under company plans. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world and across the street. They're men you'll compete with—to gain or hold your place in the electronics profession.

QUALIFICATIONS FOR CREI. College degree is not essential. If you have had basic electronic

education, practical experience in electronics, and a high school education, you can probably qualify. A good way to find out: Use the postage-paid card. It will bring you the free 54-page book which has launched thousands on their advanced careers: "Insurance for Your Future in the New World of Electronics." Tuition is reasonable and may be paid monthly. It takes just one $10-a-week raise to repay your investment in CREI education and leave you a substantial bonus the first year. Available to veterans under GI bill.

LATEST CREI COURSE: Now added to CREI's variety of courses in Electronic Engineering Technology is *Automation and Industrial Electronics Engineering Technology.* Complete course covering all electronic phases of automation. Special emphasis on theory, functioning and applications of servomechanisms and computers. Also noteworthy—lessons on machine control, instrumentation, data processing and telemetry.

RESIDENCE SCHOOL in Washington, D. C. for those who can attend classes. Day and evening classes start at regular intervals. Qualified graduates earn AAS degree in 27 months. Electronics experience not required for admission.

CAPITOL RADIO
ENGINEERING INSTITUTE

ECPD Accredited Technical Institute
Curricula Founded 1927

Dept. 1103-G **DD**
3224 16TH ST., N.W.
WASHINGTON 10, D. C.

Within the Industry

F. BIRNEY FARRINGTON, founder and president of *Xcelite, Inc.*, has announced his retirement and the election of Arch Warden as president.

The Orchard Park, New York tool company was founded by Mr. Farrington in 1921 under the name of *Park Metalware Co., Inc.* In 1951 it took its then 30-year-old tradename "Xcelite," as the corporate name.

His successor has been vice-president in charge of sales since 1957 and served as sales manager from 1947– two years after joining the company. Mr. Warden will continue to serve as sales manager in addition to assuming the duties of president.

* * *

JOSEPH C. OTIS has been named vice-president in charge of manufacturing and **HOWARD D. VANN** director of advertising and public relations for *Globe Electronics*, a division of *Textron Electronics, Inc.* The Council Bluffs subsidiary makes a line of amateur gear as well as Citizens Band transmitter/receivers . . . **KEN BURTON** has joined the *Duotone Company* of Keyport, N. J. as sales manager . . . **REAR ADMIRAL RICHARD S. MANDELKORN** (USN, Ret.) has joined *General Instrument Corporation* as executive vice-president of its *Harris Transducer Corporation* subsidiary . . . **MALCOLM O. CAMPBELL** has been named head of *Raytheon Company's* new receiving tube part and sub-assembly facility at Pawcatuck, Conn. . . . **FRANK A. COMERCI** has joined *Audio Devices, Inc.* as senior project engineer at the Stamford, Conn. laboratory . . . **WILLIAM M. ROBINSON** has been appointed chief engineer of paper and film capacitors, filters, and pulse networks for *Cornell-Dubilier Electric Corp.* . . . *Vocaline Company* of Old Saybrook, Conn. has named **EDWARD MANVILLE** to the post of sales manager of its Communications Products Division and **RALPH ROUTSONG** as marketing manager . . . **FREDERICK J. BELL** has been named vice-president (Washington D.C. Office) for *General Telephone & Electronics Corporation* . . . **E. G. DYETT, JR.**, head of the Instrument Division of *H. H. Scott, Inc.*, has been elected 1960 president of the National Noise Abatement Council. He succeeds **A. J. WEITZEL** of New York in the post . . . **ROBERT A. GIORGI** is the new manager of market development for two-way radio equipment at *General Electric's* Communication Products Department in Lynchburg, Va. . . . **WILLIAM T. HACK** has been elected president of *Audio Devices Incorporated* while **WILLIAM C. SPEED** has been elevated to the post of chairman of the board . . . *Hoffman Electronics Corporation* has appointed **HENRY F. SCHOEMEHL** director of engineering of its semiconductor operation in Evanston, Illinois . . . *Tung-Sol Electric Inc.* has elected three new vice-presidents: **FRANK J. EHRINGER, BURTON R. LESTER,** and **DR. R. BURTON POWER, JR.** . . . **A. H. ANDREWS** has joined *CBS Electronics* as an engineering specialist. He was formerly with *Marconi* of Montreal.

* * *

ANTHONY L. CONRAD has been appointed president of the *RCA Service Company* succeeding Donald H. Kunsman who has been named general manager of the firm's Electronic Data Processing Division.

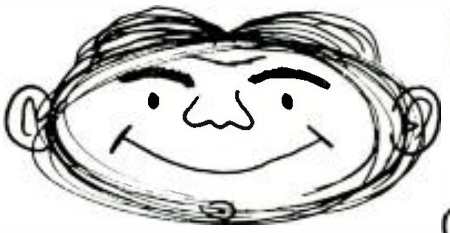
Mr. Conrad has been vice-president of the company's Government Services department since 1957—a post which will be assumed by Stephen D. Heller. Mr. Conrad joined the *RCA Service Company* in 1946 and served as manager of the company's television service branch at Albany, New York, moving to the home office in 1947 to serve in various managerial and technical capacities before joining the Missile Test Project in 1953.

He is a graduate of Lafayette College and took graduate work at Harvard University. During World War II he served as an officer in the Army Signal Corps. He received his amateur radio operator's license at the age of fourteen.

* * *

ACOUSTICA ASSOCIATES, INC. has acquired **ENDER-MONARCH CORPORATION,** Garfield, New Jersey manufacturer of illumination equipment. Shares of the New Jersey firm were acquired in exchange for common shares in the ultrasonic firm . . . **MIDWESTERN INSTRUMENT** has entered into an agreement with **TEXTRON ELECTRONICS** which provides for a transfer of its business to the Providence, Rhode Island firm. 724,167 shares of *Textron* common stock were involved in the deal . . . **HARRIS-INTERTYPE CORPORATION** has completed acquisition of **POLYTECHNIC RESEARCH AND DEVELOPMENT COMPANY** of Brooklyn from the **POLYTECHNIC INSTITUTE OF BROOKLYN.** Payment was 85 per-cent cash and the balance in *Harris* stock . . . **EITEL-**

6 months from today



WHICH WILL YOU HOLD . . .

OR

add technical training to your practical experience. Get your FCC license quickly!

then use our effective

Job Finding Service

Get your FCC Commercial License

or your money back

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

Employers Make Offers Like These

to Our Graduates Every Month

Broadcast Station in Illinois: "We are in need of an engineer with a first class phone license, preferably a student of Cleveland Institute of Radio Electronics; 40 hour week plus 8 hours overtime."

West Coast Manufacturer: "We are currently in need of men with electronics training or experience in radar maintenance. We would appreciate your referral of interested persons to us."

Our Trainees Get Jobs Like These Every Month

CHIEF ENGINEER
"Since enrolling with Cleveland Institute I have received my 1st class license, served as a transmitter engineer and am now Chief Engineer of Station WAIN. I also have a Motorola 2-Way Service Station. Thanks to the Institute for making this possible."
Lewis M. Owen, Columbia, Ky.

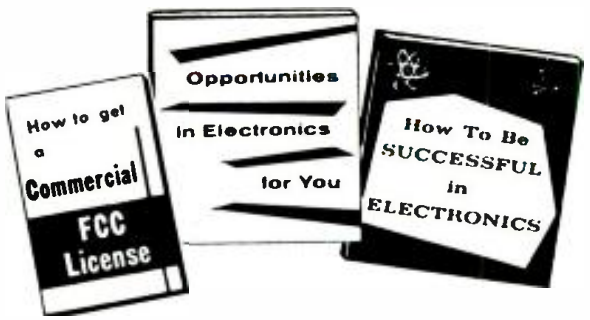
TEST ENGINEER
"I am pleased to inform you that I recently secured a position as Test Engineer with Melpar, Inc. (Subsidiary of Westinghouse). A substantial salary increase was involved. My Cleveland Institute training played a major role in qualifying me for this position."
Boyd Daugherty, Falls Church, Va.

Names of Trainees in Your Area Provided on Request

Carl E. Smith, E.E., President

CLEVELAND INSTITUTE OF ELECTRONICS
4900 Euclid Bldg., Cleveland 3, Ohio

Get these valuable Booklets FREE!



Accredited by National Home Study Council

Cleveland Institute of Electronics

Dept. RN-39, 4900 Euclid Bldg., Cleveland 3, Ohio

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

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

In what kind of work are you now engaged?_____

In what branch of Electronics are you interested?_____

Name_____ Age_____

Address_____

City_____ Zone____ State_____

RN-39

McCULLOUGH INC. has reached an agreement that will make **NATIONAL ELECTRONICS, INC.** and **INDUSTRIAL TUBES, INC.** of Geneva, Illinois wholly owned subsidiaries. No cash was involved in the transaction.

* * *

ROD KERSHENSTEIN has been appointed general sales manager for *Glaser-Steers Corp.*, New Jersey audio firm.

In his new post Mr. Kershenstein will be responsible for all sales activities of the company and will report direct to Julius Glaser, president. He was formerly with *Ampex Corporation* as eastern district marketing manager and with *Westinghouse Electric Corp.* as national sales promotion manager.

He is an alumnus of Indiana University and the University of Pittsburgh. He will make his headquarters at the company's plant, 155 Oraton Street, Newark 4, New Jersey.

* * *

INTERNATIONAL RADIO & ELECTRONICS CORP. is building a new plant to house its two new subsidiaries, "Crown International's" Tape Recorder Division and its "International Radio" Broadcast Equipment Division. The 24,000-square-foot facility in Elkhart, Indiana will permit the company to triple its output during this year . . . **SYLVANIA ELECTRIC PRODUCTS INC.** has announced plans for the construction of a multi-million-dollar electron tube manufacturing plant in Brookville, Pa. The new 100,000-square-foot facility will replace three existing plants in Brookville . . . **REK-O-KUT COMPANY, INC.** has acquired a modern one-story brick building at 109-01 37th Ave., Corona 68, New York for its "Audax" Speaker Division . . . **GRANCO PRODUCTS, INC.** of Long Island City, N. Y. will occupy a large industrial building in nearby Kew Gardens. The block-long 63,000-square-foot building will feature the most modern equipment for assembly of 5000 radio, stereophonic, and other electronic products daily . . . **BELOCK INSTRUMENT CORPORATION** has announced that its new 26,000-square-foot plant at College Point, Long Island is nearing completion. The new facility will be used for the safe machining of beryllium and for the assembly, inspection, and testing of gyroscopes and other precision instruments . . . **CGS LABORATORIES, INC.** has moved into newly constructed quarters in Wilton, Conn., consolidating facilities formerly located in Stamford and Ridgefield . . . **MAGNETIC INSTRUMENTS COMPANY, INC.** has moved into a new, fireproof building at 637 Commerce Street, Thornwood, New York . . . **SUPREME ELECTRONICS CORPORATION** of Greenwood, Miss., a subsidiary of *Hickok Electrical Instrument Company*, Cleveland, Ohio, has broken ground for a 25,000-square-foot addition to its plant. The plant is expected to be completed and in full production by June.

(*Continued on page* 107)

General Electric Bookshelf Speaker System—Superior in the four vital areas

No matter how good your other components, what you ultimately hear from your stereo system will be no better than your speakers. For this reason, exceptional care should be exercised in speaker selection. The important things to watch for are **size** (remember, you'll need two), **bass sound power level, high frequency performance**, and **appearance.** Appearance is especially important in speakers because they form an integral part of your room decor.

Size: General Electric's Model G-501 Bookshelf Speaker System brings you G.E.'s famous Extended Bass performance in an ultra-compact one cubic foot enclosure ideal for stereo. It measures only 9¼" x 13" x 22".

Bass: This dramatic new design provides up to four times the bass power output of conventional speakers in comparable enclosures. Low frequency response is unusually full and clean, thanks to the G-501's sealed enclosure and high-compliance woofer.

Treble: A new 3-inch tweeter achieves maximum dispersion of highs for full stereo effect. A special cone and voice coil extend response, while the dome improves reproduction at high volume levels.

Appearance: The compact, distinctively-styled enclosure is handsomely finished on all four sides so that it may be used on either end or either side to fit almost any room setting. Grille cloth designs are individually patterned for each of four genuine wood veneer finishes — walnut, ebony and walnut, mahogany, cherry. **$85.00** (manufacturer's suggested resale price, slightly higher in the West). Other complete speaker systems at **$57.95** and **$129.95.** **General Electric Company, Audio Products Section, Auburn, N. Y.**

GENERAL ELECTRIC

IMPORTANT: For the man who wants to make big money in Radio-Television!

ONLY SPRAYBERRY TRAINING IN RADIO and TELEVISION

offers you all of these vital new advantages to help you earn more money from the start!

NEW Transistor Course

. . . literally millions of new transistor radios are being used. We show you how to make money fixing them!

NEW Business Builders

. . . through these practical proven plans and ideas we help you make plenty of extra money in spare time while training!

NEW Training Equipment

. . . the famous Sprayberry Training kits have been newly engineered by our staff to offer you the latest in Radio-TV Service Techniques!

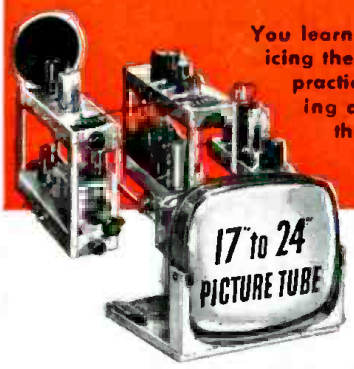
NEW High Fidelity

. . . there's big money to be made installing and servicing Hi-Fi units. Your Sprayberry training now offers you this valuable and profitable preparation!

TRAIN AT HOME—SPARE TIME

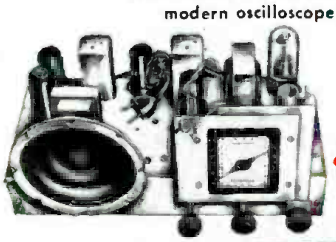
WITH THESE **25 BIG COMPLETE KITS of PARTS & EQUIPMENT**

You learn Radio-TV Servicing the best way . . . the practical way . . . testing and assembling these modern kits of equipment.



The new Sprayberry Training Television Receiver, built and tested in 5 sections.

Now offered . . . this fine modern oscilloscope.



You build this powerful two-band superheterodyne radio receiver.

You build the new Sprayberry tester — a complete 18-range Volt-Ohm-Milliammeter test meter.

FREE These two big new books are yours free! Find out what Radio-Television offers you . . . and let us show you how easily you can learn, even without previous experience of any kind. Rush COUPON today!

SPRAYBERRY ACADEMY OF RADIO-TELEVISION
Dept. 25-H 1512 West Jarvis Ave., Chicago 26, Ill.

The field of Radio-Television Servicing is such a fast moving industry that the best jobs and biggest incomes always go first to the man with the most modern, complete and up-to-date training. Thanks to constant revision and improvement . . . Sprayberry Training helps you earn more from the start . . . and keeps you earning more in the months and years ahead!

Make no mistake! All radio-television training is *not* alike. The basic purpose behind Sprayberry Training is to prepare you as rapidly and as surely as possible . . . to make top money servicing Radio and Television sets and equipment. This is where the big money has been for years . . . and will continue to be in the years ahead.

It's important for you to know that for over 30 years . . . Sprayberry Training has been preparing ambitious men for success in this interesting and profitable kind of work. Our school has helped hundreds to qualify for the best jobs . . . or to get started in profitable businesses of their own. Today our student rolls are the largest in our school's history . . . because the need and demand for Radio-Television Service Technicians has never been more urgent.

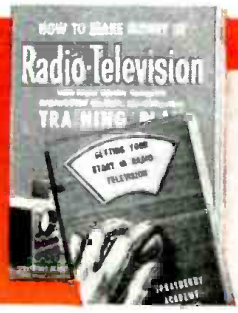
Just $6.00 Starts You

To encourage more men to enter Radio-Television at once . . . to help fill the great need for trained men . . . we're making it easier than ever before to start training. Just $6.00 enrolls you. This liberal offer is naturally limited. Get the facts now and consider enrollment while these favorable terms are available to you.

KEEP YOUR JOB . . . while learning

Under the Sprayberry Plan you train entirely at home in spare time. You combine the most modern lesson training with fascinating and invaluable practical work with 25 big kits of parts and equipment that we supply. You get the equivalent of years of shop practice . . . and you can train as fast or as slowly as you wish. We help you make excellent spare time money while learning . . . and everything you receive—lessons, books, manuals, equipment—all yours to keep!

This is the Radio-Television industry's most modern and up-to-the-minute training. Sprayberry is the *one* school that gives you personalized attention and takes a real interest in your progress. Remember . . . just $6 starts you! Mail the coupon today. Let the facts speak for themselves. Let us send you our new catalog and sample lesson . . . and *prove* the kind of opportunity that Sprayberry training can open up for you.



MAIL COUPON - No Salesman Will Call

SPRAYBERRY ACADEMY OF RADIO-TELEVISION
DEPT. 25-H 1512 W. JARVIS AVE., CHICAGO 26, ILL.

Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

NAME _____ AGE _____

ADDRESS _____

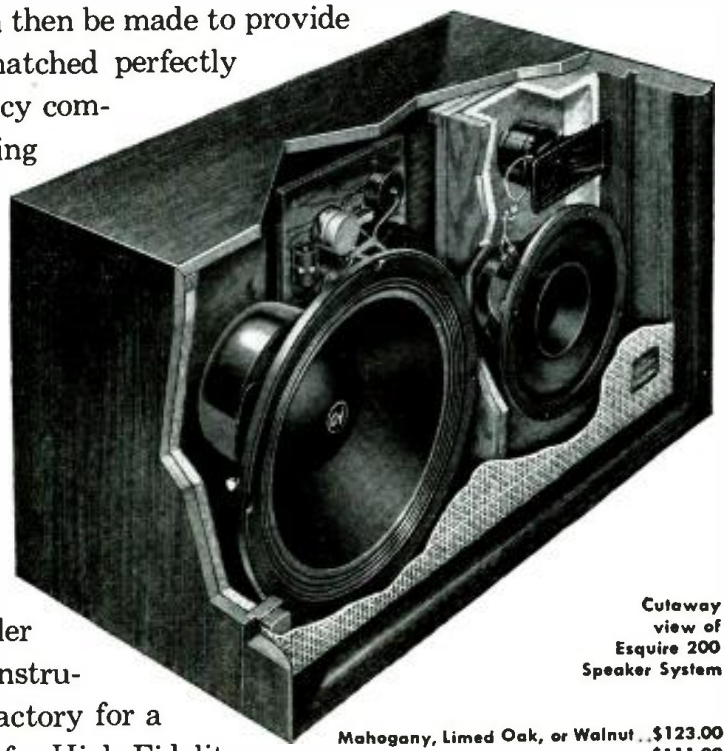
CITY _____ ZONE _____ STATE _____

It is an axiom in high fidelity that no single speaker is capable of ideally reproducing the entire musical range of a symphony orchestra. At least two speakers, each specifically designed to reproduce a part of the sound spectrum, are needed to do a really adequate job.

ELECTRO-VOICE ULTRA-COMPACT SYSTEMS OFFER MORE THAN JUST BASS RESPONSE

Ultra-compact systems are no exception to this rule. This is why two year's research went into the development of Electro-Voice's new ultra-compact line. In its tradition of providing the finest, Electro-Voice would not introduce a system in which only the bass speaker and enclosure had been engineered to the special requirements of the compact system. Each component within that enclosure had to be designed to make certain it was a perfect match to the other elements in the system. Laboratory measurements and exhaustive listening tests had to be coordinated and differences resolved. The result of these efforts can now be heard from the new Leyton, Esquire 200, Regal 300, or Royal 400. These speaker systems produce bass of astounding definition and solidity, clear undistorted treble, and remarkable brilliance in their upper ranges.

One of the key factors in producing this purity of sound was the judicious choice of crossover points, restricting each of the specially designed speakers to cover only the range over which its performance is most perfect. In all models, for example, the crossover from woofer to mid-range occurs at 200 cycles per second. With this degree of specialization, all forms of distortion are held to the lowest levels possible. Operating below 200 cycles, the bass speaker is not required to reproduce any of the mid-range spectrum and can act as a true piston. The specially designed mid-range speaker can then be made to provide exceptionally flat response, with its level matched perfectly to that of the woofer. The very-high-frequency compression driver faces only the necessity of adding "sparkle", and dispersing high-frequency sound throughout the room. The result is a clarity and definition of sound that can best be described as transparent — enabling you to feel the deepest bass, marvel at the effortless clarity in the mid-range, and delight in the brilliant definition of the upper harmonics.



Cutaway view of Esquire 200 Speaker System

Mahogany, Limed Oak, or Walnut...$123.00
Unfinished Birch.....$111.00

Whether you intend to purchase a new high-fidelity speaker system now or later, we urge you to visit your Electro-Voice dealer for a demonstration of these remarkable instruments. You may also write directly to the factory for a complete description of these new units. Ask for High-Fidelity Catalog No. 137.

CONSUMER PRODUCTS DIVISION

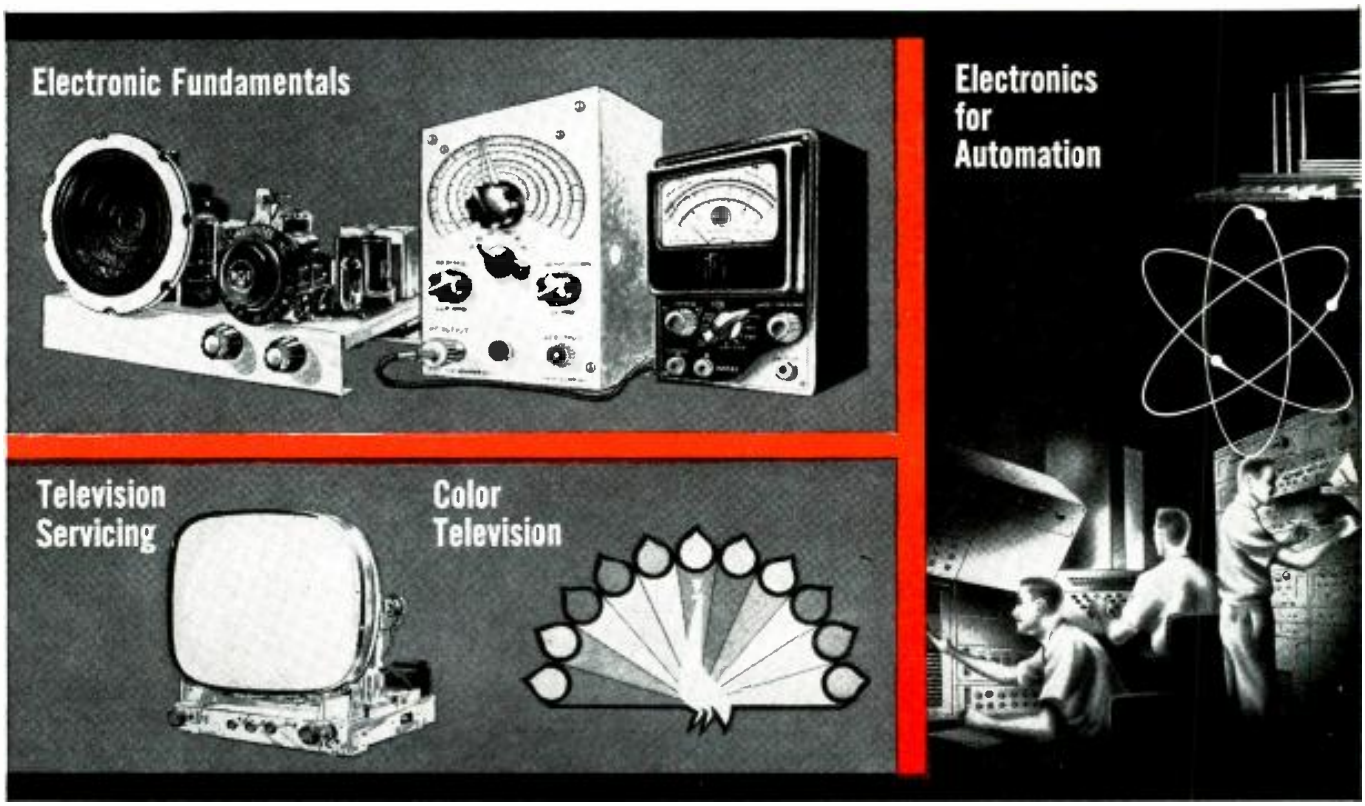
Electro-Voice INC. DEPARTMENT 30N, BUCHANAN, MICHIGAN

LET RCA TRAIN YOU IN ELECTRONICS

RCA Institutes, one of the world's leading electronic technical schools, offers a Home Study Course in . . .

ELECTRONICS FOR AUTOMATION

. . . Now you have *four* comprehensive courses for your electronic training . . . from basic electronic theory to the more advanced principles of color TV and Automation.



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RESIDENT SCHOOLS in New York City and Los Angeles offer Technical Institute and Vocational School Courses in Electronics. Day and Evening classes start 4 times each year. Resident School Catalog sent free on request.

ANOTHER WAY RCA SERVES EDUCATION THROUGH ELECTRONICS

Practical work with the very first lesson. Pay-as-you-learn. You need pay for only one study group at a time.

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Please rush me your FREE illustrated 64-page book "Your Career in Electronics," describing your home training programs. No obligation. No salesman will call.

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Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

1960 BOOM COMMUNICATIONS YEAR, FCC CHAIRMAN FORECASTS--With 570,000 radio-station licensees now using well over 1,700,000 transmitters requiring 1,900,000 authorizations for operators and a continuing rise anticipated, unprecedented activity in every phase of communications can be expected during 1960. So predicts FCC Chairman John C. Doerfer, in his year-end statement. The growing pains of more than 50 categories of all types of radio services will, he said, spiral interest. Services for marine, aviation, land transportation, industrial and public safety will show substantial gains, the report pointed out. In the limelight too, will be amateur stations which soared from 188,600 to 203,000 in 1959. Explosive enthusiasm in Citizens Radio service, which upped 1959 authorizations from 27,800 to nearly 70,000, is expected to develop a sharp boost during 1960. Mounting applications and fewer station deletions in FM emphasized an increasing faith in these static-free channels. Authorizations climbed from 690 to 825; at present there are some 665 stations on the air, whereas a year ago the count was 570. A contributing factor is that many FM stations are obtaining additional revenue through supplemental background music service to subscribers. AM broadcast growth was steady; currently there are 3450 stations on the air. Commercial TV station figures did not change materially during 1959, with slightly over 500 now operating. However, increased interest in u.h.f. translator possibilities (bringing video to remote localities) is spurring TV expansion. At this writing there are 270 translators in operation (an increase of about 70 for the year) and many more are expected to receive grants during 1960.

ELECTRONIC REMOTE-CONTROL FALLOUT SWEEPER NOW BEING TESTED--A remote-controlled radio-TV guidance decontamination sweeper--designed to keep Air Force facilities operational despite radio-active fallout--is being tested at the Air Research and Development Command's Air Force Special Weapons Center, Albuquerque, New Mexico. Equipped with three television cameras, the sweeper can clean a seven and one-half foot path of radio-active debris at one pass. Operators, located in a protected position and using radio guidance, can steer, shift gears, move throttles, operate brakes, and empty the sweeper's storage hopper. He can see surrounding terrain and the instrument panel on television screens and hear the sound of engines through an open microphone. Using the TV system, the operator can carry out a damage survey in conjunction with a cleanup operation. The cameras can be rotated exactly as the human head is turned so that all functions performed by the operator are entirely natural.

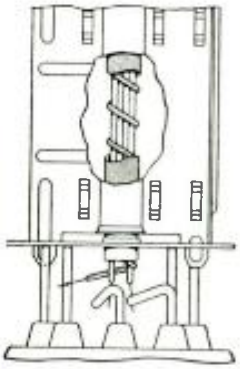
TRANSISTORIZED FIRE-CONTROL SYSTEM FOR POLARIS SUB--A fully transistorized shipboard fire control system has been developed for the "George Washington"--the Polaris-carrying nuclear-powered submarine. Designed to provide the sub's missile-inertial guidance system with all of the information necessary to guide the missile successfully to the target, the system is capable of operating under all conditions of sea and weather. Heart of the system is a battery of computers into which the target data is fed and which then transmits intelligence to the missile's guidance system. When fully installed, the system will contain more than 15,000 transistors in addition to 1054 digital boards, 18,000 diodes, 40,000 circuits, and 70,000 terminations. Despite its complexity, it has been made sufficiently compact through the use of miniaturized electronic components and advanced packaging techniques.

NATIONAL SCIENCE FOUNDATION has released figures indicating that as of January 1959 American business firms employed about 780,000 scientists and engineers. About 35 per-cent of the total were engaged in engineering and scientific research and development activities. The figures cited are based on a survey conducted by the Bureau of Statistics, U.S. Department of Labor, for the Foundation. The complete report, now in preparation, will be released later this Spring. Employment of scientists and engineers in private industry was about 4 per-cent higher in January 1959 than in January 1958. Engineering employment increased from about 605,000 in January 1958 to 630,000 for the same month in 1959 while scientists increased from about 145,000 to 150,000 in private industry employment for the same period. -30-

No more fireworks for me!

(NO MORE DAMPER ARCING FOR YOU)

Typical of the many design features of CBS dampers is this new anchored heater-cathode insulator. Actually a tungsten coil coated with insulating material, it is mechanically anchored to prevent any movement that might lead to heater-cathode shorts. As a secondary precaution, the coil has fewer turns to minimize cathode-to-insulator contact, yet maintain perfect heater-cathode spacing.



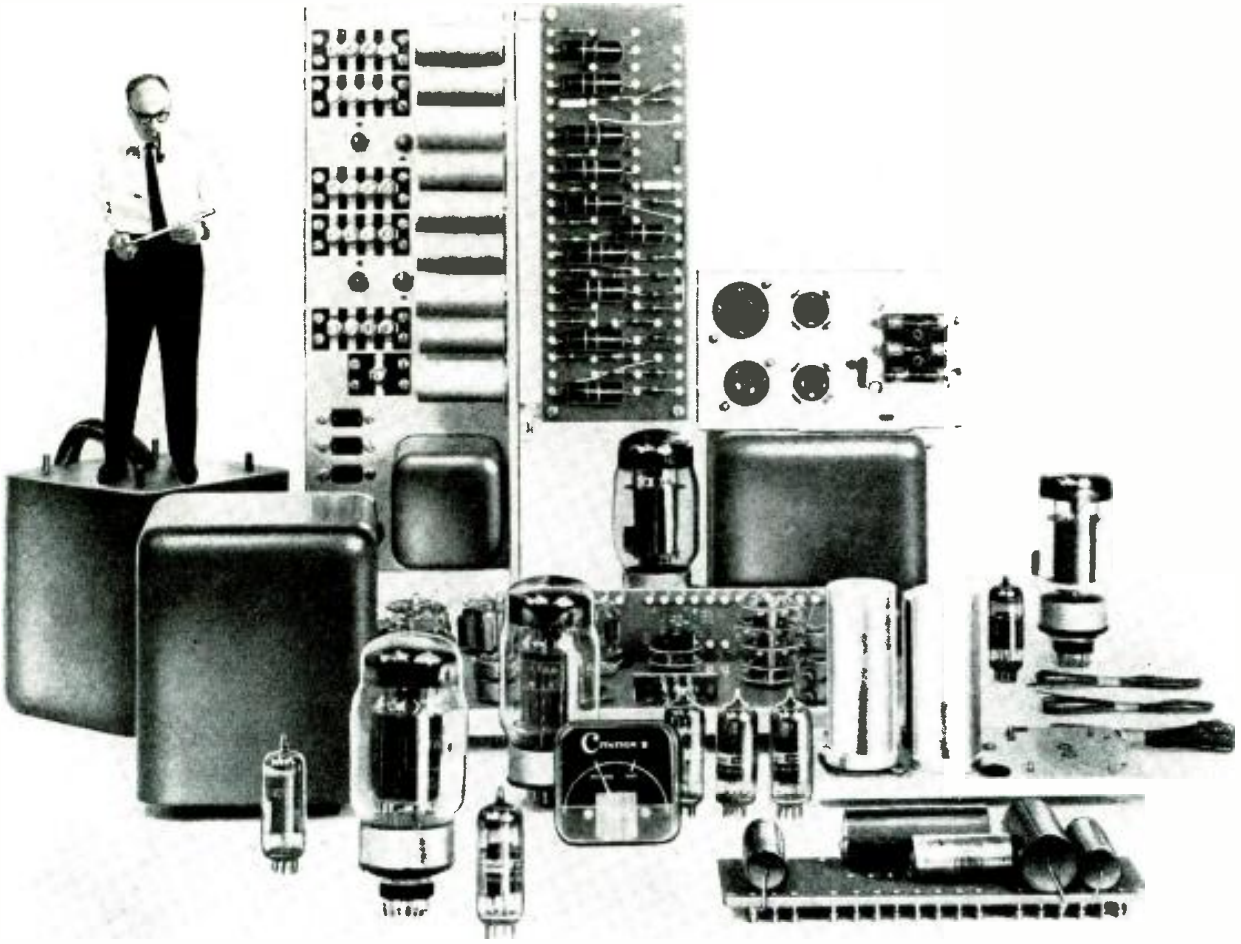
"Damper diodes are prone to fireworks. Not me. I've been arc-proofed from heater to cathode to plate . . . and I'm blast-tested to insure it. That goes for my whole family of CBS damper tubes. Use us and relax."

It's true. CBS damper diodes have been completely redesigned to offer you *total reliability* . . . proved in performance by leading TV and radio set manufacturers. You, too, can profit more from the *total reliability* of CBS tubes. To prove it . . . just replace with CBS.

TOTAL RELIABILITY... proved in performance

Receiving, industrial and picture tubes transistors and diodes audio components and phonographs.

CBS ELECTRONICS
Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.



We don't pack an engineer into each new Citation Kit but...

...the engineering *built into* each kit is so precise that the unit constructed in the home will be the equal of the factory-produced instrument.

It is far more difficult to design a kit than to produce a completely manufactured product. In the plant the engineer can control his design from the moment of inception until the final packaging. The kit builder has only his tools, his ingenuity and little, if any, test equipment.

Therefore, the complex process of in-plant production and control which guarantees the fine finished product must somehow be *embedded* in the kit design. The Citation engineering group at Harman-Kardon, headed by Stewart Hegeman, has succeeded in doing just this in the design of the new Citation I, Stereophonic Preamplifier Control Center and Citation II, 120 Watt Stereophonic Power Amplifier.

Only heavy duty components, operating at tight tolerances, have been selected for the Citation Kits. As a result, even if every component is operated at its limit – remote as this possibility is – the instruments will perform well within their specifications.

Rigid terminal boards are provided for mounting resistors and condensers. Once mounted, these components are suspended tightly between turret lugs. Lead length is sharply defined. The uniform spacing of components and uniform lead length insure the overall stability of the unit.

Improper routing of leads, particularly long leads, can result in unstable performance. To prevent this, the Citation II is equipped with a template to construct a Cable Harness. The result: each wire is just the right length and in just the right place to achieve perfect performance.

These truly remarkable achievements in Control Engineering are only a few of the many exciting new developments in kit design from the Citation Division of Harman-Kardon.

THE CITATION I, *Stereophonic Preamplifier Control Center,* is a brilliantly designed instrument, reflecting engineering advances found only in the best professional equipment. The control over program material offered by the new Citation I enables the user to perfectly re-create every characteristic of the original performance. (The Citation I – $139.95; Factory-Wired – $239.95; Walnut Enclosure, WW-1 – $29.95.)

THE CITATION II, *120 Watt Stereophonic Power Amplifier,* has a peak power output of 260 Watts! This remarkable instrument will reproduce frequencies as low as 5 cycles virtually without phase shift, and frequencies as high as 100,000 cycles without any evidence of instability or ringing. *At normal listening levels, the only measurable distortion in this unit comes from the laboratory testing equipment.* (The Citation II – $159.95; Factory-Wired – $219.95; Charcoal Brown Enclosure, AC-2 – $7.95.) All prices slightly higher in the West.

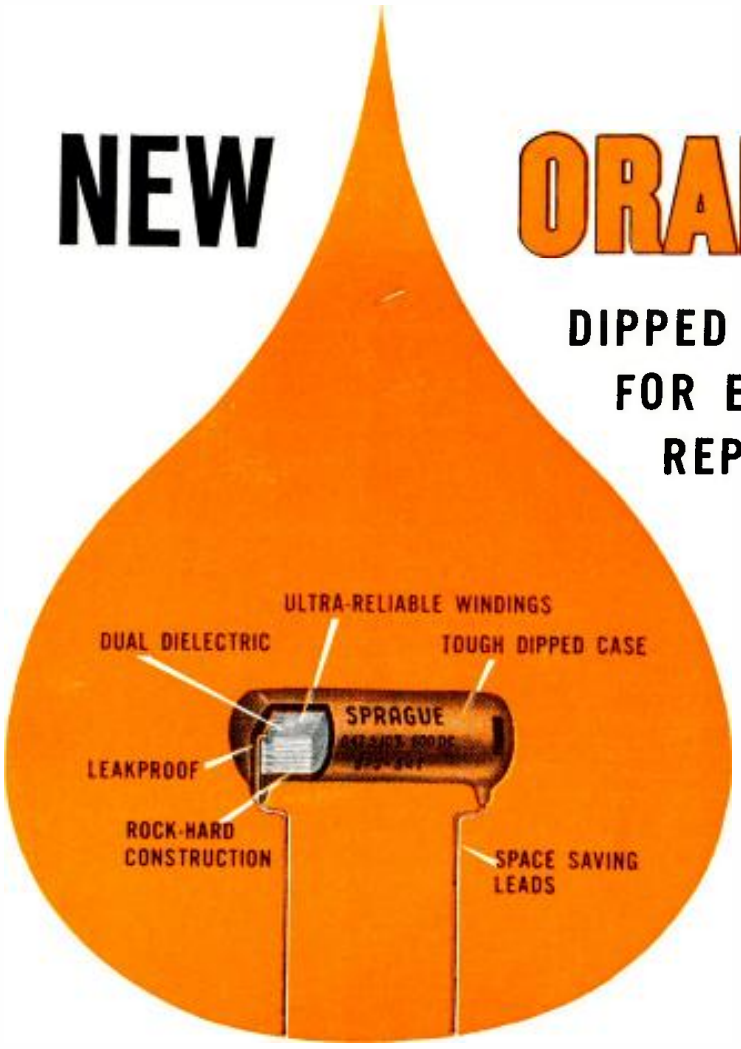
Harman-Kardon has prepared a free detailed report on both of these remarkable new instruments which we will be pleased to send to you. Simply write to Dept EW-3, Citation Kit Division, Harman-Kardon, Inc., Westbury, L. I.

Citation I

Build the Very Best **CITATION KITS** *by* **harman kardon**

NEW ORANGE-DROP®

DIPPED DIFILM® CAPACITORS FOR EXACT ORIGINAL REPLACEMENT



THIS NEW . . . MINIATURE . . . DIFILM CAPACITOR OUTPERFORMS ALL OTHER DIPPED TUBULAR CAPACITORS!

SPRAGUE DIFILM *does it again!* First to give you at regular prices the finest molded tubular capacitor made—the DIFILM BLACK BEAUTY . . . and now the newest DIFILM capacitor—the ORANGE-DROP dipped capacitor.

SPRAGUE ORANGE-DROP CAPACITORS are especially made for easy installation in tight spots . . . where only an exact replacement will fit. They are the exact same dipped capacitors used by leading manufacturers in many TV sets.

WHY ORANGE-DROPS BEAT HEAT AND HUMIDITY

Sprague Orange-Drop Mylar*-Paper Dipped Capacitors combine the proven long life of paper capacitors with the effective moisture resistance of film capacitors. Their duplex dielectric of kraft paper and polyester film is impregnated with HCX®, Sprague's exclusive hydrocarbon material which saturates the paper and fills voids and pinholes in the film before the HCX polymerizes. The result is a solid, rock-hard capacitor section which is then double-dipped in bright orange epoxy resin for moisture protection. Leads are neatly crimped for easy installation on printed wiring boards.

SPRAGUE ORANGE-DROP CAPACITORS are a natural teammate for the molded Difilm Black Beauty®. Black Beauties, born out of engineering to tough missile standards, are still far and away the best replacement capacitors—better than any other molded or dipped . . . paper, film, or film-paper combination . . . capacitor made for entertainment electronics.

Where a dipped capacitor is called for, no other dipped unit can match the ORANGE-DROP. Your distributor is stocked with all popular ratings in 200, 400, 600, and 1000 volts in handy Sprague Kleer-Paks. Order some today.

*Du Pont Trademark

don't be vague—insist on

SPRAGUE® the mark of reliability

ANOTHER TESTED RELIABLE PRODUCT BY THE WORLD'S LARGEST CAPACITOR MANUFACTURER

SHIP WITHOUT AN OCEAN

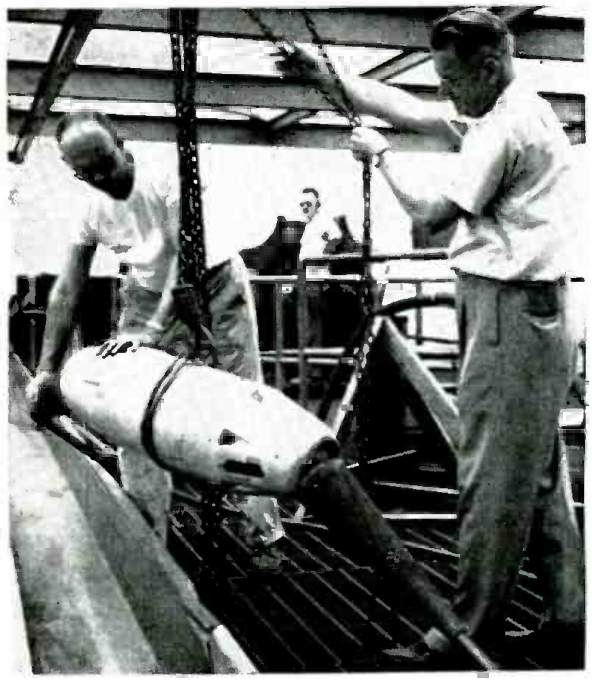
How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils *below* decks, must be positioned *on* deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.



Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

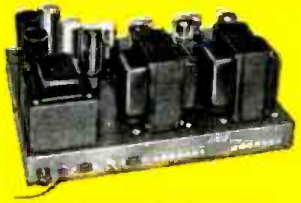
In STEREO and Mono Hi-Fi . . . the experts say your best buy is EICO®

"The overall design of the HF-81 is conservative, honest and functional. It is a good value considered purely on its own merits, and a better one when its price is considered as well."
— Hirsch-Houck Labs (HIGH FIDELITY Magazine)

- Advanced engineering • Finest quality components
- "Beginner-Tested," easy step-by-step instructions
- LIFETIME service & calibration guarantee at nominal cost
- IN STOCK — compare, then take home any EICO equipment — right "off the shelf"— from 1500 neighborhood EICO dealers.

Stereo Amplifier-Preamplifier HF81

Stereo Preamplifier HF85



70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86

FM Tuner HFT90 FM/AM Tuner HFT92
AM Tuner HFT94

Stereo Integrated Amplifier AF4

12W Mono Integrated Amplifier HF12
Other Mono Integrated Amplifiers:
50, 30, & 20W (use 2 for stereo)

2-Way Bookshelf Speaker System HFS1
3-Way Speaker System HFS3
2-Way Speaker System HFS5

Over 1 MILLION EICO instruments in use throughout the world.

Add 5% in the West.

HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. "**Excellent**" — SATURDAY REVIEW; HI-FI MUSIC AT HOME. "**Outstanding quality . . . extremely versatile.**"—ELECTRONICS WORLD LAB-TESTED. **Kit $69.95. Wired $109.95.** Includes cover.

HF85 Stereo Preamplifier is a complete, master stereo preamplifier-control unit, self-powered for flexibility & to avoid power-supply problems. Distortion borders on unmeasurable even at high output levels. Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. Switched-in loudness compensator. "**Extreme flexibility . . . a bargain.**"—HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Includes cover.

New HF87 70-Watt Stereo Power Amplifier: Dual 35W power amplifiers of the highest quality. Uses top-quality output transformers for undistorted response across the entire audio range at full power to provide utmost clarity on full orchestra & organ. IM distortion 1% at 70W, harmonic distortion less than 1% from 20 to 20,000 cps within 1 db of 70W. Ultra-linear connected EL34 output stages & surgistor-protected silicon diode rectifier power supply. Selector switch chooses mono or stereo service; 4, 8, 16, and 32 ohm speaker taps, input level controls; basic sensitivity 0.38 volts. Without exaggeration, one of the very finest stereo amplifiers available regardless of price. Use with self-powered stereo preamplifier-control unit (HF85 recommended). **Kit $74.95. Wired $114.95.**

HF86 28W Stereo Power Amplifier **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision eye-tronic® traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. "**One of the best buys in high fidelity kits.**" — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*.** **Cover $3.95.** *Less cover, F.E.T. incl.

New AM Tuner HFT94. Matches HFT90. Selects "hi-fi" wide (20c — 9kc @ —3 db) or weak-station narrow (20c — 5kc @ —3 db) bandpass. Tuned RF stage for high selectivity & sensitivity; precision eye-tronic® tuning. **Kit $39.95. Wired $65.95** Incl. Cover & F.E.T.

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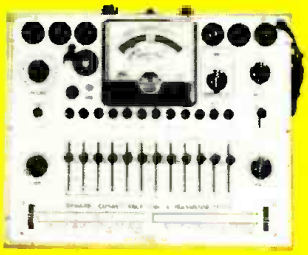

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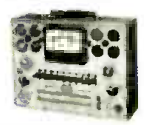

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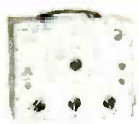

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Scatter Radio Communications

By ROBERT B. STECKER

Superintendent, Systems Engineering-East Defense Projects Div., Western Electric Co.

Tropospheric scatter systems with their high powers and giant antennas provide beyond-the-horizon coverage of the highest quality and reliability for remote areas.

Communication by means of scatter radio is one of our new marvels. Thousands of miles of scatter radio communications links have been built throughout the world and many new routes are under construction. One of the most dramatic systems is the one constructed by the *Western Electric Company* for the United States Air Force linking the DEW (*D*istant *E*arly *W*arning) Line stations across the entire northern rim of the North American continent. *Western Electric* also constructed for the Air Force the "White Alice" network which provides over 3000 route miles in Alaska.

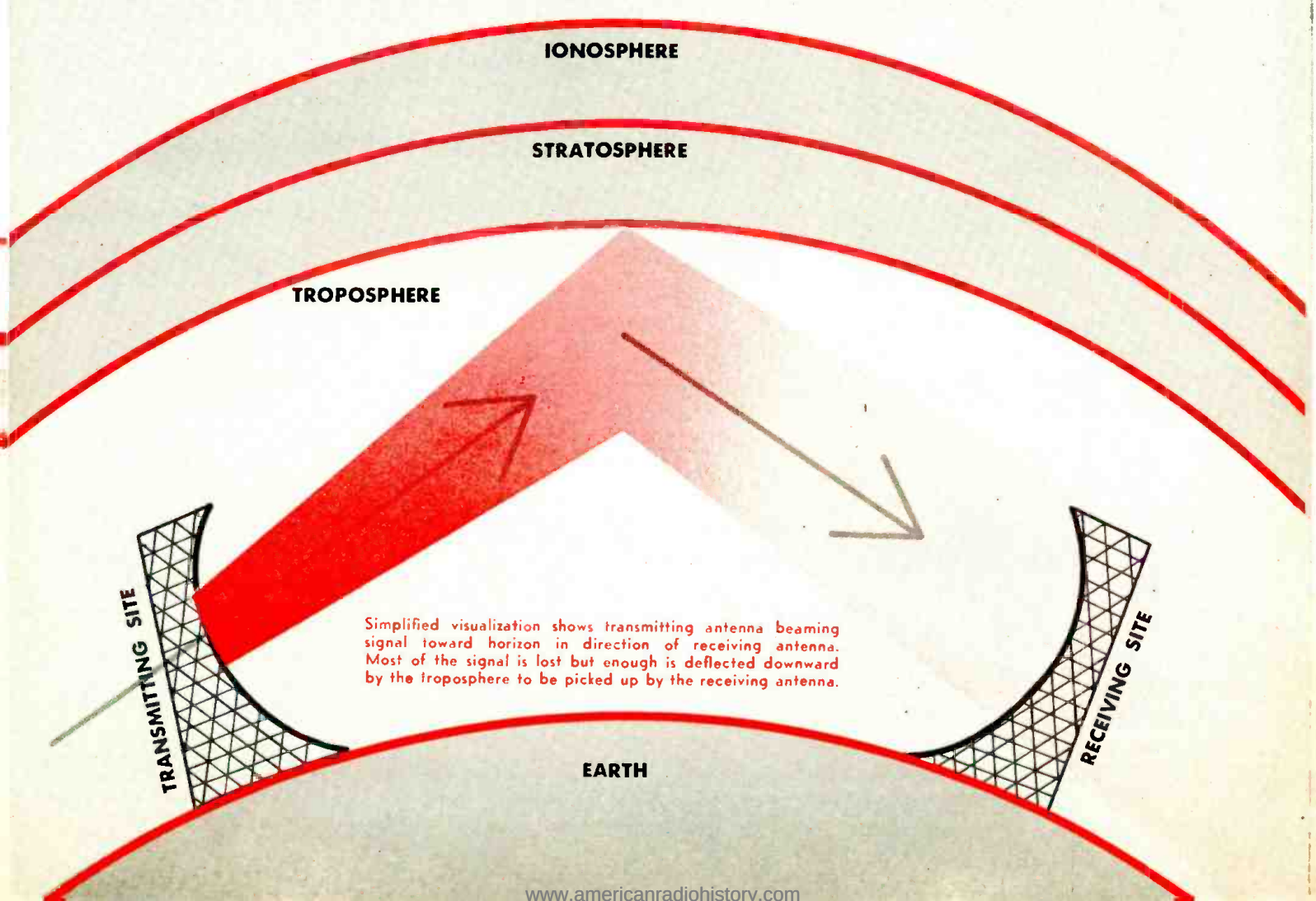
There are two types of scatter systems: *ionospheric scatter* (in which ionized layers 40 to 60 miles above the surface of the earth act on the signal) and *tropospheric scatter* (in which the signal is acted on by that layer of the atmosphere up to an altitude of about 6 miles).

Ionospheric scatter systems have had fairly limited application because they can provide only a few kilocycles of usable bandwidth. These systems employ links about 1000 miles long and generally carry only a few telegraph signals.

Tropospheric scatter systems, however, while spanning only a few hundred miles per link, can provide hundreds of kilocycles of bandwidth and have emerged, largely under military auspices, as the accepted way of providing dozens of communication channels of the highest quality in remote areas where difficult terrain and severe weather conditions make all of the more conventional wire and microwave techniques impractical.

The Transmission Mechanism

The troposphere is the layer of atmosphere nearest the earth. It is the area in which almost all weather phenomena takes place. The atmosphere in this six-mile layer acts as a refractive medium to radio frequencies and makes tropospheric scatter transmission systems possible.



Simplified visualization shows transmitting antenna beaming signal toward horizon in direction of receiving antenna. Most of the signal is lost but enough is deflected downward by the troposphere to be picked up by the receiving antenna.

One of six radar stations forming the DEW Line's Aleutian Segment, designed to provide early warning against hostile planes trying "end run" around DEW Line's western flank. Radar antenna is within large dome, other antennas provide scatter communications.

Tropospheric scatter is essentially a "brute force" type of radio system. Large amounts of radio-frequency energy must be generated. Even with very large antennas to focus the energy toward the distant receiver, almost all of the radiated energy is lost in the troposphere and only a very small portion actually reaches the receiver.

The transmission mechanism can perhaps be most easily understood by imagining yourself driving along a dark country road at night. You are approaching a large city which lies just beyond the next hill. As you climb the hill, you can see the glow from the lights of the city even though the lights themselves are below the horizon and out of sight. Although light waves travel in straight lines, a portion of the light has been scattered by dust and other particles in the air and reaches your eye.

The scattered light is a very small fraction of the total and so, too, the radio energy which is scattered in the troposphere and reaches the receiver is a minute part of the total energy which has been radiated.

Field of Applications

This new type of radio system has three distinctive characteristics which tend to define its field of application:

1. *Long Repeater Spacing.* Depending on such factors as terrain, transmitter output power, and antenna size, high quality tropospheric scatter radio links can span distances ranging from under one hundred to several hundred miles. A typical link with 10-kilowatt transmitters and 60-foot diameter parabolic antennas is about 150 miles long. This offers great advantages over microwave systems, particularly in rugged, inaccessible terrain, where both construction and maintenance costs for strings of intermediate repeater stations, spaced 20 or 30 miles apart, might be prohibitive.

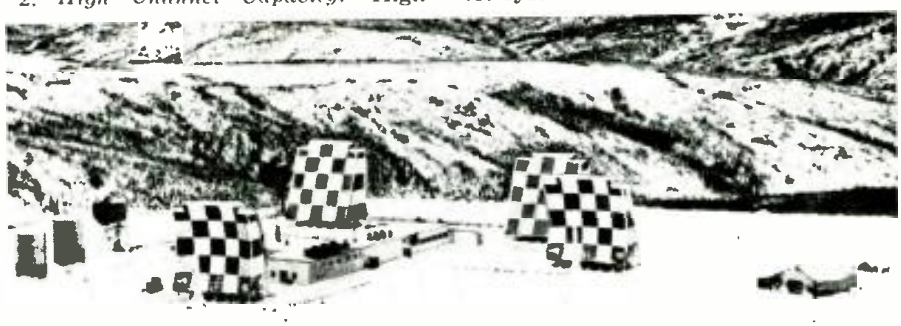
2. *High Channel Capacity.* High quality tropospheric scatter systems have been built to carry over 100 voice channels. New systems now under construction will have an ultimate capacity of 240 channels. While this is below the capacity of some microwave routes, it far exceeds the channel-carrying capabilities of either h.f. or v.h.f. radio systems. It has proved suitable for all but the heaviest military routes and finds commercial application in thinly populated areas.

3. *Freedom from Atmospheric Interference.* Properly engineered tropospheric scatter radio systems can provide very high quality and continuous 24-hour reliability since, like microwave systems, they are virtually free from interference caused by such things as ionospheric disturbances, magnetic storms, sunspots, and aurora. This is in contrast to h.f. and v.h.f. systems where service is frequently degraded or disrupted by this type of interference.

Two other factors combine to make it almost certain that tropospheric scatter systems will be useful primarily in remote areas or for crossing natural barriers, such as lakes or bays. These are the large size of the stations and the high level or radiated radio-frequency energy required.

Almost all of the tropospheric scatter systems now in existence use either 30-foot or 60-foot diameter antennas. A few 45-foot size have been used and the introduction of huge 120-foot antennas on some very long links has just begun. A relay station having a pair of 60-foot antennas facing each direction requires in the neighborhood of 10 acres of ground and would be out of the question for urban area installations.

Transmitter outputs of 1 and 10 kilowatts have been widely used. Some 2-kilowatt units are also in the field and new 50-kilowatt units are being developed. These power levels are high potential sources of interference in built-up areas. Also, for proper operation and to protect against possible dan-



Air view showing four red and white checkerboard scatter communications antennas at isolated "White Alice" station situated on a mountain in northern Alaska.

◀ Installation men walking by large scatter dish during one of Alaska's fogs.

ger from radiation, it is necessary to clear areas immediately in front of the antennas of all structures, trees, and other obstructions, and restrict personnel access in these areas. Mountaintop or sea-coast site locations are preferable where the radio beam can shoot into space or out over the water.

How Tropospheric Scatter Began

The key factor in radio transmission is noise. For successful operation, the signal reaching the receiver must be significantly greater than all the other atmospheric and man-made impulses which appear as noise at the receiver input. Tropospheric scatter systems make use of high power transmitters and very large antennas to deliver usable signals over radio paths with propagation losses in excess of 200 db. By way of comparison, this is some 70 db or 10 million times more loss than that of a typical line-of-sight microwave path.

Even with allowable path losses of 200 db or more, the classic "smooth earth" theory of radio propagation would have limited path lengths to under 100 miles. It has long been recognized that some radio energy is bent around the curvature of the earth, but the theory predicted that this would diminish almost immediately to unusable proportions as the distance beyond the horizon was increased even slightly.

Evidence that this extremely rapid signal attenuation with distance was not being encountered in practice became apparent during World War II. Cases were noted where radar equipment picked up targets at distances theoretically well beyond their maximum range. In the years following the war more evidence was accumulated. The television "freeze" in 1949 was brought about largely because of the unexpectedly high interference between TV stations operating on the same channel although located many miles apart.

In the same period the *Bell Telephone System* was constructing multilink microwave systems for the transmission of telephone and television channels throughout the country. Here, too, there was concern with "overreach" of a signal from one transmitter into receivers several links down the line and, theoretically, well out of range.

A number of studies of this unusual propagation phenomenon were made. In 1950 Kenneth Bulling of the *Bell Laboratories* summarized information showing that beyond-the-horizon transmission was possible to a far greater extent than had been predicted earlier and suggested that this type propagation be put to practical use in areas where terrain or other conditions made long spacings between repeaters imperative.

The first experimental tropospheric scatter system to be built was an 8-link system for the United States Air Force. This system, called by the code name "Pole Vault," provided communication between early warning radar stations in Newfoundland and was completed in 1954. It worked as predicted and proved conclusively that tropospheric scatter radio was a useful new communications tool.

Equipment

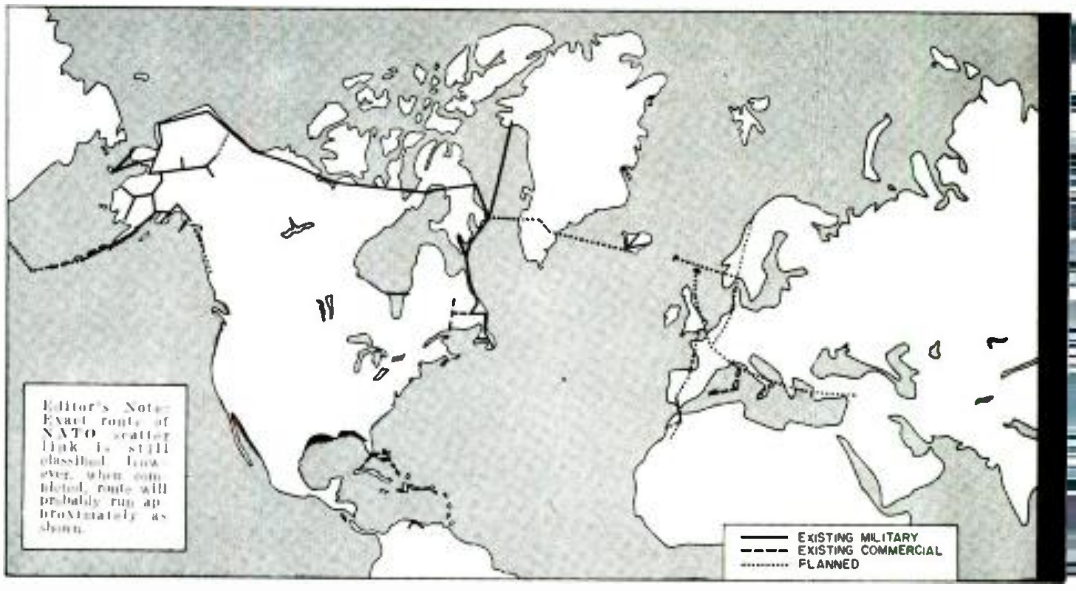
A whole new family of equipment units has grown up to meet the needs of tropospheric scatter. Frequency modulation predominates although some single sideband is used. The optimum frequency band for use with practical antenna sizes is about 750 to 1000 megacycles and most of the systems in the field operate in this range. Good results can also be obtained in the 400-mc. range and the 2000-mc. range has been used although over-all link losses are greater.

The velocity-modulated klystron tube has been the means of providing kilowatts of radio-frequency energy at these u.h.f. frequencies. A typical 10-kw. klystron amplifier occupies four 7-foot-high cabinets, one for the klystron itself and three for the related power supplies. It requires less than 10 watts of driving power and about 38 kilowatts of prime power. Water cooling is required and separate heat-exchanger units are furnished for each amplifier.

The 10-watt exciter units each occupy one 7-foot bay. They use fairly straightforward frequency multiplying techniques to convert the baseband output of the channelizing equipment into the u.h.f. range. Special modulator circuitry is required when large numbers of channels and very broad bandwidths are used.

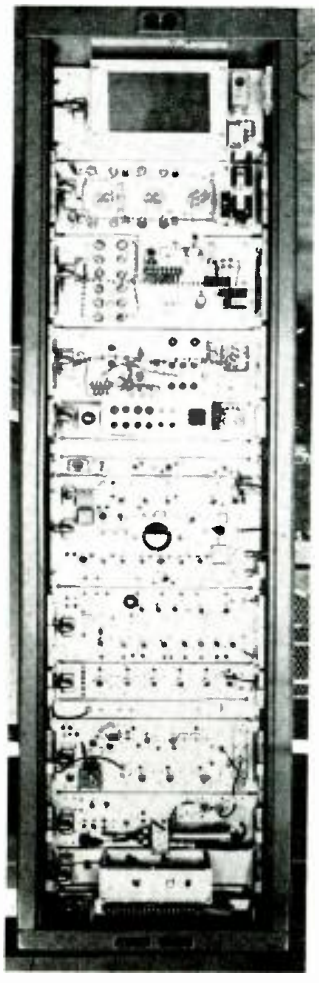
Superheterodyne receivers with very sensitive low-noise input circuits are used. Like the exciters, each receiver occupies one 7-foot bay. Noise figures of 7-8 db have been obtained using special close-spaced triodes in the first stages. New equipment now being produced will achieve the heretofore impossibly low noise figure of about 2 db by means of parametric r.f. amplifiers.

As would be expected when using scatter type transmission, the received



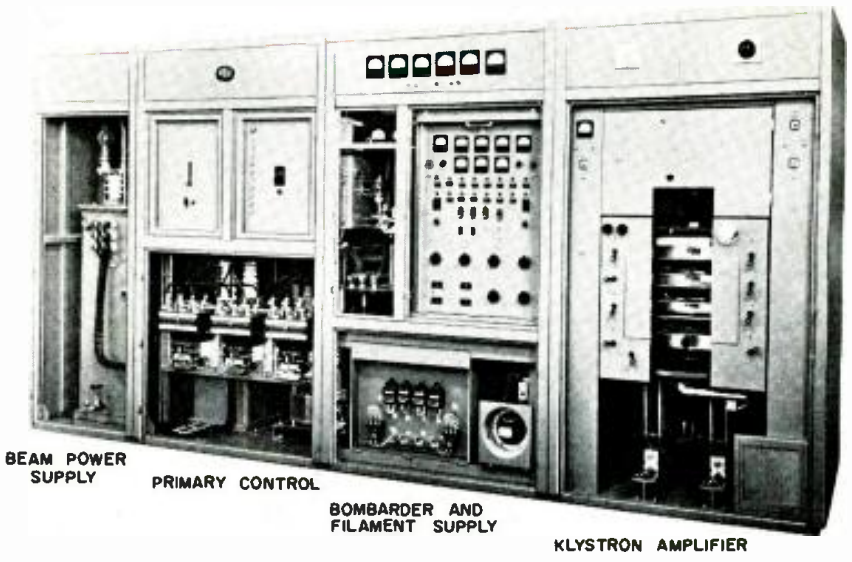
World map showing routes followed by presently existing and planned tropospneric scatter communications links. Both military and commercial systems are indicated.

Receiver for scatter communications link employs standard relay-rack construction.

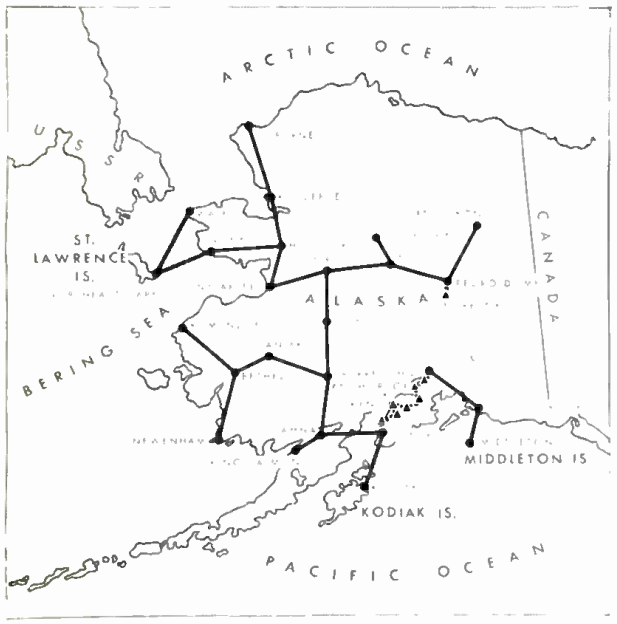


signal level tends to fluctuate rapidly over quite a large amplitude range. All tropospheric scatter systems employ diversity reception to minimize the effect of these fluctuations. The early systems used dual space diversity and almost all of the more recent systems use a combination of space and polarization, or frequency, diversity. In such quadruple diversity systems the same signal is sent over four essentially independent paths and received on four separate receivers simultaneously. A combiner circuit takes the four receiver outputs and delivers a single combined output signal to the channelizing equipment.

Rigid 3⅛-inch diameter coaxial cable is used for the high-power transmission lines in the buildings and waveguide—about the size of home heating ducts to handle the relatively low u.h.f. frequencies—is used in the outside runs to the antennas. Some outside runs have used flexible coaxial cables such as "Styroflex" or "Heliax" instead of waveguides when power levels of 1 or 2 kw. were used or when the run was intended for receiving only.



Front panel view of the power-amplifier portion of one of the transmitters employed in the scatter system. A 10-kilowatt klystron amplifier delivers the r.f. output to the antenna. Exciter for this amplifier is in a single, adjacent rack.



Basic route of "White Alice." Solid dots show scatter stations; triangles and the broken lines show connecting microwave links.

Practical System Problems

Some of the more serious problems encountered in the construction of tropospheric scatter systems result from the rugged remote areas in which most of these systems have been built.

High wind velocities and ice formation have been common and have required strong, heavy antenna structures with massive foundations. Most of the antennas are made of steel. Where severe icing is expected, the antenna structures have been closed in with sheeting to prevent a buildup of ice on the structural members. Some of the enclosed antennas are equipped with large oil heaters for de-icing purposes.

The size and weight of the antennas make orientation adjustments a problem. A 60-foot antenna may weigh 100 tons and once emplaced cannot readily be moved to aim it more accurately. This has required that the survey work of establishing precise antenna locations and azimuths, together with the pouring of concrete foundations and erection of the antennas themselves, must all be done with extreme care. A final emplaced orientation accuracy of less than 5 minutes of arc has not been uncommon. Some slight adjustment of the position of the horn feeding the antenna is possible and this permits a slight shifting of the antenna beam by means of defocusing or squinting.

Good prime power quality and reliability have been difficult to achieve. Local power generation has been the rule and many of the diesel plants have had inadequate regulation to eliminate voltage and frequency surges as vari-

(*Continued on page* 130)

COVER STORY

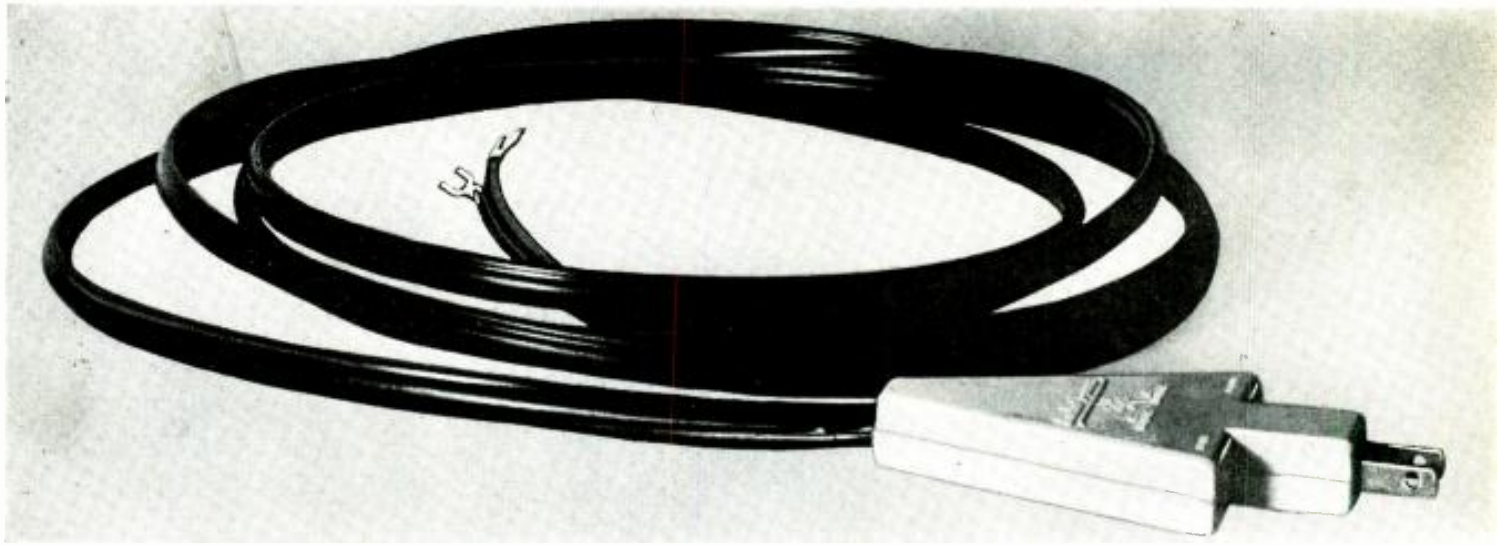
THE CHECKERED ANTENNA, 60 feet tall and made of 100 tons of steel, belongs to Alaska's 3000-mile communications system called "White Alice." When completed in 1958, "White Alice" was the largest tropospheric scatter network ever to be built and the first to provide commercial service. The most distant points on the long-haul system in Alaska include Cape Lisburne, on the northwest tip of North America; St. Lawrence Island, in the Bering Sea; and Wales, only 56 miles from the coast of Russia. Some 375 companies and over 3500 persons, under the direction of the Western Electric Company, manufacturing and supply unit of the Bell Telephone System, in three years built the network that not only conquered Alaska's lonely distances, but also the static-choked atmosphere and the savage storms which have always hampered radio and wire communications near the top of the world.

The antenna pictured is one of many among the 33 stations of "White Alice." When transmitting, many telephone and telegraph channels are combined into a single radio signal which is brought to the feed horn on a tower in front of the huge antenna. The feed horn directs the radio signal against the curved surface of the antenna, which beams the energy toward the horizon and a similar receiving antenna which may be 200 miles away. The aim is precise. The antennas cannot be off as much as 1/20 of a degree. During construction they had to be carefully positioned because once up, these massive structures cannot be re-aligned.

The versatility and practicality of tropospheric scatter communication techniques have now been demonstrated for several years by the "White Alice" network with its 170,000 telephone circuit miles and 50,000 telegraph circuit miles. Built at a cost of about $140,000,000, the network paved the way for the new systems now under construction in other parts of the world. Large as it is, the "White Alice" antenna on the cover will be dwarfed by some now under construction. The checkered patterns which mark such antennas as obstacles for fliers will be even more appropriate as the new giants rise into being. —30—

(Photo: A. Lavine, Western Electric Co.)

"Line-Cord" Antennas:



Fact and Fiction

By **SIDNEY C. SILVER**
Service Editor, ELECTRONICS WORLD

Neither miracles nor frauds, these signal couplers may prove quite satisfactory in some circumstances.

QUESTION: Line-cord antennas are now being promoted heavily as the long-sought miracle solution to the problem of the external TV antenna. They are also being attacked as completely fraudulent. Which side is right? Do they work or don't they?
ANSWER: They do "work." Regarding the claims and counterclaims, neither extreme is true. There are situations in which they would be useful for TV and FM reception. They are definitely more than "just a length of wire."
QUESTION: Some critics suggest that these units introduce shock hazards. Are the units dangerous enough to cause concern?
ANSWER: They are no more hazardous than many radios, TV receivers, and other household appliances. In fact, they tend to be safer than most such electrical equipment.
QUESTION: Are they worth trying?
ANSWER: One of them might be worth a try—under the right conditions and at the right price—but buying blindly is not recommended. If your particular situation warrants a try, you can protect yourself with a money-back guarantee.

ALTHOUGH it occurred more than thirty years ago, we clearly recall an incident involving an old-time radio buff. He was grinning over a gadget that looked like a diamond-shaped spider web and stood about two feet high. It was an open-loop antenna that he could use indoors on top of his radio cabinet—and it worked. He no longer had to string wire all over his roof. A few years later, even this was outmoded by smaller loops inside the radios, out of sight. They also worked.

Just a few years ago, TV viewers were being tempted by what appeared to be a comparable miracle: a single length of wire connected to one side of the TV set's antenna input at one end and terminated at the other end in an intriguing little box. The miracle, inside the box, was a capacitor, a pitch-like material, a slab of rubber, or thin air. With the box snipped off, the wire worked just as well, which was not well at all.

The latest contender for "miracle" status is a length of 300-ohm lead that also terminates in a box, with the latter plugging into (or otherwise coupling to) house wiring. This "revolutionary discovery," often represented as using "radar principles," is said to "convert your house wiring into a giant TV or FM antenna." Tests on typical units quickly revealed, alas, that the long-awaited miracle is not yet here. However, the mystery box now contains something that makes enough sense to deliver reasonable results in many cases.

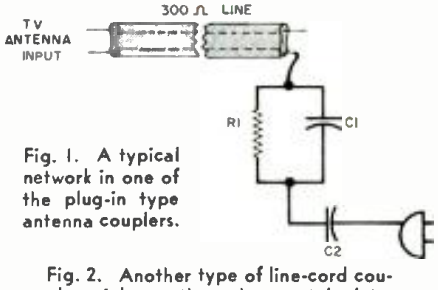
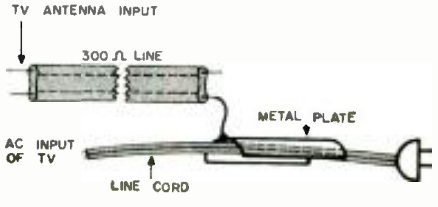


Fig. 1. A typical network in one of the plug-in type antenna couplers.

Fig. 2. Another type of line-cord coupler picks up through a metal plate.



Following unfavorable comment by the National Better Business Bureau and other agencies, many have gathered that the devices are complete frauds. Much as we would like to wear the mantle of the fearless crusader, we cannot dismiss the line-cord devices so unqualifiedly. The BBB attack is largely against the misleading advertising promulgated by many, though not all, of the manufacturers or purveyors of the devices. As to actual performance, the BBB quotes other sources. These other sources appear to have been rather hasty in their tests and in the conclusions drawn from them.

The unit shown at the beginning of this article is typical of most available. Inner detail appears in Fig. 1. It consists of a simple *RC* high-pass filter in series with a blocking capacitor, to keep d.c. or low-frequency a.c. out of the TV set's antenna input. The network is connected between one leg of the house wiring and one side of the antenna input.

Component values, which are not particularly critical, vary somewhat from one manufacturer to another. R_1 may be in the order of 500,000 ohms,

(*Continued on page* 139)

FM Wireless Microphone

Fig. 1. Miniature transistorized FM transmitter shown in use.

By
D. E. THOMAS and J. M. KLEIN
Bell Telephone Laboratories

An experimental FM transmitter that can be easily built from readily available components at a cost of approximately $20.00.

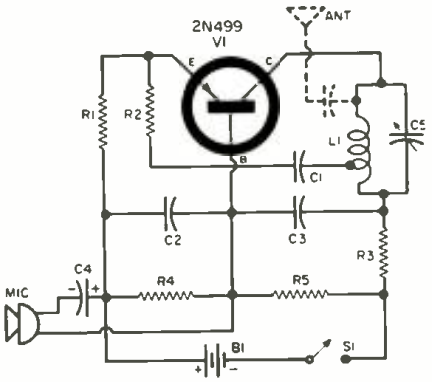
EVER since the appearance of the article describing an experimental transistorized FM transmitter[1] numerous requests have been received for information on commercial components for duplicating the original circuit. Unfortunately, the point-contact transistor around which the original transmitter was designed was an experimental device which became obsolete before it could be coded for manufacture.

Since requests for information on how to build a similar transmitter are still being received, the authors worked out another circuit covering an experimental FM transmitter which can be built with readily available commercial components at a cost of approximately $20.00. Construction is simple and no difficulties should be encountered.

A photograph of the new transmitter, which was designed as a wireless microphone, is shown in Fig. 1. Like the earlier circuit, it was designed to operate in the commercial FM band. The schematic diagram is shown in Fig. 2, along with a listing of the required parts. Detailed specifications are given because of repeated requests for complete construction details. However, equivalent components of other types will work equally well and, in the interests of ready availability and possible cost saving, many experimenters may be willing to sacrifice size and substitute somewhat larger components than those specified. One possible exception to the "substitution" rule would be the transistor since a change in this component might require readjustment of circuit element values or even a change in circuit configuration.

The 2N499 transistor used in the transmitter performs the triple function of r.f. oscillation, frequency modulation, and audio amplification. Since the frequency of oscillation of this transistor is somewhat closer to its cut-off frequency than the point-contact transistor used in the original transmitter, less phase shift is required in the feedback coupling circuit to maintain oscillation. Feedback is obtained from a tap on the tank coil, L_1, through a series resistor-capacitor (R_2 and C_1), rather than through a capacitance only. The frequency modulation function of the transmitter is accomplished in the same way as described for the earlier transmitter—namely by feedback-loop phase shift, resulting from *alpha* cut-off frequency shift under the control of an audio-frequency signal input.

Fig. 2. Schematic of the wireless mike.



R_1—300-400 ohm, 1/10 w. res.
R_2—240 ohm, 1/10 w. res.
R_3—1500 ohm, 1/10 w. res.
R_4—2400 ohm, 1/10 w. res.
R_5—12,000 ohm, 1/10 w. res.
All resistors are Allen Bradley Type TR
C_1—15 μμf. mica capacitor
C_2, C_3—.001 μf. disc ceramic capacitor
C_4—20 μf., 15 v. elec. capacitor
C_5—.8-12 μμf. piston-type variable trimmer
L_1—6 t. #24 bare tinned copper wire on 1/4" 36 TPI polystyrene coil form. Feedback tap at exactly 1 full turn.
Mic.—Reluctance microphone (Shure MC-20)
Ant.—Telescoping antenna (Lafayette F-343 with sections cut down to approx. 2¾", see text)
B_1—15-volt battery (Burgess Y-10 or Eveready 504)
S_1—S.p.s.t. slide switch
V_1—Transistor (Philco 2N499)
1—Can (Type HU315-2) and cover (Type HU-315C-2) available from Hudson Tool & Die Co., Inc., Newark 5, N. J.

The inductance L_2, which can be any low-capacitance r.f. choke with an inductance greater than 1 μhy., is needed to avoid shunting the emitter at r.f. and interfering

Since the 2N499 is a junction-type transistor, its high common-emitter current gain at audio frequencies was used to eliminate the need for an additional transistor to amplify the audio output of the microphone to the level needed to produce adequate frequency deviation. This is accomplished by introducing the audio signal into the base of the transistor. Fig. 3 is the equivalent circuit of the transmitter at d.c. and audio frequencies. It will be noted that R_1 appears directly in series with the emitter of the transistor at audio frequencies. This reduces the maximum available common-emitter current gain. If more audio gain is needed, it can be obtained by shunting R_1 by means of the optional *LRC* circuit shown in Fig. 3. The inductance

1. "Single-Transistor F-M Transmitter," Electronics, February 1954. Pages 130-133.

with r.f. oscillation. The capacitance, C_6, which should be of the same value and type as C_4, is needed to avoid disturbing the d.c. biasing of the transistor. The audio gain can then be adjusted by varying the resistance of R_6.

Construction

The actual placement of the components may play an important part in circuit performance at v.h.f. frequencies. The layout indicated by the callouts of Fig. 4 should be followed as closely as possible. The transmitter shown in this photograph has a miniature jack for connecting an external microphone and matching transformer. This jack can be seen between the microphone and switch in the picture.

All components, except the antenna, are mounted on one side of a $2\frac{1}{2}$" x $1\frac{7}{8}$" panel. Most of the parts are supported by their own leads which are passed through holes in the panel and wired on the underside. Fig. 5 shows this component wiring and the antenna mount. The bottom section of the antenna is wound in polyethylene sheet and clamped to the underside of the panel directly beneath the L_1-C_2 tank circuit so that its only r.f. coupling is the parasitic capacitance between it and the tank circuit. This limits radiation to that needed for a portable p.a. microphone with a range of about 200 feet and also reduces frequency pulling due to any change in radiation impedance of the antenna.

Adjustments

The value of R_1 should be adjusted

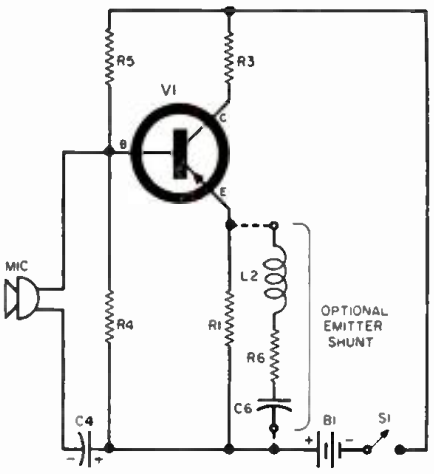


Fig. 3. Equivalent circuit. Value of R_6 is found by experimenting with 10,000-ohm pot.

for the particular transistor used so that the d.c. voltage drop across R_3 is approximately 6 volts when the battery is new. It has been our experience that the R_1 adjustment, plus the adjustment of C_3 to give the desired carrier frequency, will be all that is required. However, for those 2N499 transistors which happen to be on the edge of production acceptability, the circuit may not oscillate. In this case, a slight adjustment of R_2 and/or C_1 should produce oscillation.

Possible Variations

An external microphone of different impedance or larger size may be used. The space occupied by the small reluctance microphone could then be utilized for a suitable audio impedance-matching transformer. The alternate microphone selected should be connected to the transmitter by a coaxial microphone cable. In this case, the microphone cable will provide sufficient radiation for limited local transmissions and the collapsible dipole antenna may be omitted. The audio input impedance of the transmitter will vary widely depending on the transistor used, the value of R_1, and whether an emitter shunt is used to increase the audio gain, as shown in Fig. 3 and described previously. However, if an audio impedance of 1000 ohms is assumed and an audio transformer selected to match the microphone to 1000 ohms, the actual audio impedance match will be satisfactory.

Considerably greater than public-address range could be obtained by use of an efficient radiator suitably coupled to the transmitter. However, it must be remembered that the wireless microphone described is an experimental device. Any wireless microphone built for actual p.a. or entertainment use would have to comply with FCC regulations with respect to transmitter frequency, frequency stability, and power.

Acknowledgement

The concept of a frequency modulated transistorized transmitter originated with R. L. Wallace, Jr. The earliest transmitter was built by L. C. Schimpf, using an early tetrode transistor modulated by a condenser microphone across the tank circuit. —30—

Fig. 4. The layout of components employed in the transmitter.

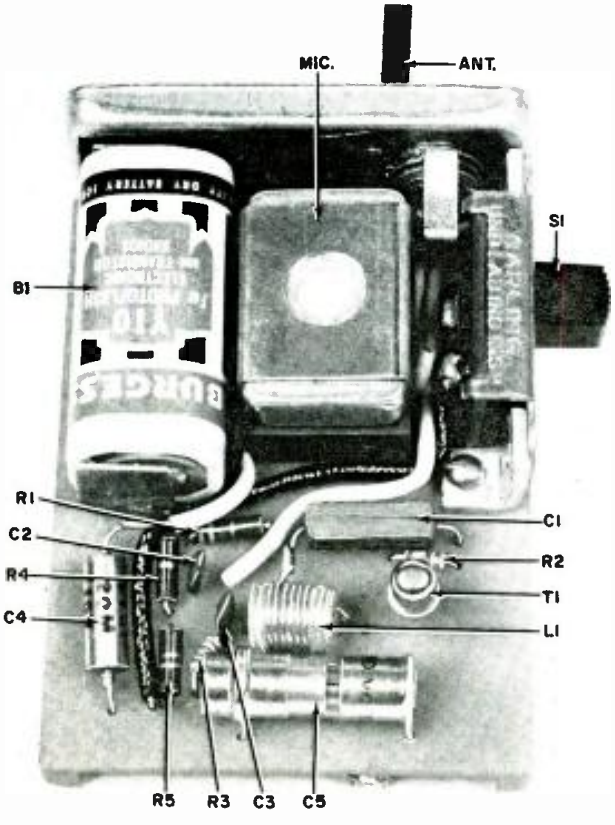
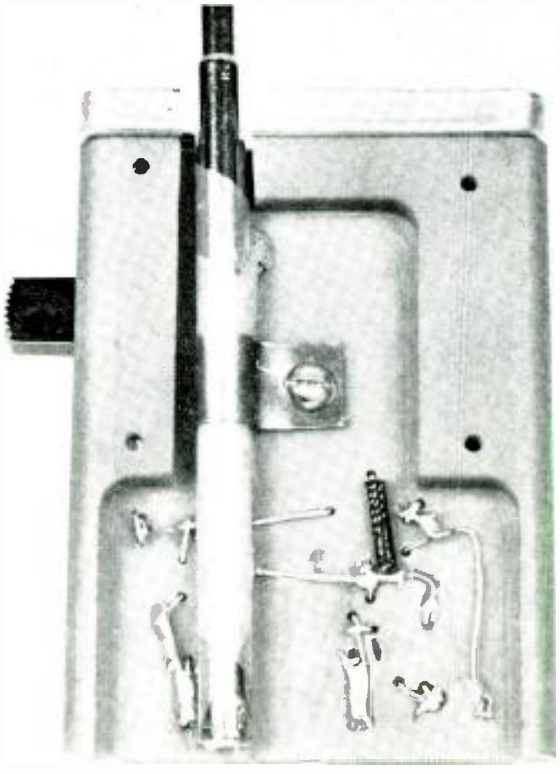


Fig. 5. Backside view of unit shows wiring and antenna mount.



What will TV technician and set buyer find in the latest models? A look at the lines of 15 leading manufacturers.

New TV Designs for 1960

By **WALTER H. BUCHSBAUM**
Industrial Consultant, ELECTRONICS WORLD

IF YOU ACCEPT the notion that the design of the TV receiver has pretty much settled down, with few really significant changes in the last couple of years, the 1960 lines may have a few surprises for you. Last year, taking note of the fact that little had changed, we commented that there were still no truly flat picture tubes, that commercial receivers using transistors were yet in the crystal-ball stage, and that color TV was making slow gains.

The past year saw the introduction of a fully transistorized, portable TV set. Although color still has not swept the country, it continues to gain ground and, more important, the rate of gain seems to have gone up gratifyingly. There have been some picture-tube developments. There is also an increase in the use of auxiliary equipment and circuitry not essential to the functioning of a TV receiver as such. In addition, there is an encouraging trend toward the restoration of certain features that have been in use for years but have been abandoned along the way. More sets use power transformers, width controls, and magnets or other means to eliminate raster pincushioning than did last year.

Significant trends also include use of the 23-inch rectangular picture tube with integral safety glass and a more extensive use than in the past of remote-control or automatic devices and elaborate channel indicators.

In the 23-inch picture tube, the safety glass mask, which was previously part of the cabinet assembly, is now permanently fastened to the CRT. Probably the main advantage of this arrangement is that dust cannot collect between the screen and the safety glass.

The most frequently used remote-control devices are transistor oscillators operating either around 40 kc. or up to 400 kc. with receivers tuned to pick up this radiation. One manufacturer even offers a pneumatic control. Other features offered on some TV receivers include clock timers, resettable circuit breakers, provisions for stereo audio and, in a number of deluxe sets, really good audio systems. A few manufacturers, in an effort to augment their home receiver market, have designed sets for special applications, such as chassis for custom installations, hospital TV sets, and special classroom receivers.

The service technician will be happy to hear of the growing awareness by TV designers that printed wiring can be a stumbling block to efficient troubleshooting. Practically every company now using printed wiring has made some provision for identification of individual parts, circuit connections, and test points. At least three major TV set producers advertise the fact that their printed wiring boards are easy to service because of the added identification features. During the past few years, the firms using printed wiring have run into some kind of trouble in the field and, as a result, substantial improvements in printed wiring techniques were needed. The printed-wiring manufacturers have set up an organization and agreed on certain standards to improve reliability. One TV set manufacturer guarantees its printed boards. Another uses a technique which had proven satisfactory to the military.

The service technician has also received greater consideration in the layout and assembly of most TV sets. Accessibility of all major components is stressed, especially in portables and table models. Quite a few receivers that use remote control, power tuning, and other accessories, however, are still hard to service because the addition of these extra chassis often blocks access to some part of the TV set itself. The various remote-control systems, power tuning, and elaborate channel indicators may well turn out to replace printed wiring as the Number One servicing headache in the new 1960 TV models. The difficulties most apt to be encountered are broken leads, defective contacts, or just plain mechanical wear but, as every experienced technician knows, that type of trouble can involve more difficulties than the average electrical defect. For one thing, the manufacturer's instructions on disassembly, lubrication, and adjustment of the various tuning mechanisms will have to be followed carefully and exact replacement parts will be required, probably available only from the set manufacturer.

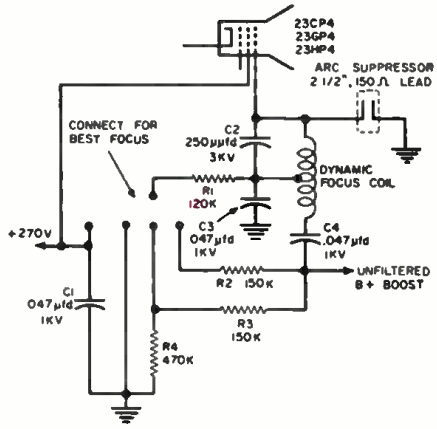


Fig. 1. This Admiral circuit dynamically adjusts focus during scanning.

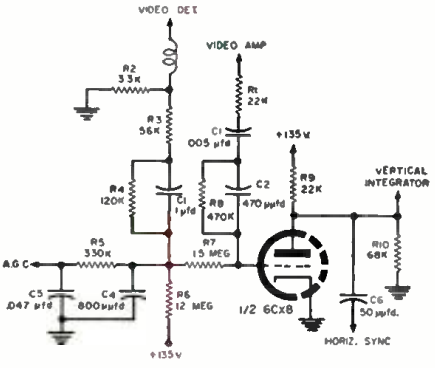
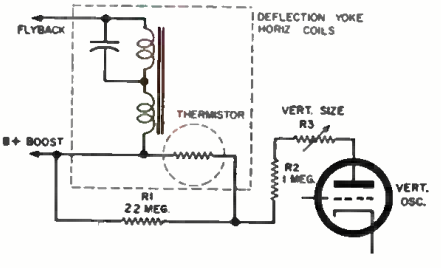


Fig. 2. G-E uses a single triode as a sync amplifier, separator, and clipper.

Fig. 3. Zenith uses thermistor to stabilize vertical size during warm-up.



Admiral

After giving printed-wiring methods a really thorough evaluation, this manfacturer now advertises a five-year guarantee on all printed boards. Presumably this is valid only for the wiring and not for the components mounted on the boards. The boards have all parts on one side and all of the wiring on the other.

Admiral uses the new 23-inch picture tube with the integral faceplate. Advantages include the fact that no dust collects, annoying reflections are reduced, and assembly is simplified somewhat. Good focus across the entire face of the tube is assured by a special dynamic-focus circuit, which adds an a.c. signal to the conventional d.c. focus voltage. This use of dynamic focus voltage is common in color TV sets, but novel in black-and-white models. It therefore deserves some comment. As shown in the circuit of Fig. 1, a portion of the unfiltered horizontal-sweep boost voltage is applied to a tuned circuit that shapes it to the desired, compensating waveform. Because relatively high voltage peaks may develop at the focus anode, a 2½-inch length of 150-ohm twin-lead is connected, as shown, to act as an arc suppressor. Essentially, this length is just a small, high-voltage bypass capacitor. Adjustment for best over-all focus is performed by the installing service technician: he connects the free end of the 120,000-ohm resistor (R_1) to the contact which gives the best over-all picture sharpness.

Like quite a few other manufacturers, *Admiral* offers an ultrasonic remote control. The remote unit uses resonant metal rods, but the receiver is of the conventional type.

American T & R

This company makes only hand-wired receivers and both electrical and mechanical designs are very conservative. Most of the models are in the deluxe class and quite a few feature elaborate sound systems. *ATR's* philosophy is to improve the quality of its product rather than look for innovations.

Andrea Radio Corp.

Known mostly for deluxe models and selling to a quality rather than mass market, this company also adheres to hand wiring and has used this fact as an advertising point for the past few years. Most of the *Andrea* models have

Fig. 4. 12-lamp "computer" panel (lower right) on Packard-Bell mounts behind channel window, lights up chosen channel.

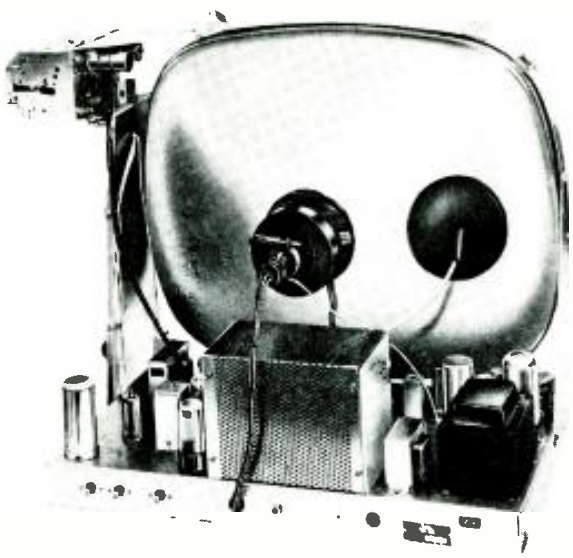


Fig. 6. This separate Andrea chassis, available for custom installation, uses 21-inch, 110-degree CRT for compactness.

provision for using the audio section as a second amplifier channel for stereo, but only a single output tube is used. Fig. 6 shows a compact 21-inch, 110-degree picture-tube chassis that is available for custom installation.

Emerson

A two-transistor remote-control unit is introduced that works not only with a number of available console models but with the 17-inch portable as well. The 40-kc. signal from the remote-control unit is sent out through a transducer and received by a microphone. A dual-diode discriminator circuit is used to detect the two frequencies, 39.5 and 40.5 kc., which actuate the channel switching and volume control. In most other respects *Emerson's* 1960 models feature conventional circuitry and also conventional design.

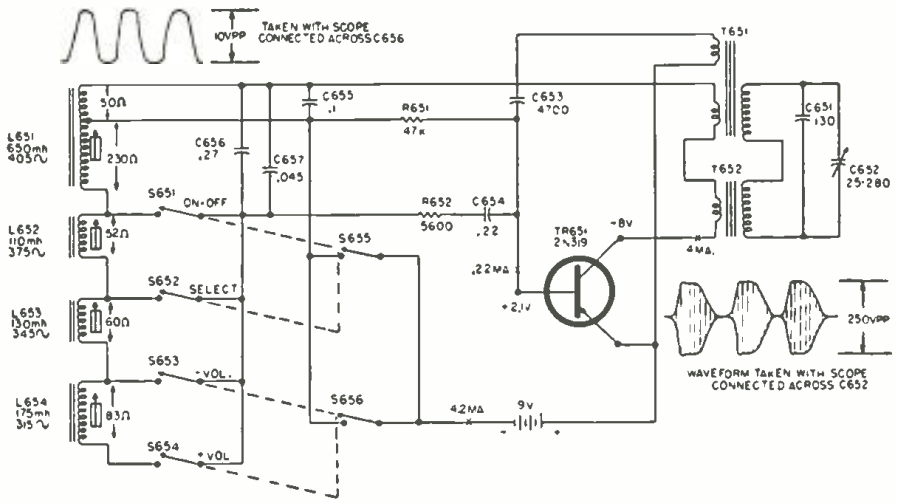
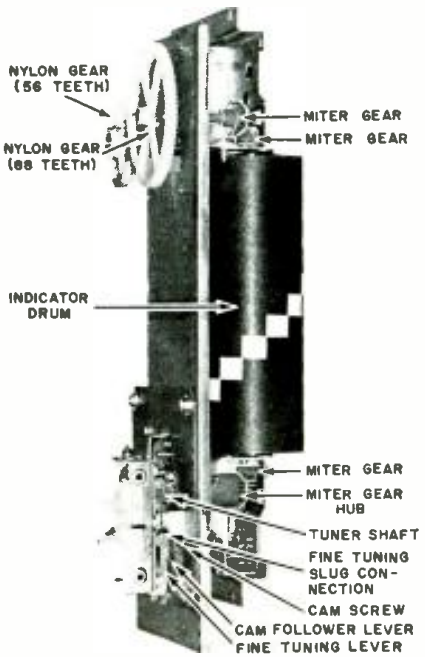


Fig. 7. G-E's transistorized remote-control transmitter provides 4 functions.

Fig. 5. Mechanism of power-driven tuning indicator used by Westinghouse.



General Electric

This year's *G-E* receivers all use a full power transformer and, on one type of chassis– germanium rectifiers, while the good old vacuum-tube rectifier has re-appeared in a whole series of models. In the way of circuit oddities, there is a single triode stage in the "M5" chassis that serves as sync amplifier, separator, and clipper. Fig. 2 shows the circuit. The sync pulses from the video detector are negative, while those coming from the video amplifier plate are much larger and go positive. The combination of biasing and opposite-polarity signals provides the clipping and limiting action.

G-E's remote-control system is interesting in several respects. It provides four functions ("on-off," channel selection, volume increase, and volume decrease), as shown in Fig. 7, and does so by modulating a single transistor oscillator with four different frequencies. A ferrite antenna coil radiates the 322-kc. oscillator signal over a usable range of about 50 feet. At the receiver, the four control (modulating) frequencies are detected and amplified to drive four resonant-reed relays. The control function depends on the frequency with which a particular reed is excited. At 315 cps, the "volume increase" relays will close, while at 345 cps the "volume decrease" circuit is actuated. The resonant-reed relay should be relatively trouble-free but, if servicing is required, the manufacturer's procedure must be followed exactly and any replacement will have to be obtained direct from *G-E*.

Hoffman

This manufacturer offers hand-wired receivers of very conservative circuitry. Major innovations involve the use of a 23-inch picture tube with integral faceplate and the introduction of a TV receiver especially designed for classroom use. On the latter, only the most important controls are available at the front panel—and the "on-off" switch is key-operated to keep the students from

(*Continued on page* 104)

Top photo shows system inventor, Dr. Wm. E. Glenn, recording signal from TV set by means of a series of minute wrinkle patterns on plastic-coated transparent film. In the bottom photo, the film is projected through an adapted movie-film projector.

Thermoplastic Recording

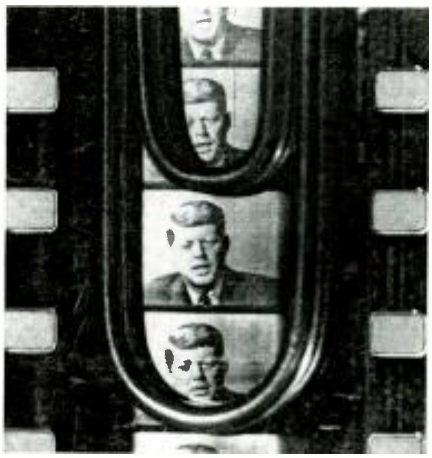
New laboratory technique transforms TV picture signals into wrinkle patterns on charged transparent movie-like film — produces electrical signals and optical images.

MINUTE wrinkle patterns applied electrostatically on transparent movie-like film form the basis of a new laboratory technique called "thermoplastic recording." This unique process combines special electronic recording methods to create an image that can be projected with a slightly modified movie-film projector. The system, demonstrated recently for the press by *General Electric* laboratories, was able to record video signals from a TV set on special movie-like film. The film was played back on a small motion-picture projector modified with a special optical system. The quality of the reproduced images was fairly good although they were marred by surface imperfections and scratches on the film. Information on signal-to-noise capabilities was not available.

It was emphasized that this is a laboratory development and commercial products using the technique are still in the future. Experimental recorders designed for military applications are expected by year's end.

Dr. William E. Glenn, the inventor of the system, said that recording bandwidths of about 50 mc. are possible with his system at film speeds of only 5 ips. This is about 10 times the bandwidth available with present video tape. No chemical processing is required, and the film can be erased and reused many times. The inventor said further that the new system should be inherently far simpler and less costly than other methods used to record TV pictures. Colored images may also be produced by means of the technique.

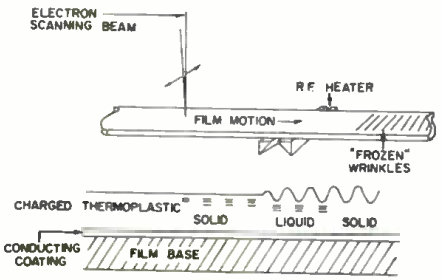
The recording process uses a special thermoplastic tape or film that has a base similar to standard motion-picture film. The surface of the thermoplastic is charged by a scanning electron beam in a pattern corresponding to the picture to be recorded. As the film moves through the recorder, a current induced in the transparent conducting coating by an r.f. heater heats the film and melts the plastic. The charges are attracted to the conducting coating and depress the surface of the film. After the surface has been deformed by the charges, the film is allowed to cool; this freezes the ripple pattern in place. Erasing is accomplished simply by reheating the film. —30—

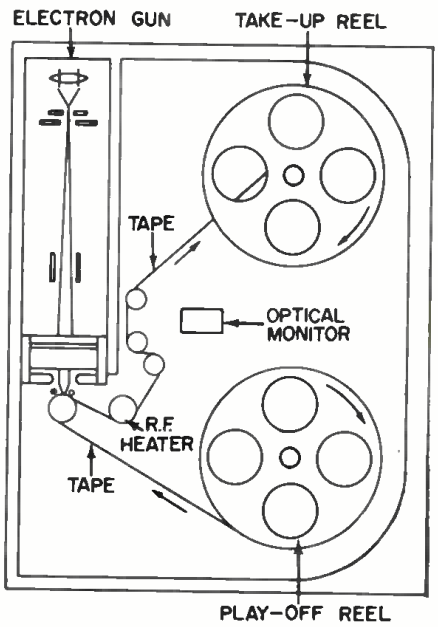


Each frame of thermoplastic record is less than a quarter inch wide and fits easily within an ordinary paper clip.

(Right) Front-panel drawing of the new recorder. This assembly operates in a vacuum behind transparent front cover.

(Below) The tape or film moves past a scanning beam that lays down a charge pattern. Wrinkles following this pattern are produced when the plastic layer is melted, then allowed to solidify.





Know Your Electronic Chemicals

PART 2

By **WALTER H. BUCHSBAUM**
Industrial Consultant, ELECTRONICS WORLD

Properties of cements, lubricants, insulators, miscellaneous chemicals. Choosing the right one.

IN THE preceding article describing cleaners and solvents and their applications, the point was made that the choice of the right chemical for each job was highly important. This principle applies with equal force to cements and lubricants, of which there is considerable variety. The advantages and limitations of each and how they should be used are important to know, especially with respect to the several types widely available at local parts distributors. In addition, the user often has to be aware of certain preparatory steps that are required before certain cements may be used successfully.

How to Cement

Practically every type of glue or cement is intended to work on either chemical or mechanical principles. Special-purpose cements usually form a chemical union with the materials they are supposed to hold together. General-purpose cements hold materials together by adhesion due to surface tension, capillary action, vacuum (suction), or some other mechanical property. One precaution will become apparent from a brief consideration of the first principle of cementing. When the cement itself is intended to react chemically with the material to be glued, accidental application to good parts of the material can result in spots or stains that may be permanent. If, for example, we spill a few drops of polystyrene cement on a styrene cabinet, this will soften and wrinkle the surface, in a few seconds, beyond repair. Cements intended for mechanical adhesion can also cause spots, especially if their solvents affect such substances as wood finishes. A good example is the use of "Pliobond" for gluing fabric to wood. The "Pliobond" solvent is methyl-ethyl ketone, which will attack most wood finishes but will not affect such plastics as Bakelite.

In the cross-section drawings of Fig. 1, we see how the basic glues work. First (Fig. 1A) is the case of similar plastics glued by the same material. This results in a continuous piece of one material. In fact, the repaired spot may be stronger than the rest of the plastic, since this particular point is likely to be thicker than the rest of the material.

When two different plastics or other substances are cemented by a third material, the adhesion on each side may be due to the action of a solvent that attacks both materials, as in Fig. 1B. Capillary-action glues for holding porous materials and "vacuum" (suction) adhesives for joining smooth surfaces are shown respectively in Figs. 1C and D. In either case the cement must harden to form a strong and tough joint.

Whether chemical reaction or physical action is involved, the cement will not work properly if the surfaces to be joined are not clean. The least that is required in any type of cement job is that all dust and surface grime be removed. In some instances it helps if the surface is sanded down slightly or otherwise roughened. Occasionally the cement (or its solvent) can itself be used to clean off the surface before the final coat is applied. Before using any chemical, it is always worthwhile to read the instructions. Here are some helpful hints for any cementing job:

1. Clean surfaces well. 2. Prepare in advance clamps, a vise, or another method for holding the work while cement dries. 3. Keep a clean rag at hand. Use old newspaper or other waste as a base for the job so that dripping cement will not ruin anything. 4. Apply cement sparingly and only to the surfaces to be cemented. 5. Fix cemented pieces into position quickly and clean off excess cement at once. 6. To speed drying, an infra-red lamp, a fan, or both may be used, but be careful not to heat plastics too much.

Types of Cements

Those cements that form a chemical bond are usually used to glue specific plastic materials together. They are very effective and, if properly used, the new bond can be stronger than the orig-

inal material. It is important that the right material and the corresponding cement be used, since otherwise the desired chemical fusion will not take place. For example, it would be futile to cement two pieces of Lucite (an acrylic) with vinyl cement. The latter adhesive, however, will practically weld vinyl pieces together so that they are permanently joined.

In the mechanical or physical type of cementing, surface roughness and porosity are the most important factors. If we want to glue a piece of vinyl to an acrylic, then neither vinyl nor acrylic cement should be used, but a plastic "all-purpose" cement, or even a rubber-base glue, could work. The catch here is that the bond will never be as strong as if two similar plastics had been joined with their common-base glue. In other words, we can glue rubber strips to Lucite, but they will not hold as well as if a Plexiglass or other acrylic had been glued with acrylic cement to the Lucite.

Special plastics cements are available at radio parts jobbers to work with seven basic plastic materials. These adhesives, together with the materials with which they react (in parentheses), are as follows:

1. Acrylic (Lucite, Plexiglass). 2. Epoxy (various laminates including fiberglass, printed-wiring board coatings, sockets). 3. Nitrocellulose (clear plastics such as celluloid). 4. Phenolic (Bakelite, as used in knobs, coil forms, insulators). 5. Polyethylene (plastic tubing, cabinet coverings). 6. Styrene (polystyrene, used in coil forms, cabinets). 7. Vinyl (tubing, cabinet coverings).

These plastics are very common in electronics and occur in all types of equipment. One difficulty is that these materials are used for such a wide variety of things that it is often difficult to tell what kind of plastic is involved in a particular broken item. Here are some hints:

Phenolics can take quite a bit of heat, but they start to give off a very characteristic odor long before they burn. Anyone who has ever smelled a composition resistor in the early stages of overheating should be able to recognize phenolic ever after. The odors of acrylic, styrene, and vinyl are also quite distinctive when a hot soldering iron is applied to an inconspicuous corner of the material. Epoxy is hardly affected by the soldering-iron test and also does not react very much to any of the conventional solvents. Nitrocellulose has a "celluloid" odor even without any heat, and is easily attacked by acetone and similar solvents.

Despite the many plastics for which cements are readily available, there are a few that cannot very well be glued together. Nylon, Teflon, silicon rubber and similar "special" materials will defy most conventional chemical and physical glues. There are special cements designed for some of these materials, but they are generally available direct from the manufacturers only, and usually in large quantities only.

Some of the plastic cements also have excellent insulating properties; accordingly many of these are prepared and sold as preparations designed specifically for that purpose. Polystyrene, also often known as "Polydope," "Q" dope, or coil dope, is excellent as a high-frequency, low-loss insulator. It is used on coils to hold the wires in place and, at the same time, serves as insulation between wires. Other plastic preparations, such as krylon, an acrylic, can be sprayed into high-voltage areas to coat critical points and improve the insulation. Still another insulating application is the coating of antenna terminals to keep out moisture.

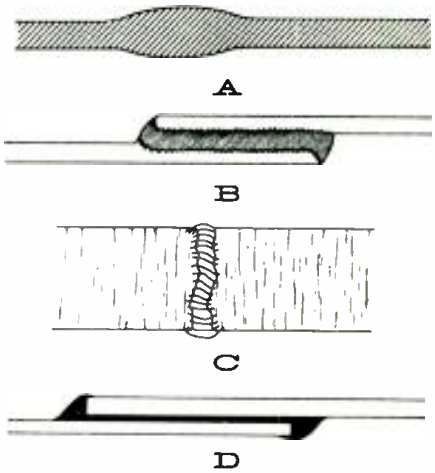


Fig. 1. Most glues bond the surfaces they bring together by one of four basic types of holding action. Illustrated here, they are explained in the text.

The cements that depend on mechanical adhesion are also widely used in electronics: some of them are essentially plastics as well. As a matter of fact, nitrocellulose glue is more popularly known as "service cement," because it is used for anything from speaker repair to a substitute for wood glue. In the latter use, it does not provide a particularly strong bond, but often a bond that is less than full strength is sufficient. The various cements available as "plastic cement" or "general-purpose cement" (like "Duco") operate on a physical rather than chemical principle. These adhesives are especially useful when materials of different nature are glued together. Of special utility is "Pliobond" or similar rubber-based glues, which can be used to glue rubber, fabric, plastic, metal, and even glass. This does not mean that they will mend broken pieces, but rather that a strip of metal can be glued to another strip of metal (or glass, or plastic) and that the bond is fairly strong. In using this type of cement it is often necessary to apply several coats to materials that have a rough and porous surface before the final gluing is done.

A notion as to the wide range of available preparations may be derived from the group shown here, a relatively small sampling from a single manufacturer's line. From left to right we have one of several types of cement, a lubricating oil, soldering flux, a solvent or remover for some types of finishes and plastics, and a preparation for dressing dial and drive cords.

How Lubrication Works

Actually, the principle of lubrication is simply to "float" the moving part on the lubricant. This means that the lubricant is placed between two or more surfaces subjected to wear and, because the lubricant is essentially liquid, friction between the two solid pieces is minimized. This principle works as well in a shaft bearing as on a contact wiper arm. From it we see at once that, where electrical contacts are lubricated, the lubricant should be electrically conducting.

We also see that the viscosity, or "degree of flowing" of the lubricant, is

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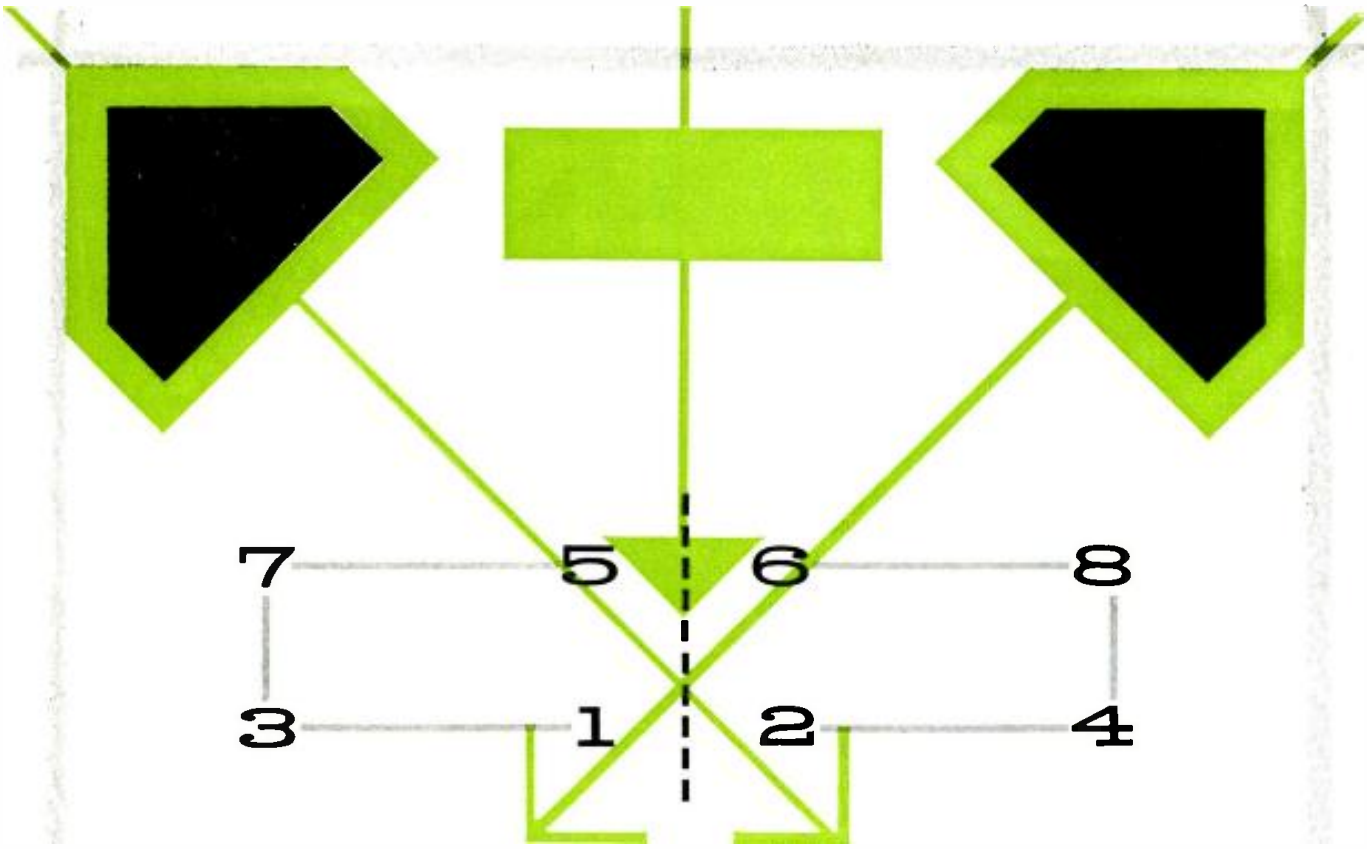


More About Wide-Stage Stereo

By **PAUL W. KLIPSCH** / Klipsch and Associates, Inc.

For stereo coverage of a wide listening area the addition of a center channel speaker along with a pair of corner speaker systems is recommended.

STEREO ENHANCES reproduced sound by supplying the sensations of depth, improved definition, and enlargement of apparent volume of the listening room.

Defining "high-fidelity" as the accurate reproduction of original tonality has its counterpart in stereo as the accurate reproduction of the geometry of the original sound. The two should convey to the listener the mental picture of the original sound, both in tonality and geometry. The essentials of stereo are:

1. Breadth or apparent width of the sound source.
2. Spatial continuity or a continuum of sound rather than several point sources.
3. Directionality or the ability of the observer to locate sounds across the stage in approximately the locations as originally generated.

Steinberg and Snow[1] showed that three sound channels were necessary and sufficient to achieve a reasonable approach to these requirements. Experiments by this writer confirm their conclusions, including the feasibility of deriving three channels from two sound tracks.

Two-Speaker Stereo

The author's own early experiments in stereo led to the conclusion that if two speakers were far enough apart to produce a satisfactory stage width, there was a tendency toward a two-source effect.

In a 16 foot by 25 foot room, the various arrangements of speakers shown in Fig. 1 were tried. In Fig. 1A, the stereo effect was noted only at close proximity to the array; in Figs. 1B and 1C, the listening distance was greater but the two-source or "hole-in-the-middle" effect was objectionable. In Fig. 1D there was a lack of stereo effect while in Fig. 1E, the stereo effect was evident, but the dependence on wall reflections resulted in poor mid- and high-frequency response and a hole-in-the-middle. In all cases, focus of a soloist was possible only for one

listener on the axis of symmetry.

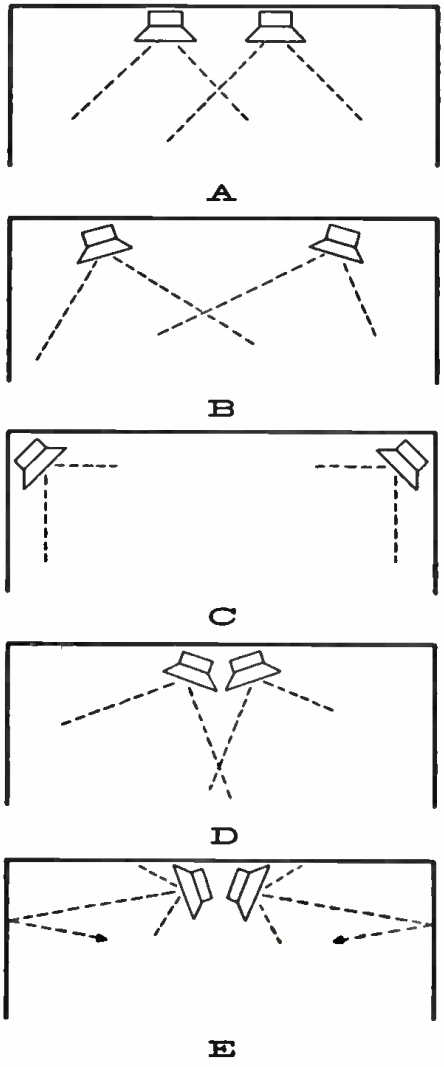
Phantom Center Speaker

The derivation of a phantom center channel has been the subject of a number of articles but seems to have been done first by Steinberg and Snow in 1933. The manner of derivation has been discussed in various publications.[2,3,4]

Qualitatively, the derived third channel resulted in retention of the geometric integrity of a string quartet and a large orchestra; a soloist standing some six feet to the left of the podium was reproduced a little to the left of the center speaker.

Quantitively, a study was made of the geometry of reproduction.[3] Sounds were generated in the pattern shown in Fig. 2A. With a two-speaker playback, an observer plotted the apparent sound sources as shown in Fig. 2B. With the three-channel playback using the derived center channel, a typical observation was that of Fig. 2C. As a "control" the same observer listening to the original sound (not over the loudspeakers) plotted the apparent sources as shown in Fig. 2D. The sounds were generated by a person speaking at the indicated locations, outdoors, and reproduced in a 16 foot by 25 foot room with speakers on the 25-foot wall. The results in Fig. 2D were obtained with the observer wearing a hood so he could see to plot his results but could not see the person speaking at the indicated locations.

Fig. 1. Arrangements used in experiments.



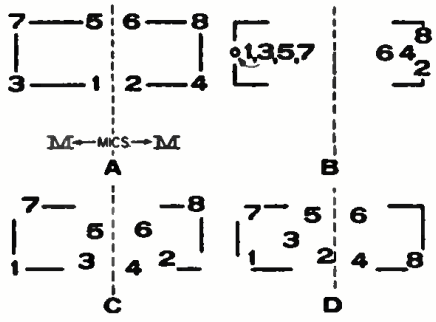


Fig. 2. (A) Actual locations of sound sources. (B) Apparent locations with two speakers. (C) Apparent locations with center speaker added. (D) Apparent locations during live listening experiment.

Observers as much as 11 feet off-axis plotted results which were almost as accurate as those shown. This corroborates the work of Steinberg and Snow, indicating only small shifts of the virtual sources as the observer moves in front of a three-channel array.

Phantom-Channel Theory

The philosophy behind the phantom-channel technique may be stated as follows:

If two microphones are properly placed relative to each other and to the sound source, their combined output is that of a single microphone in the middle; this microphone "that wasn't there" can be reproduced by re-combination. The output of an actual third microphone can also be recovered by re-combination.

In practice, this combination may be accomplished by simple addition. The theory of the third channel derived from two sound tracks is still being developed, but it appears that crosstalk is subordinate to signal mutuality. (Crosstalk is the inadvertent transfer of signal from one channel to another; signal mutuality is the natural consequence of one microphone in a stereo array picking up signals pertinent to other microphones.[7])

The fact that the center channel carries sound from the flanks as well is true whether the channel is derived or independent. Experience shows that with proper adjustment of levels, a high degree of accuracy of geometric reproduction may be obtained with either the derived or independent center channel. As little as 2 db can produce a shift in the virtual sound source.

Speaker Placement

In the experiments involved with Fig. 2, the flanking speakers were placed in corners. This was deemed desirable for improved stereo geometry and also for improved tonality. Referring again to Figs. 1A, 1B, and 1C, no sound appears to come from outside the speaker array. Although the arrangement of Fig. 1E produced a "wide-stage" effect, it could not fulfill the requirements either of good geometry or good tonality. Thus, the arrangement of Fig. 1C plus a center channel was regarded as the only feasible array.

Monophonically the speaker response is improved by corner placement as a result of: 1. Complete room coverage with 90-degree tweeter radiation angle; 2. Better tonality or response; and 3. Accuracy in the lower three octaves of response.

Fig. 3 illustrates the benefits to be derived from corner placement—as far as tonality is concerned. A 15-inch driver unit in a 6.7-cubic-foot closed box on legs was tested four feet from the walls at a corner, on the floor in the same place, and on the floor in a corner. The curves show the responses for these various locations. Most no-

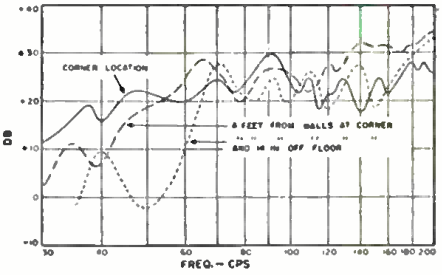


Fig. 3. Bass response of speaker system.

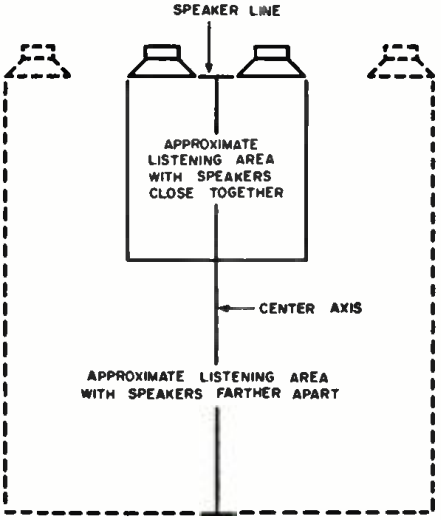
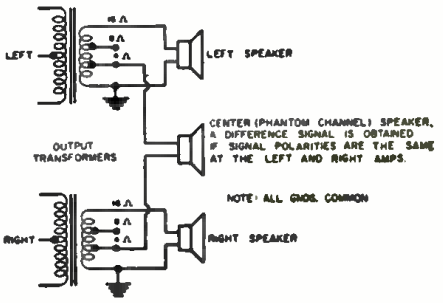


Fig. 4. Increase in area of stereo effect.

Fig. 5. Simple method of obtaining the phantom channel after the power amplifiers. Speakers have 16-ohms impedance and equal efficiency. Connection to 4-ohm tap results in half (3 db less) power to center speaker.



ticeable is the improvement below 60 cycles, but actually of comparable importance is the smoothing out of the 100-200 cycle range.

One must conclude from this that tonality and geometry demand corner placement of flanking speakers.

An experiment, not reported elsewhere, concerns a corner center speaker with wall-type flanking units, arranged in an "L" configuration. It was found that the geometry of reproduction was unnatural. Attempts to bring the center unit into proper geometry by increasing its signal input had the effect of causing it to "jump forward" into monophonic prominence. It is believed that the delay effects of some 5 to 10 milliseconds cannot be compensated successfully by increasing the volume, at least experience thus far negates the use of this configuration.

Corner placement permits the maximum separation and consequently the maximum listening area. The listening area is proportional to the square of the distance of speaker separation. (Refer to Fig. 4).

Outdoors, two speakers seven-feet apart could be detected as "stereo" at a distance of more than 50 feet.[5] Indoors, the distance decreased, with 14 feet providing *barely discernible* stereo effect. The maximum satisfactory listening distance was about 7 to 10 feet. Wider speaker placement insures adequate angle while addition of the center channel insures proper focusing so that the angular stage width becomes that of the original sound. Recall that the string quartet and soloist were properly located on playback as well as with a large orchestra.

Microphone Placement

Early stereo demonstrations appear to have concentrated on spectacular effects rather than reproduction of true stereo geometry. One such appears to have achieved a "three-peephole" playback effect by placing three microphones too close to the three separated sound sources.

Most current tapes and discs apparently have been cut using microphone placement which is compatible with three-channel playback. The bulk of this author's experience has been with two microphones. The current trend toward recording three sound tracks and later dubbing these to two involves a technology which is an art and science in itself. It is possible that microphone techniques which are capable of improving two-channel playback will offer even greater benefits in playback using three channels.

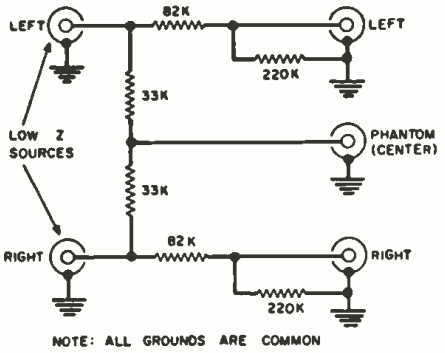


Fig. 6. Deriving the center channel.

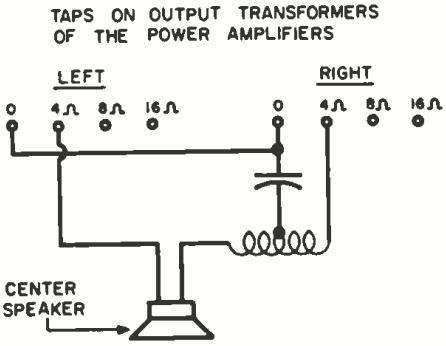


Fig. 7. Method proposed of combining the same polarity signals without cancellation.

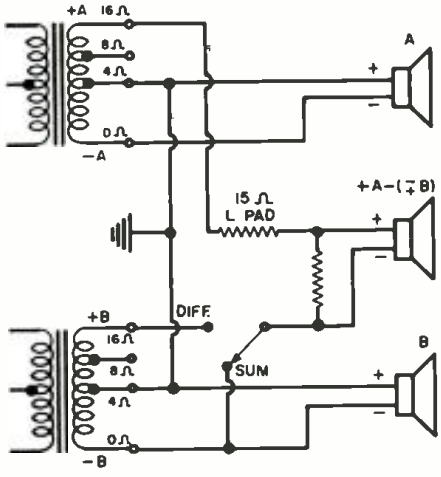


Fig. 8. This circuit may upset feedback ratio and cannot be used in all amplifiers.

Deriving the Phantom Channel

The re-combination to derive a center channel may be accomplished in various ways. The original circuit[2] is shown in Fig. 6. This represents a "sum" combination while the "difference" circuit is shown in Fig. 5.

Systems using only two power amplifiers are based on intrinsic amplifier stability (precluding types using "damping control" or other forms of positive feedback).

Some recordings have been encountered in which focus of the center channel required a "sum" re-combination while others required a "difference" treatment. This option may be taken using the circuits of Figs. 7, 8, and 9. Fig. 9 employs the *Electro-Voice* XT-1 1:1 transformer. Fig. 7 involves the use of a special coil which is still in the experimental stage and not currently in production. It is believed the frequency at which 90-degree phase shift occurs should be placed at about 100 cycles.[4]

Fig. 8 derives the "sum" or "difference" without the exciting current and possible distortion of an additional transformer or coil. Fig. 10 shows a "sum" signal derivation using a preamplifier which permits a polarity reversal. ("Polarity" is used here rather than phase. "Phase" is the angular relation between two directed quantities where the angle may be any value while polarity applies to the special case where phase angles are confined to 0, 180, and 360 degrees.)

All of the circuits, except that employing three amplifiers, assume speakers of approximately the same sound pressure output per volt of input. Im-

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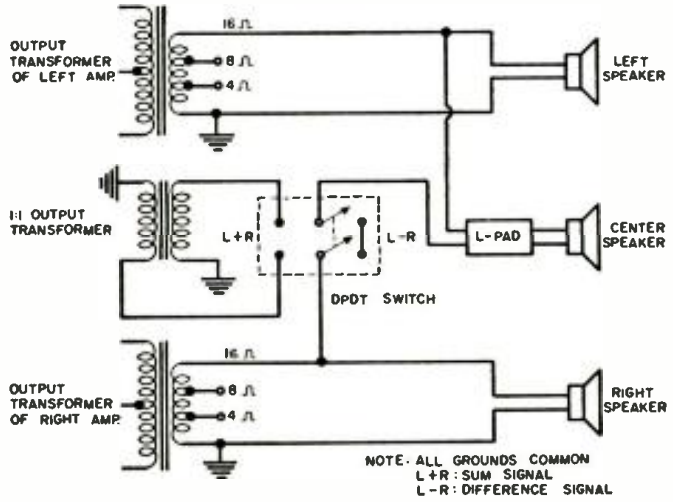
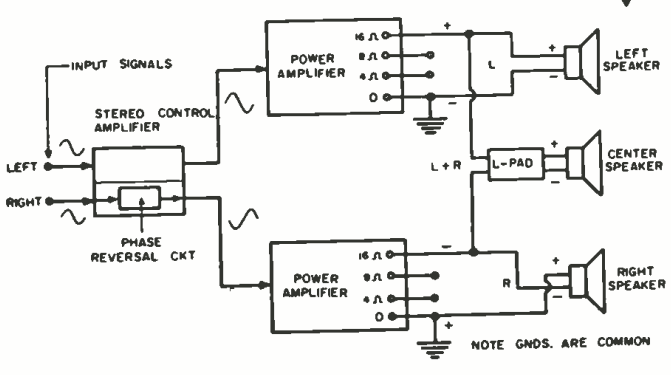
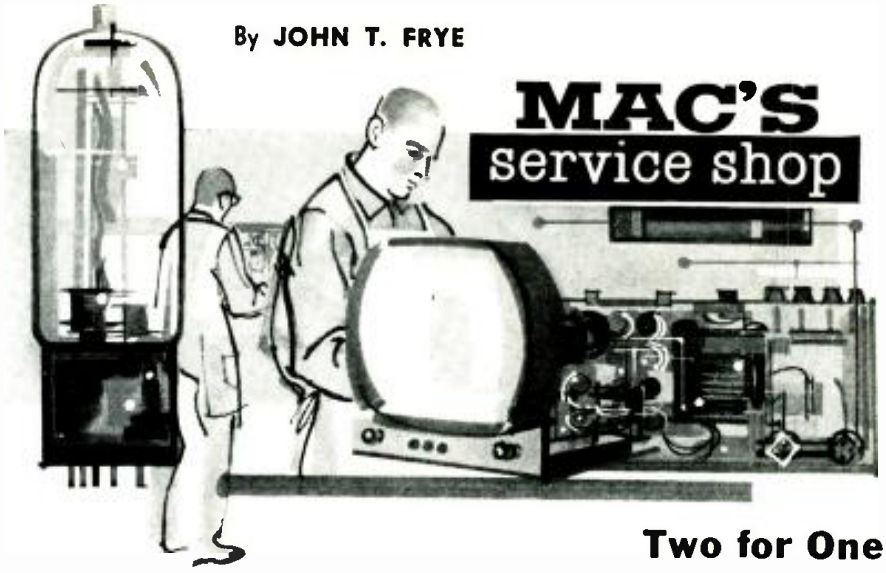


◀ Fig. 9. Another method proposed by the author to obtain a sum and difference phantom-channel signal with 1:1 transformer.

Fig. 10. Method of obtaining a sum signal from two power amplifiers by first reversing phase of one of the input signals. ▼



By JOHN T. FRYE



MAC'S service shop

Two for One

OUTSIDE it was a stormy March morning. The howling wind, laced with driving snowflakes, shook and rattled the heavy "Radio & TV Service" sign over the door of Mac's Service Shop. Inside things were a little stormy, too, at least with Barney, the red-headed Number Two man of the service establishment. He stood a couple of feet away from the bench and bent his lanky body at the hips into an uncomfortable-looking right angle so he could rest his elbows on the bench and cup his chin in his hands as he scowled fiercely at the little a.c.-d.c. chassis in front of his nose.

"Is all that muttering and sighing and flouncing around your subtle way of sending up distress signals?" Mac, his employer, asked with a teasing grin.

"Of course not!" Barney retorted. "Can't a man stop to think without some joker's supposing he's asking for help? The complaint—well justified, incidentally—on this little fiend is that it picks up all sorts of code, teletype-writer, and other short-wave signals right along with the broadcast band it is supposed to tune. The condition is said to be much worse at night than in the daytime; so wouldn't you know the woman who owns the set is an insomniac who does most of her listening in the early morning hours!"

"That figures," Mac said with a nod. "What have you done so far?"

"Changed tubes. Checked the a.v.c. bypass. Checked the loop antenna for short-circuits or poor connections. Checked the oscillator grid voltage. Checked the oscillator waveform with the scope. Everything is perfectly OK."

"Why did you check the oscillator waveform?"

"I thought maybe it was putting out exceptionally strong harmonics that were causing the trouble. In such a case I'd expect the oscillator waveform to depart noticeably from a sine wave."

"Sounds logical, but I doubt the oscillator is causing the trouble. Almost any oscillator will have strong enough harmonics well down in the short-wave region to heterodyne strong signals there to the i.f. frequency if these signals are allowed to reach the converter signal grid. Normally these high-frequency signals are kept from the grid of the converter by the selectivity of the antenna tuned circuit. This parallel-resonant circuit between the input grid and cathode of the converter is tuned to the broadcast band and has a very high impedance at its resonant frequency. Short-wave signals in the region of several megacycles should find a very low capacitive reactance through the tuning capacitor and so be short-circuited to the cathode. Let's radiate a signal from a loop of wire connected to the output of the signal generator and see if we can find what high frequencies are getting through."

Barney set up the signal generator and a little tuning quickly established that signals in the vicinity of thirteen megacycles were the ones causing the trouble. When the chassis of the a.c.-d.c. receiver was touched with a finger, these interfering signals became much louder. Mac was studying the diagram of the receiver while Barney was running these tests.

The input of the converter stage was a little unusual. The tuning capacitor frame was grounded to the chassis and the antenna loop was connected across the r.f. section of this capacitor. A small mica capacitor connected the hot side of the tuned circuit to the grid of the converter tube. The a.v.c. voltage was fed to this signal grid through a decoupling resistor, the bottom end of which was bypassed to "B−." A coil of wire in series with a .1-μf. capacitor was labelled an "r.f. filter" and was connected between the chassis and the "B−" point to which the converter cathode was returned.

Mac took the grid-dip oscillator and its set of coils from a cabinet and put one of the coils in the instrument. Then he turned the receiver chassis over and pointed to a .1-μf. paper capacitor with a few turns of wire wound around one end. "See if you can find a resonant frequency for this coil," he said as he handed the grid-dipper to Barney.

"I sure can!" Barney soon announced; "and it's at thirteen megacycles."

"Fine! Now short out that little coil and let's see what happens."

When this was done, leaving only the .1 μf. capacitor between chassis and "B−," the unwanted signals disappeared. Broadcast reception was just the same as before, but the annoying birdies were completely gone, even when the full output of the signal generator was fed into the loop of wire.

"Now how did you know about that?" Barney demanded.

"Because I ran into exactly the same thing on one of these sets not more than three months ago," Mac confessed with a chuckle; "and I'll admit it had me 'bugged,' as you would put it, for quite a while. I ran it down with the signal generator, the grid-dipper, and the diagram, just as you did.

"You see that series-resonant circuit made up of the capacitor and the little coil of wire wrapped around it is supposed to be broadly resonant at the i.f. frequency so as to offer a very low-impedance path between the chassis and 'B−' at that critical frequency; but the joker is that the coil and its distributed capacity form another parallel-tuned circuit resonant at 13 megacycles. This acts as a barrier between any 13 megacycles signal on the chassis and 'B−.' On the other hand the low impedance the tuning capacitor presents to this high-frequency signal allows it to go to the converter grid, to heterodyne with a harmonic of the oscillator, and to pass right on through the i.f. amplifier along with the broadcast signals being received. Short-circuiting the coil or removing it allows the 13 megacycle signal to go to ground and so prevents the trouble."

"You know," Barney said slowly, "I should have remembered that it's easy to get two resonant circuits for one combination of a coil and capacitor—one series-resonant and the other parallel-resonant. That's at the bottom of a lot of parasitic oscillation troubles that plague transmitters."

"I am never quite easy about having to make a change in a manufacturer's circuit," Mac continued; "so I wrote the service department of the people who made the receiver. They sent back a service note mailed out to their dealers some months ago in which they described the self-same symptom and recommended that the coil be removed to correct it. I didn't recognize the set without its cabinet until I started studying the diagram; then I decided it would make a stronger impression on you if I had you track down the cause of the trouble step by step."

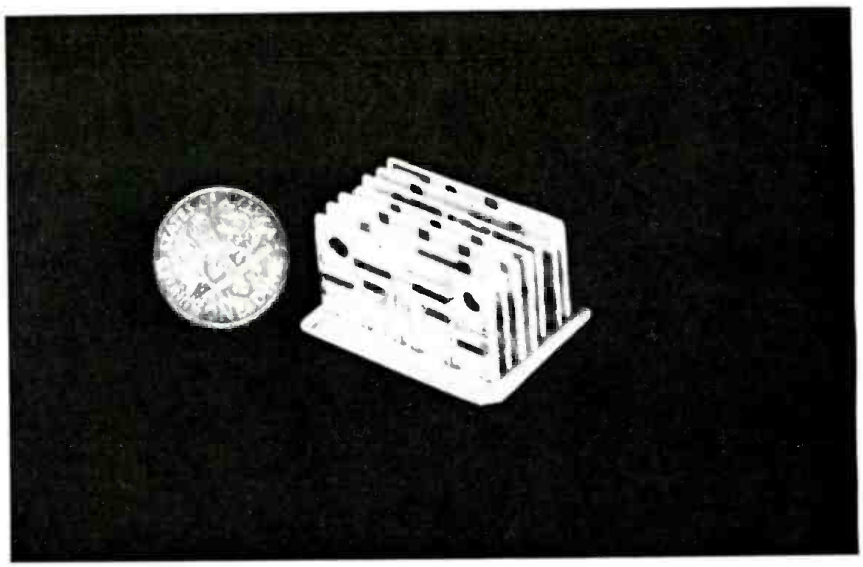
"Gee, thanks loads!" Barney said sarcastically. "Now, Doctor, I have a question for you: of two equal lengths of wire of the same diameter, one of copper and the other of gold, which will have the least resistance?"

"I suppose the gold one," Mac replied.

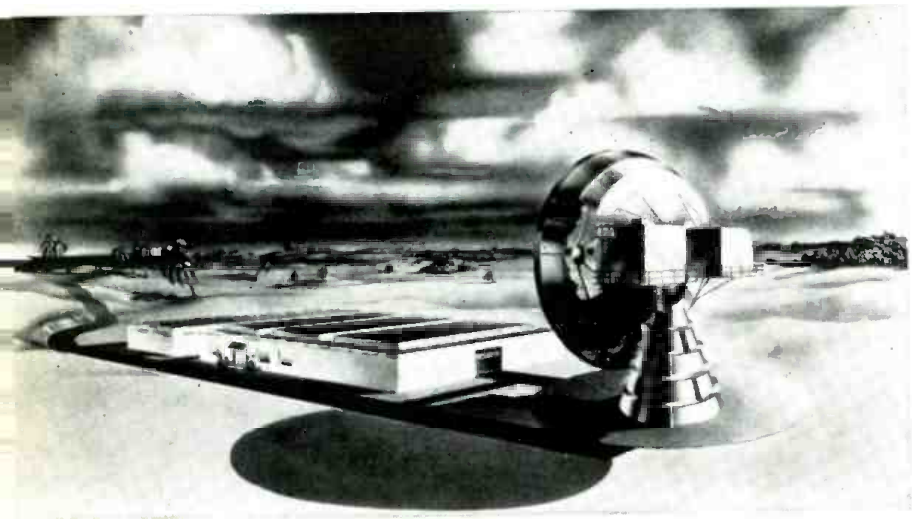
(*Continued on page* 128)

Microminiature Circuits

The first model of a complete adder circuit for use in a ballistic missile computer is shown full size in the photo. The unit, made up of 7 ceramic-plate circuits, has been reduced by fifty times in volume over the smallest package that has been made with conventional parts. Some 85 components (resistors, capacitors, and transistors) are in the ½" x ½" x 1" package. All components except the transistors are presently available in commercial quantities from *Aerovox Corp.*, and the transistors will soon be available. Ceramic base plate circuits may be interconnected as shown or contacts at one or more of the edges may be used with special connectors. The whole unit can be hermetically sealed if required.



recent developments in electronics

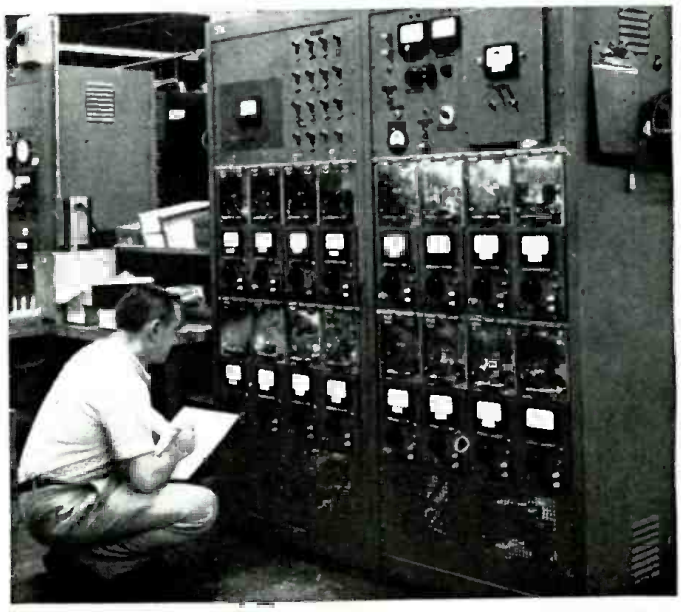


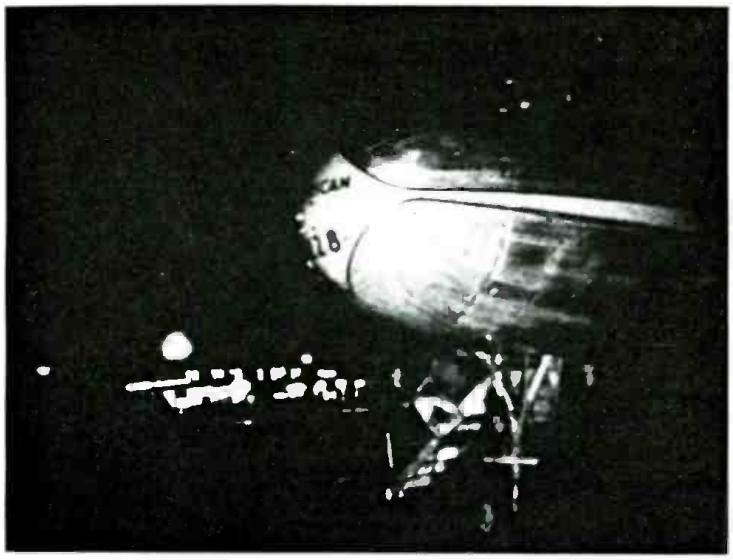
Five-Story Tracking Radar

This huge unique radar, designed to track ICBM's at a distance of thousands of miles, will be developed for the Advanced Research Projects Agency by the *Raytheon Co.* The five-story high antenna, which fires a narrow pincushion-shaped microwave beam from the radar transmitter, weighs 80 tons. The new radar will be one of the nation's longest range precision units. Scheduled for late-1961 delivery, the radar is to be used in conjunction with missile test firings in the Pacific.

Tester for Guidance-System Tubes

Electron tubes which have key functions in the guidance systems of missiles such as the "Jupiter" and "Atlas" undergo a rigid testing program at *General Electric's* power tube plant at Schenectady, New York. Test operator is shown checking microwave triode tubes that are undergoing a 500-hour pulsed life test under actual operating conditions. Tubes are checked every 48 hours for power output. The complete testing procedure lasts for some 500 hours.





Super-Sensitive TV Camera Tube

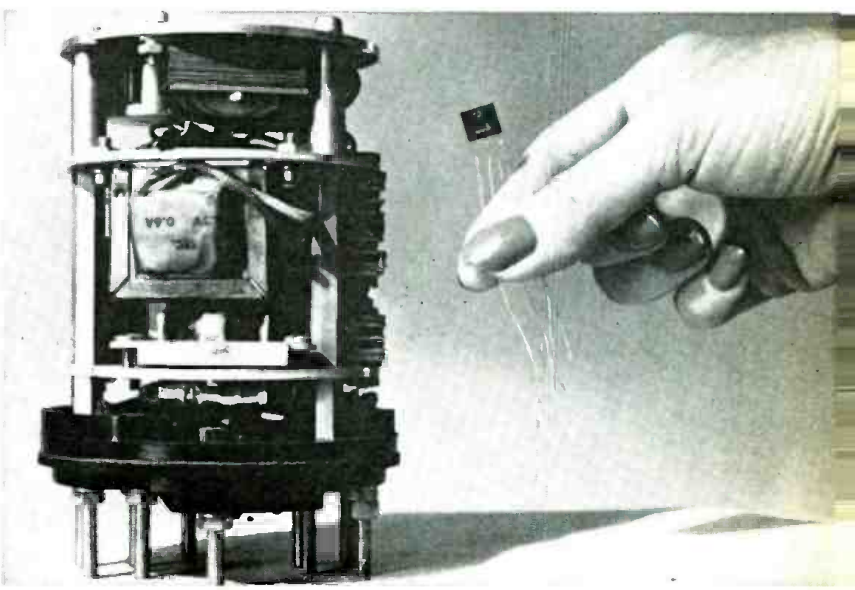
A new super-sensitive TV camera tube, type GL-7629, has been released by *G-E*. The new image orthicon is physically and electrically interchangeable with a standard camera tube, but it requires from 1/10 to 1/20 the light needed by standard tubes now in use. It can produce usable pictures at one footcandle of illumination. Photo shows the same scene televised with a standard orthicon (left) and with the new tube (right). Tube shows great promise in color work.

Missile Circuit Assembly Aid

This new rotary wheel has replaced the standard assembly line workbench in assembling small missile electrical and electronic components at *The Martin Co.* The wheel has 24 assembly positions and automatically rotates clockwise at a predetermined rate as three operators, working as a team, assemble components (in this case demodulators). A power-operated rotary switch permits remote control of special electrical circuits for stepping, counting, and selecting.

Hall-Effect Power Transducer

Hall Effect refers to the generation of small voltage due to the displacement of positive or negative charges within a material in a magnetic field. Employing this principle, *Westinghouse's* new Hall multiplier is employed as a power transducer, being used to convert a.c. watts to a d.c. millivolt control signal. This signal may be applied to a control device or to a telemetering transmitter. The new transducer has a much higher speed of response than the thermal converters usually employed.



Signal-Powered Audio Compressor

By **ED C. MILLER**
Technical Director, Inland Broadcast Co.

Construction of simple volume compressor for recording or communications; entirely powered by audio signal.

A GERMANIUM diode is referred to as a "non-linear" device because current flows much more readily in one direction than in the other. But it is also non-linear in another respect. As the voltage across such a diode is increased from zero in the direction of maximum current flow, the current does not increase linearly. In a 1N64, for example, the current increases as shown in Fig. 1. This characteristic means that at different amounts of applied voltage, the alternating current impedance of the diode varies widely. The diode impedance is measured in the same manner as the plate impedance of a vacuum tube, that is: $R_p = \Delta E_p / \Delta I_p$.

If an audio signal is applied, through a series resistor, to such a diode and the d.c. voltage across the diode is changed, the signal across the diode will also change, becoming smaller as the d.c. voltage is increased. If the d.c. voltage is varied in direct proportion to the applied audio signal, an automatic gain circuit, or volume compressor, results. In fact, the d.c. voltage may be obtained directly from the applied audio signal by rectification and filtering.

A circuit to accomplish this is shown in Fig. 2. Here CR_2 is the diode compressor, getting its audio signal through the series resistor, R_S. CR_1 acts as a rectifier, converting some of the audio signal into pulsating d.c., which is filtered by R_A and C, and the resulting smooth d.c. applied to the compressor diode (CR_2) through resistor R. As the audio signal is increased, the d.c. voltage to the compressor diode is increased proportionately. This reduces the impedance of CR_2 and hence increases the loss in the network R_S and CR_2.

Within certain limits of frequency response, attack and release times, such a circuit may provide an almost constant output (within 1 db) over an input change in excess of 20 db. As there are many types of such diodes, and most of them can be adapted to such a circuit, the design considerations are important if the particular characteristics of the individual diode are to be used most advantageously.

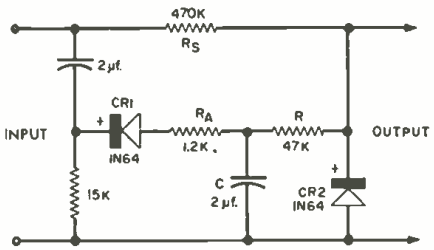


Fig. 2. Schematic of compressor used.

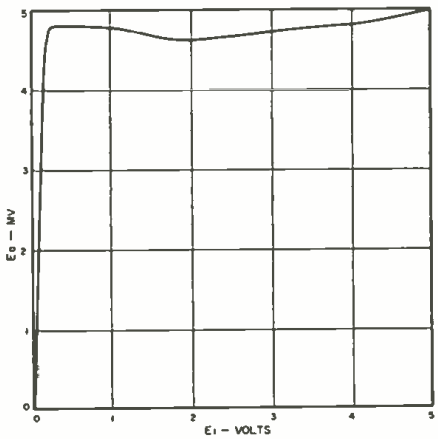


Fig. 3. Input-output curve of circuit.

First, from the voltage-current chart for the desired diode, the area of most linear compression is determined graphically and the extremes marked "A" and "B." The impedance of each of these points is also determined graphically. From Fig. 1, for a 1N64, Z_B is about 454 ohms and Z_A is approximately 5000 ohms. This is slightly more than 20 db impedance change. This circuit, naturally, has a loss, the amount of which is determined by the diode impedance and the value of series resistor R_S. The larger the value of R_S, the greater the loss. It is therefore desirable to keep R_S as small as possible, but if it is too small, the audio signal appearing across the diode will be sufficiently large that the impedance seen by the signal will vary considerably between the positive and negative portions of the cycle, introducing distortion. Again, from the chart of Fig. 1, an output voltage (E_o), that is, audio voltage across the diode, is chosen to appear fairly linear. For example, 5 or 6 millivolts would appear suitable over the range of compression. For the purpose of calculation, let us use 6 millivolts for E_o. This will be used in determining the value of R, later.

The resistor, R, is chosen to have a certain maximum effect on the diode curve between Z_A and Z_B. If the maximum effect of R on the diode curve is to be 1 db, the ratio is 1.122. As far as the audio is concerned, R is in parallel with CR_2, so its maximum effect on the total output impedance will be at the largest value of diode impedance, or Z_A.

Thus, $R = Z_A / 0.122 = 41{,}000$ ohms.

(Continued on page 140)

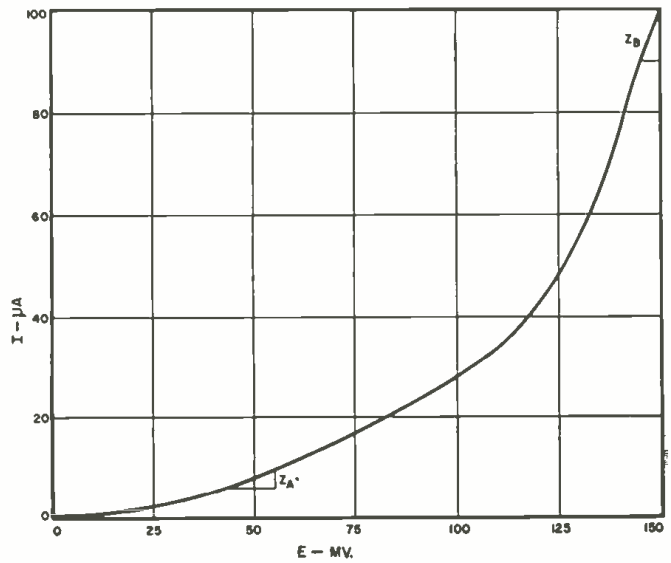
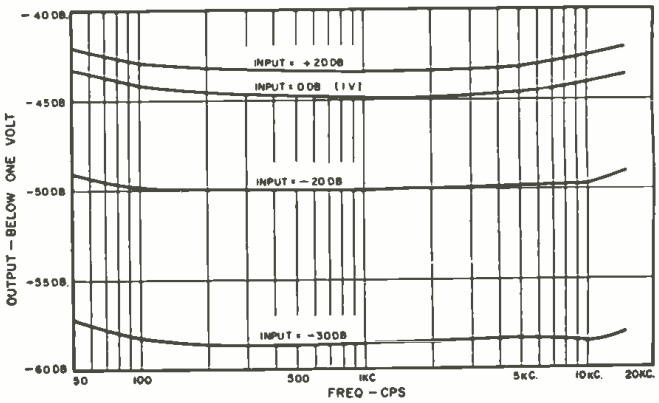


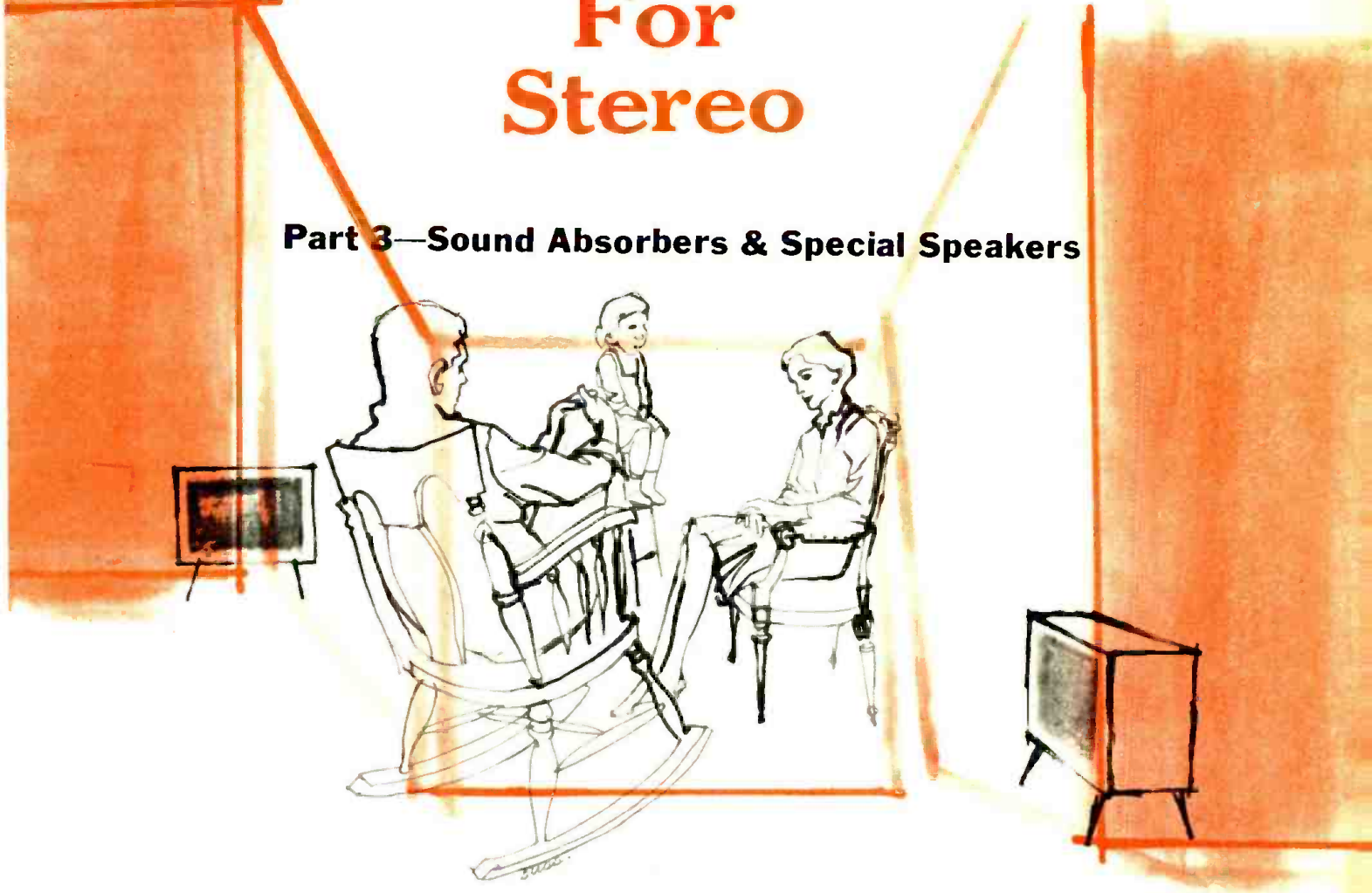
Fig. 1. Voltage versus current characteristics of the 1N64 diode. Note the different impedance values at different operating points.

Fig. 4. Audio frequency response curves at various input levels.



Room Acoustics For Stereo

Part 3—Sound Absorbers & Special Speakers



By **ABRAHAM B. COHEN** / Advanced Acoustics Corp.

Practical methods of tailoring room acoustics for the best stereo performance. Various speaker setups are covered.

THE static effectiveness of the acoustic condition of a room is determined by the room structure and its furnishings. However, it may be greatly affected by many factors such as the number of people in the room, the type of program being reproduced, and whether windows or doors leading into the room are open or closed. As discussed in Part 2 of this series, this condition can be kept under control by means of variable sound absorption devices which may be installed and adjusted at will to meet these variables as well as provide the proper acoustic environment for the various types of stereo speaker systems available today.

Room Acoustic Adjustment

In the earlier articles we discussed the possibility of providing variable control over room acoustics by means of retractable drapes, so that the overall reverberation time could be adjusted to take into account the number of people in the listening room at a given time.

If the reader wishes to make a simple test which will demonstrate the efficacy of such variations, without getting involved in physical changes in his room, let him listen to his sound system first with the windows open and then closed. If he has two average-sized windows in a room, say 3 feet by 6 feet each, this amounts to 36 square feet of glass with practically no absorption when closed. Next open both windows wide. If they are casement windows you can get a full 36 square feet of open space; if they are double-hung windows you will, of course, get only 18 square feet of open space. The open windows represent an additional 36 or 18 units of absorption. The acoustical effect of this added absorption should be readily apparent, especially if you place yourself not too far from the windows. From a practical standpoint much of our hi-fi will just "go out the window" of course.

Now, the amount of absorption produced by opening the room's windows is not much greater than that introduced by a small group of people. If you do nothing to compensate for their number, your audio demonstration will sound flat and dull, and you will try to push your system harder or boost the highs. The immediate reaction of the newcomer to hi-fi will be "Do you have to play it so loud?" The answer is "yes," in order to overcome the psychoacoustical "smallness" of the sound due

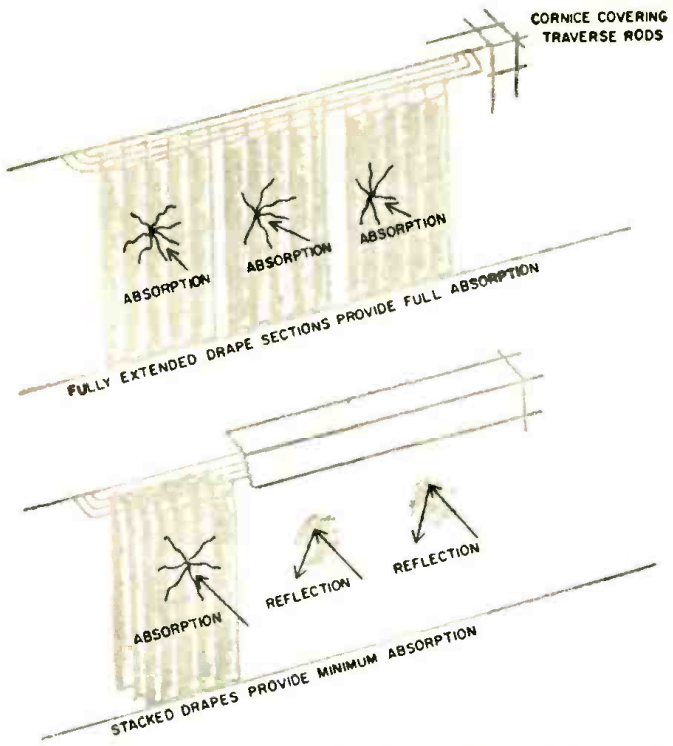


Fig. 16. Method of "stacking" drapes so that a wide variation of absorption control may be obtained to compensate for increased number of people in room, or to change the reverberant condition to suit the type of music that is being listened to.

to the lack of proper reverberation which normally enlarges the sound. It is thus desirable to adjust the room on the live side with some means provided for its variation to accommodate changing interior room conditions.

In our earlier treatment of reverberation time as a function of room size it was indicated that the reverberation characteristics also varied for different types of musical reproduction. For example, the clean, curt articulation of fast musical passages with notes coming in rapid succession and literally falling all over one another, would be completely smeared into oblivion if they were to be reproduced in a room so reverberant that the sound of one note kept swirling around the room long after it was played and while a new note was trying to make itself heard.

Similarly, the articulation of a man's voice may be completely obliterated if he talks at a rapid fire rate in a highly reverberant auditorium. The ever-reflecting echoes would wash around the listener in such profusion that the original delivery might be completely obliterated. This same auditorium, however, might be admirably suited to slow, majestic organ music. The auditorium, with its long reverberation period, would allow ample time for the organ's characteristic slow phrases to be properly re-enforced. The pipes would "resound" through the spaciousness of the auditorium.

Because of variations in program material, no single room can be "optimum" for all types of sound reproduction. Sliding scales have been worked out by acoustic engineers correlating the general type of music to be heard with room size and optimum reverberation time. In many cases a good compromise can be reached in an architectural structure so as to accommodate a fairly wide range of musical performances with optimum results.

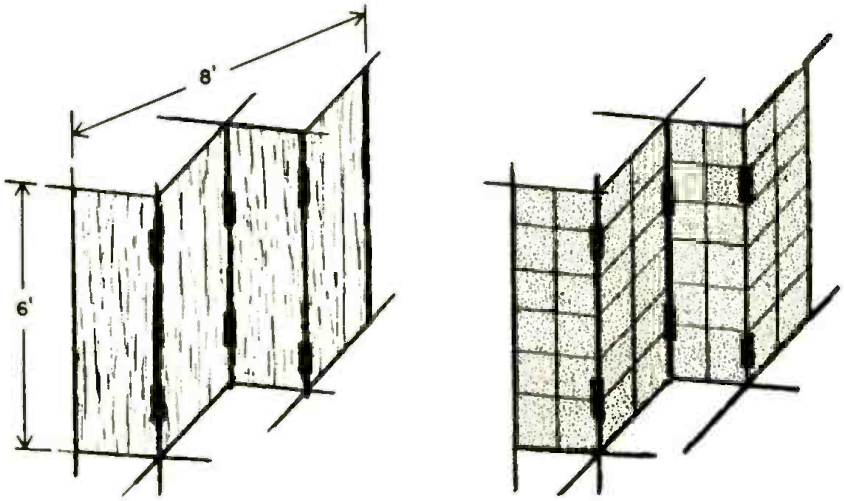
Where one strives for the ultimate in sound conditioning, then means for adjusting the room or auditorium to the type of performance are usually included in the structure. Specifically, recording or broadcasting studios frequently make use of such acoustically variable devices to insure optimum reproduction of a particular type of performance. Some of these professional techniques can be adapted for use in the home with gratifying results.

In order to have control over the acoustics of our listening room, it is best to start with a fairly "live" condition. Then, as more people come into the room the liveness will drop to the desired level or as the character of the music is varied we may alter the liveness of the room to suit the program by the addition of absorptive surfaces. One simple means of staying on the "live" side while providing the requisite flexibility is to use drapes mounted on traverse rods so that they may be pulled out straight or gathered in folds. With draperies, the home decorator does not find herself limited to specific areas which must be covered. She has a choice of materials and draping methods by which various reverberation combinations may be obtained.

Traverse-type, or drawstring, drapes are an excellent means of varying room acoustics to suit either the *type of music or the number of people* in the room. It is to be expected that friends and relatives will visit occasionally. If four people drop in we have added another 16 units of absorption to the room and even though the party may liven up socially, the room becomes deader acoustically. In fact, with four or five more people in the room, it would be desirable to remove the drapes entirely in order to maintain proper reverberation. Of course, removal is out of the question once they are up but there are means of manipulating them to get the proper reverberation correction as, for example, compressing them into a very small space—if they are hung on a traverse rod.

We may also adapt, in rather simple fashion, some of the proven techniques of the professional recording and broadcast studio. In broadcast studios reversible wall panels with different sound absorption characteristics are often used. Depending on the characteristic desired as a function of the size of the performing group and the placement of the individual sections of the group, these panels can be adjusted to provide the correct reverberation time. While we can't expect such an installation in the average home, in new houses being built for the serious audiophile there is no reason why some devices can't be incorporated. In existing structures we may employ an al-

Fig. 17. An approximate change in absorption of 6:1 may be obtained by use of a folding screen wood-panelled on one side and with acoustic tiles on the other.



WOOD PANELS ON ONE SIDE OF SCREEN

48(SQ. FT.) X .12(ABS. COEF.) = 5.8 UNITS

ACOUSTIC TILES ON OTHER SIDE OF SCREEN

48(SQ. FT.) X .75(ABS. COEF.) = 36 UNITS

ternate method of varying the acoustic environment by "stacking" the drapes. This method, as illustrated in Fig. 16, relies on the number of layers in the stack to provide the variation. Thus, if we consider an area of 80 square feet of drapes (8 feet high by 10 feet wide) in the room previously discussed, broken up into three separate sections 3⅓ feet wide, each section capable of being pulled back of the others, then we have an option of the full 80 square feet or as little as 27 square feet of acoustical "treatment." For more or less flat-hung drapes, this would give us an absorption coefficient which could be varied from 80 x .15 = 12 units to one-third of that value or 4 units. This means that if the room is properly adjusted for your immediate family when the drapes are fully extended, should 3 or 4 more people (at 15 or 16 units of absorption) arrive, all you would have to do is retract the drapes and the acoustic environment is again "normal."

Another method of adjusting the room involves the use of folding room-divider-type screens. If these screens are wood panelled on one side and covered with an absorbent surface, such as acoustic tile, on the other, there will be available an approximate 6:1 ratio of acoustic absorption. As shown in Fig. 17, if the screen were 6 feet by 8 feet when opened, its wood-veneered side would provide 5.8 units of absorption (48 x .12) while the tiled side would yield 36 units (48 x .75), which for the small area involved is quite a respectable change. Still another change can be obtained by applying acoustic tiles to doors which lead into the listening room. If such doors are of standard size (2½ feet by 7 feet), when covered with acoustic tile they provide 13 absorption units (17.5 x .75). Such panels may be made reversible by installing them in recessed grooves (see Fig. 18A) so that the panel may be slipped in with the tiled side outward or the veneered side showing, as dictated by existing conditions. Or, such panels may simply be hung from hooks from the top of the door frame, as shown in Fig. 18B, and are thus quickly reversible. Where metal clad doors are involved, simple strap hooks that go over the top of the door may be used. See Fig. 18C.

Finally, for the handy householder there is the semi-professional installation consisting of pivoted, double-faced louvers (as shown in Fig. 19) with acoustic tiling on one side and wood veneer on the other. These louvers could be assembled on a framing panel and hung as a unit. The absorption by this method is dependent, of course, on the size and number of the louvers and their positioning. A second effect, and an important one, is obtained with these pivoted louvers. By leaving them in a semi-open position, rather than in a totally closed condition (in either direction), a more random diffusion of sound is obtained, thus minimizing standing waves within the room.

While we have spent considerable space on how to correct the over-all acoustic condition of the room by the addition of effective absorbent materials, it should be remembered that to be effective these treated sections should be scattered in a random fashion throughout the room so that one end of the room isn't completely live and the other end completely dead. Thus, in the matter of drapes rather than have one solid area 10 or 12 feet wide, it would be better to divide the drapes into smaller sections of, perhaps, 3 to 4 feet wide and place them on more than one wall.

This same principle should hold when applying the tiles. Not only will this random application of the treatment break up inherent and troublesome room resonances, but it will permit us to balance the room for stereo program material and for the different types of speaker systems which might be adopted.

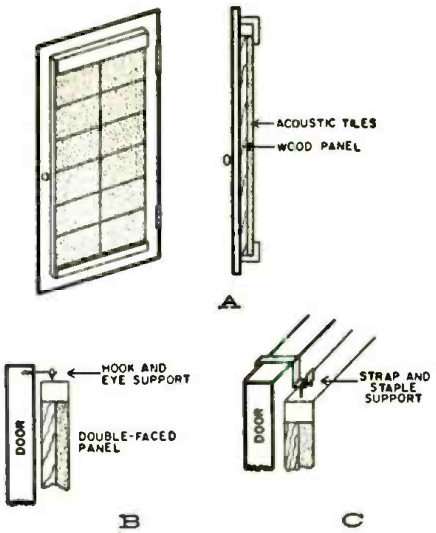


Fig. 18. A double-sided reversible panel applied to door area may provide either 13 absorption units when the tile side faces out, or 1.5 absorption units when the wood panelled side faces out. Some supporting methods are indicated in figure.

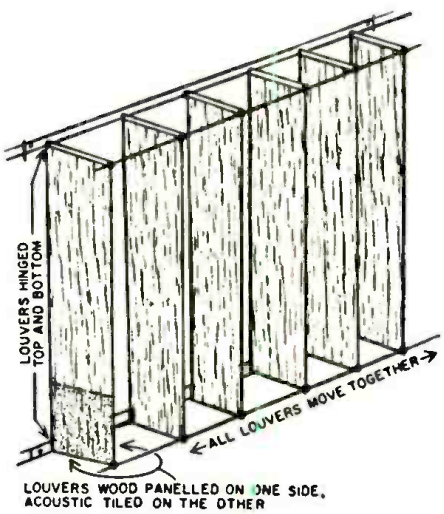


Fig. 19. A reversible louver assembly can give a wide variation of acoustical control over the reverberation of a room in proportion to the size and orientation of the louvers that are used. See text.

Balanced Speaker System

In acoustically balanced rooms, that is, where the acoustic effect from the listener's left is the same as that from his right, due either to the original room condition or to its adjustment, we will discover that more than one type of speaker system will perform satisfactorily. The speaker systems, shown in Figs. 20A, 20B, and 20D (Fig. 4, Part 1, Jan. issue and reproduced in this part) are all essentially *balanced* systems although they differ from one another in design concept.

In Fig. 20A, although there is no center speaker, an apparent "middle" is heard when speaker phasings are correct and when the program content of each channel includes judicious amounts of program from the other. The overlapping *common* program content from one channel to the other produces an apparent sound field located between the two speakers. In order to obtain optimum "center fill" to heighten the stereo effect of this balanced-speaker system, the speakers must be backed by a live, hard surface which will then function as a re-radiating device. Moreover, in a system such as this balanced-speaker layout, the "center fill" becomes more apparent when the speakers are angled in towards the listener rather than flat against the wall.

This effect occurs because by angling the speakers, more of the high frequencies of each speaker field overlap at the listener's post. When these overlapping higher-frequency fields contain common program material at equal level, their apparent source will be directly in front of the listener. Obviously, then, the speaker separation and the common angle between them will not only determine the maximum area of equal stereo perception but will also be indicative of the degree of apparent center fill.

Phantom Channel System

In the case of the system diagrammed in Fig. 20B, where there is an actual center speaker delivering a third signal from both channels and consisting of common program components in both, speaker separation and corresponding angles are not nearly as critical as in the previous case. The "center fill" is always present irrespective of positioning or angling of the main channel speakers. Obviously, the system employing a phantom channel may be spread out over a greater wall area than would be the case with a simple two-speaker system. However, as the system is stretched out, the full-range speakers will have to be toed in centrally otherwise the stereo-determining high-frequency beams from the end speakers will not overlap sufficiently to produce a large enough stereo listening area. In an effort to widen the wall of sound by stretching out the phantom system, it is necessary to insure that the wall back of such a sys-

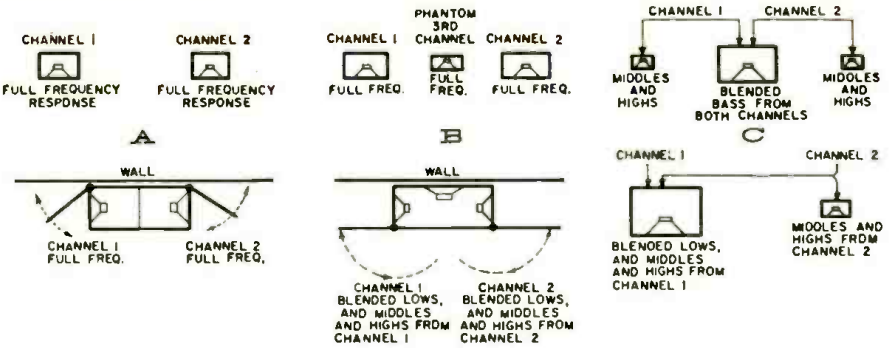


Fig. 20. The wide variety of stereo speaker systems in use. (Repeated from Part 1.)

tem is acoustically uniform. It would not do to have areas of absorbent material on the wall behind such speaker cabinets. Such absorbent areas would, by their acoustic characteristics, create soft spots that would not reflect the sound sufficiently to guarantee the continuity of the sound wall from one source to the other.

This latter condition can be achieved by putting the end speakers in the corners of the room. In Part 2 of this series, we showed that for maximum sound radiation from a corner, the corner should be live. If the wall adjoining the corner enclosure is acoustically soft, there will be no apparent sound source reflected from the wall and radiation will be reduced.

Carrying this idea to its conclusion, as shown in Fig. 21, we see that soft spots intervening between the speakers will create discontinuity in the wall of sound while hard reflecting surfaces will help merge the sound sources into a blended wall of sound. We again arrive at the same conclusion regarding room acoustics for this system as we did for the simple, two-speaker system. Even though capable of greater extension and greater uniformity of sound, we still need a completely live backdrop, or shell, from which the system's sound may be projected into the room.

Back-Hinged Door System

The system that is possibly least dependent on environmental acoustics is that of Fig. 20D for when the side doors (hinged at the back) are angled to throw the sound into the center of the room, the speakers see the individual hard reflecting surfaces of the doors as live reflecting areas. Even when opened up wide against the walls, these doors will act as adjacent hard reflective surfaces for the sound that hits them, thus adding some degree of liveness to the reproduction.

Although for general reverberation conditions it may be desirable to keep the over-all back wall as live as possible, some stereo effect may be lost with this hinged-door system. When only the doors serve as the reflecting surface, then the direction of the reflection and the subsequent stereo effect becomes a function of the door angle. Where, however, a completely live wall backs up the doors of the cabinet, then there is reflection from both the door *and* the wall and control of the stereo effect by door manipulation is reduced.

Satellite System

The system of Fig. 20C, where the lows from both channels are combined in one speaker which, in turn, is flanked by higher frequency satellite speakers, perhaps lends itself to greater decorative flexibility than the other systems just described. For the balanced bass woofer enclosure we want a live wall behind the system. However, the fact that the satellite speakers carry only the high-frequency program components indicates that their sound fields will be more "beamed" than will the blended bass from the common woofer, especially if the satellites are horn-type speakers. Where such beaming occurs, there will be a minimum of rear sound wave projection which means that no special acoustical treatment need be given the wall areas behind the satellites since there will be no sound field to be reflected.

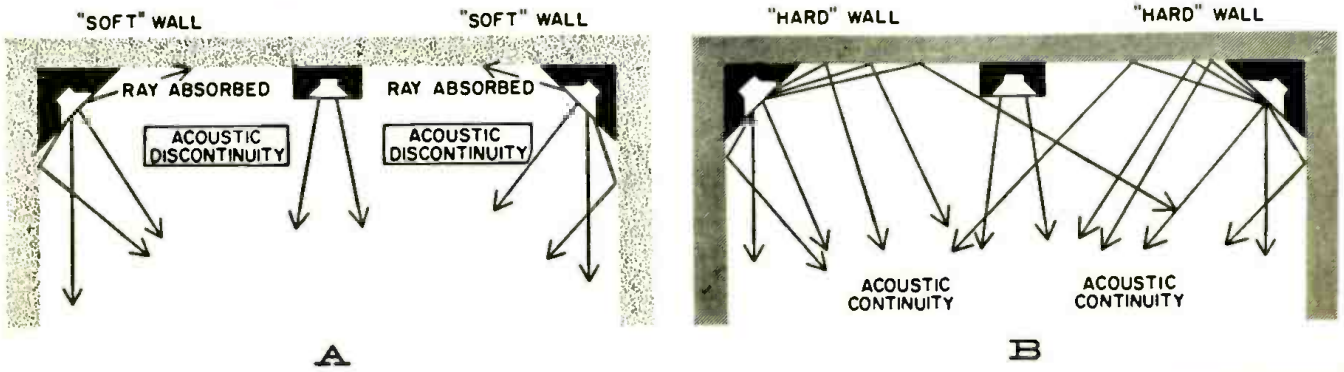
This preponderance of directly beamed sound from the satellites means that the walls behind the satellites can be decorated in any manner, leaving only the area surrounding the common woofer live enough to bounce the sound out into the room. The satellites may be removed some distance from the common woofer before a discontinuity of sound will be noticed between the satellite and common woofer. Psychoacoustically, we take the fundamental lows from the common woofer and add them to the higher frequency components from the satellites to produce the illusion of the entire program coming from the satellites. However, if we stretch the system too much and/or get too close to the satellites, there will be a discontinuity of channel content. As in previous examples, when stretching out such a system in an attempt to enlarge the wall of sound, then it will be helpful to increase the live wall area to cover not only the common woofer but to reach out to the satellites as well. This live wall, by creating *new* apparent low-frequency sound sources, will help to "bridge" the lows from the blended source over to the satellites and smooth out the wall of sound. It is also recognized that as the satellites are moved farther from the center they should be angled in more and more to provide maximum overlapping areas of the high frequencies.

Front-Hinged Door System

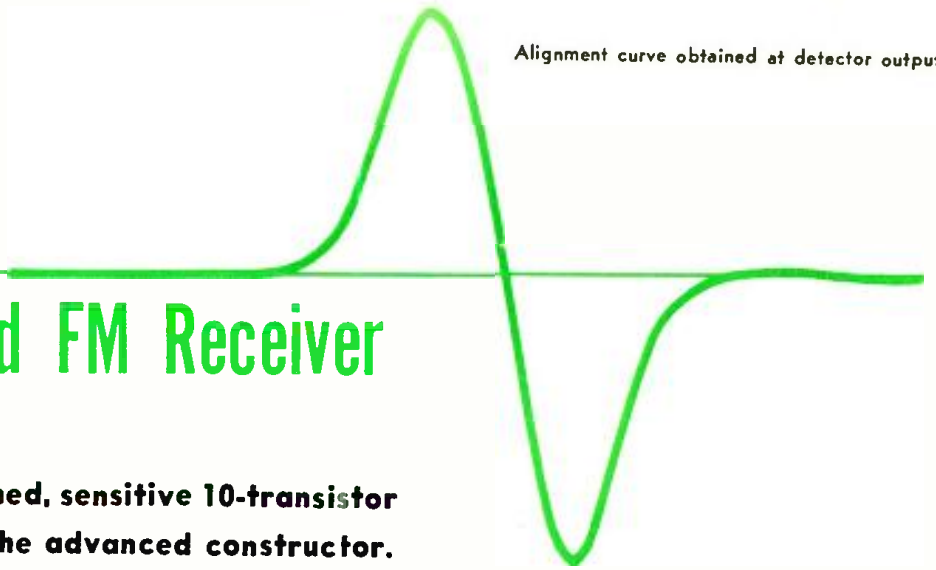
Perhaps the system most dependent on room acoustics for its stereo performance is the one shown in Fig. 20E. Due to the fact that the common woofer faces the rear, unless this wall is quite live the lows will be overly subdued. Certainly if there is any draping of this area the lows will be unduly absorbed. For this system, then, a hard, highly reflective back wall is definitely prescribed for maximum low-frequency performance. However, we are more directly concerned with the orientation of the high frequencies which emerge from the sides of the cabinet and reach the listener *via* both wall-reflected

(*Continued on page* 93)

Fig. 21. (A) When speaker systems are spaced far apart with absorbent areas between them, there is little sound reflected from these absorbent areas and there results a discontinuity in the "wall of sound." (B) A reflective wall produces apparent sound sources between the spaced systems and improves the continuity of the "wall of sound" between the loudspeaker systems.



By **DONALD L. STONER***



Alignment curve obtained at detector output.

Portable Transistorized FM Receiver

A real scoop—a well-designed, sensitive 10-transistor portable FM receiver for the advanced constructor.

THE recent introduction of transistorized FM portables by *Sony* and *Telefunken* has produced a flurry of excitement in that segment of the American public that knows and enjoys good music. Except for an occasional trip to the AM band, their radio listening is done exclusively between 88 and 108 mc.

Although foreign imports have provided strong competition for domestic transistor radio sales, the FM portable has had no U. S. competition to date! As this is written, there are no fully transistorized AM/FM portable receivers manufactured in this country.

To the casual observer it might appear that American manufacturers have been caught with their junctions down. To a certain extent this is true. However, the basic problem has been the lack of components priced to compete with the imports. As an example, until recently v.h.f. transistors were in the neighborhood of $10.00, far beyond the domestic receiver market. The necessary i.f. transformers were simply not available.

These problems have now been largely overcome with the introduction of the *Philco* MADT transistor group and the *J. W. Miller Co.* 1463-T series of transformers. The receiver to be described uses this new "team" and can be built for considerably less than $50.00, with a well-stocked junk box.

Circuit Description

This portable FM receiver is of conventional design and tunes 88 to 108 megacycles. The receiver utilizes ten transistors as r.f. amplifier; mixer; oscillator; i.f. amplifier (3); 1st audio; push-pull class B (2); and as an automatic frequency control amplifier.

Referring to Fig. 1, and starting at the antenna jack, the signal is coupled to the antenna coil (L_1) through C_1, a 470 $\mu\mu$f. disc capacitor. The impedance of coil L_1 matches the antenna to the transistor base and serves further to minimize images. Forward bias for the r.f. amplifier V_1 (T-1694) is obtained at the junction of R_1 and R_2 while R_3 provides d.c. stabilization. No neutralization is required due to the low junction capacity and the stage shows no tendency to oscillate.

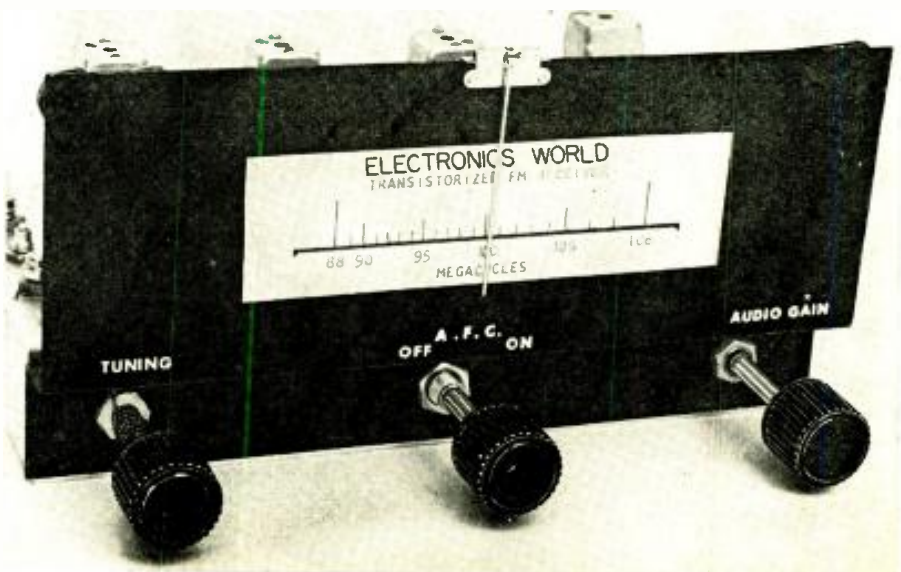
The amplified signal appears across L_2 and is coupled to the mixer (V_2, a T-1696) at a low-impedance point on the coil. Bias is applied to the base through R_4 and R_5, with R_6 providing the customary stabilization.

The oscillator is a v.h.f. version of the common-base circuit. Feedback energy is coupled from the collector to the emitter through C_{12}. Coil L_3, along with the circuit capacity, determines the frequency of oscillation which is always 10.7 mc. above the incoming signal. Resistors R_9 and R_{11} provide bias and R_{10} is used for d.c. degeneration. Transistor V_{10} and diode CR_1 are part of the a.f.c. circuit and will be discussed later. All tuned circuits in the front end are tracked with a three-gang variable capacitor (C_3, 3-10 $\mu\mu$f.).

The i.f. strip utilizes two T-1657's (V_4 and V_5) as common-emitter neutralized amplifiers. In the V_4 stage, resistors R_7 and R_8 provide forward bias while R_{17} is used for emitter stabilization. Resistors R_{19}, R_{20}, and R_{22} serve the same purposes respectively in the V_5 stage. Resistor R_{21} is used for decoupling. A third T-1657 (V_6) functions as an amplifier/limiter and does not require neutralization due to the load imposed by the detector. Once again R_{25} and R_{26} form the bias divider network and R_{27} makes the stage thermally stable, due to emitter degeneration. Resistor R_{28} introduces a degree of limiting in the collector circuit of V_6. In all the 10.7 mc. i.f. stages the bases are fed from low-impedance taps on the double-tuned coils. The i.f. bandwidth compares favorably with tube-type transformers.

Although crystal-diode FM detectors are frequently not too satisfactory, this one performs every bit as well as the tube version of the ratio detector. This

Front-panel view of the fully transistorized portable constructed by the author.



* Electronic Publications, Box 137, Ontario, Calif.

is due to careful transformer design and the fact that matched diodes (1N541's) are included in the can assembly, mounted under a "swedge-cap" on the top of the transformer. Separating the diodes from the below-chassis circuitry minimizes regeneration, for they are a prolific source of i.f. and harmonic energy.

Transformer T_4 balance, which determines AM rejection to a large degree, is exceptionally good. Resistors R_{30} and R_{31} are customarily 1500 and 1000 ohms respectively but in this circuit were optimized at identical values —in this case 3300 ohms.

Incidentally, determining correct values for these resistors provides an interesting sidelight on the design of this receiver. An electric razor was used as a noise source and the interference was superimposed on a station which did not quite limit. After R_{30} and R_{31} were optimized, the noise source was not audible even when placed on the dipole!

The remainder of the ratio detector circuitry is typical, with the exception of C_{29} and C_{30}. These capacitors were required to eliminate a feedback loop which occurred between the detector and the mixer base.

The characteristic plus-zero-minus signal appears across the volume control (R_{32}) and this voltage is used to control the "Varicap" automatic frequency control diode, CR_1. This amazing device, manufactured by *Pacific Semiconductors*, exhibits a variable capacity effect when reversed biased. A d.c. amplifier (V_{10}) increases the tiny ratio detector voltage to a swing of approximately 8 volts on a strong station. Resistor R_{14} and capacitor C_{16} form a low-pass filter for audio decoupling. Frequency response of the audio system is unaffected by degeneration in the a.f.c. circuit for the filter cut-off is below the frequency passed by the audio transformers. Resistor R_{15} provides forward bias for the d.c. amplifier and is adjusted for a static collector potential of 4 volts, with the a.f.c. switch off. When these conditions are established, the anode of the a.f.c. diode is approximately 7 volts more negative than the cathode and acts as a variable capacitor as mentioned earlier. When tuning across the moderately strong FM station, the collector of V_{10} swings between 0 and 8 volts, which varies the diode capacity. Due to the closed loop a.f.c. the oscillator locks in on the station. The "Varicap" diode is tapped at a low-impedance point on the coil to prevent oscillator loading and tracking problems.

It should be pointed out that capacitors C_{14} and C_{16}, in conjunction with the transistor, provide the basic elements for a blocking oscillator and C_{15} is needed to reduce this tendency.

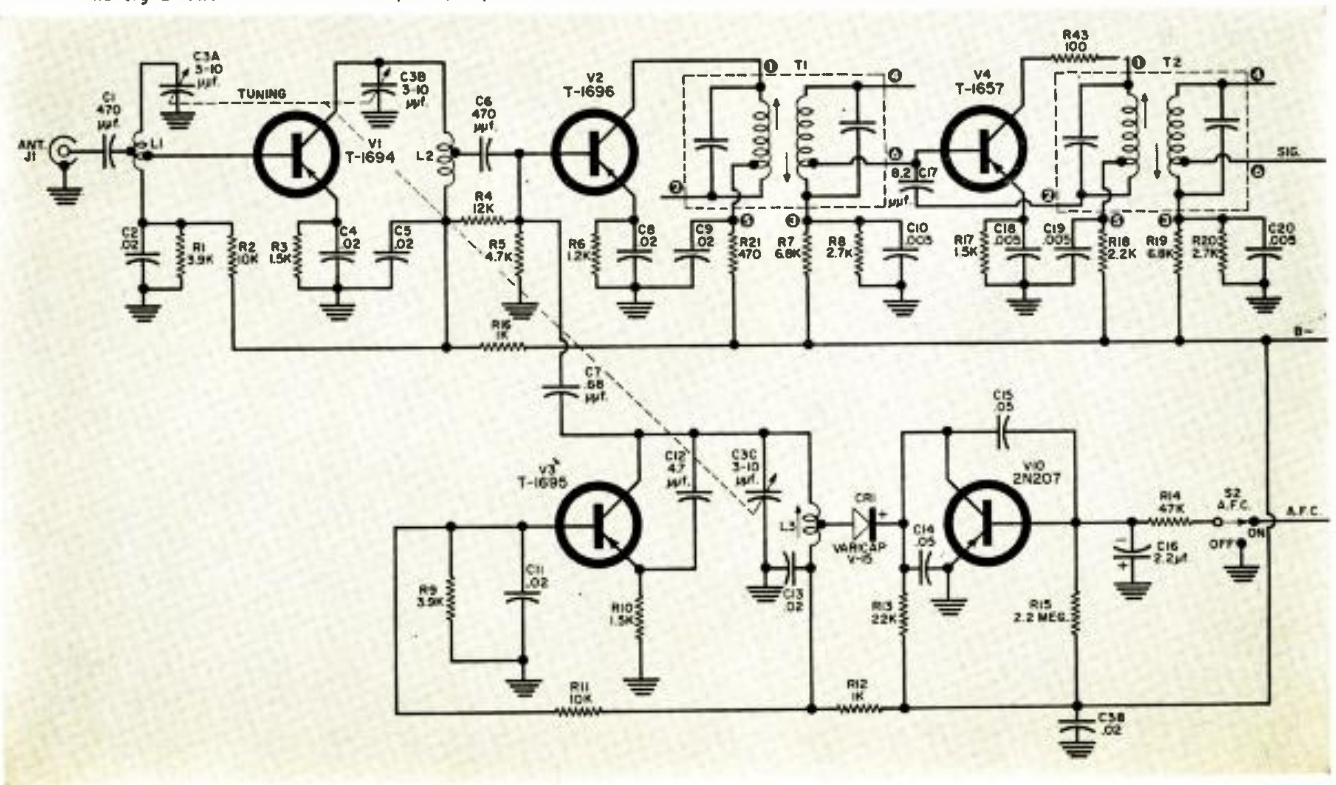
The problem of receiver drift with voltage and temperature changes is eliminated with the a.f.c. system. With a.f.c. correction the receiver will perform beautifully even with the varying potential found in automobiles.

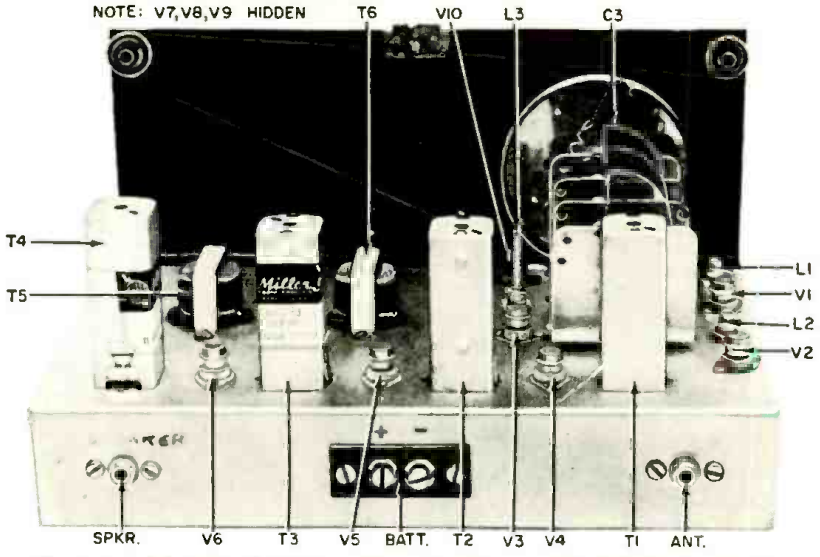
The audio circuitry is also conventional. Audio appearing at the arm of the volume control is coupled to the driver (V_7, a 2N226) through a low-impedance de-emphasis network, consisting of R_{32} and C_{27}. Bias appears at the junction of R_{10} and R_{11}, and R_{39} stabilizes the stage. Capacitor C_{25} prevents audio degeneration. The amplified audio, in push-pull form, is applied to the bases of V_8 and V_9. Note that the diagram indicates only one 2N224, for this EIA (formerly RETMA) number is actually a matched pair of 2N225's. The network R_{36} and R_{37} delivers bias to the class B stage to prevent "crossover distortion." A 2.2-ohm resistor (R_{35}) in the common-emitter circuit degenerates this stage. A large *RC* network, consisting of R_{34}, C_{28}, and C_{31}, minimizes the class B stage current variations on the other circuits. The output transformer is tapped to match a variety of speaker impedances.

The receiver is constructed on a 5" x 9" aluminum chassis and the layout can be determined from the photos. The front-end components are grouped around the tuning capacitor to obtain the shortest possible lead lengths. Although the antenna coil is tapped for 72 ohms input, a two-turn link could be substituted to provide optimum match for 300 ohms. Naturally, J_1 would have to be changed to a two-screw terminal strip to maintain transmission line balance.

Obviously no attempt has been made to miniaturize the unit, for this is usually folly in an engineering prototype. It is quite likely that the chassis size could be reduced to 5" x 7" (or less) and the tuning capacitor recessed to eliminate several square inches from the package.

Fig. 1. Complete schematic diagram of the portable transistorized FM receiver. The design-center voltage is 12 volts so that it may be employed on positive-ground automotive systems. Because the current required is only about 20 ma. with no signal and 70 ma. on audio peaks, dry batteries may be used. For example, ordinary penlight or mercury cells, or





Rear view of the portable receiver showing transformer and transistor placement.

It was hoped that a testing laboratory report would be available in time for inclusion in this article since no one would believe the author's performance figures! It would appear that the receiver requires *less than* 5 microvolts for *30 db* of quieting. Those transistors seem to be doing a good job.

Lacking a formal report, a few personal experiences with the receiver may prove interesting. While calibrating the dial a new station was picked up. It turned out to be KITT in San Diego, 120 miles south of the author's home. A pair of rabbit ears on the workbench was being used as the antenna at the time. Now that the station has been spotted, it may be found there most of the time. Although it does not limit, it is quite usable.

While testing the receiver, 29 out of 34 stations in this area (70 mile radius) were received. Multipath distortion, from the mountains to the north, made three stations unusable.

The receiver was tested in the automobile, again using the rabbit ears sticking out the window. The receiver was tuned to a 10-kw. Los Angeles station and no ignition noise was heard on the way to Los Angeles and back, a distance of about 60 miles. No frequency drift was observed although the temperature on the front seat varied from 40 to 75 degrees.

The most glowing compliment came from an audiophile friend. He summed up the performance in three words, "Man—that's clean!" And he's not far wrong—it *is* clean. The fidelity of those little transistors makes you wonder about that big 60-watt heater, with the KT66's, in the front room!

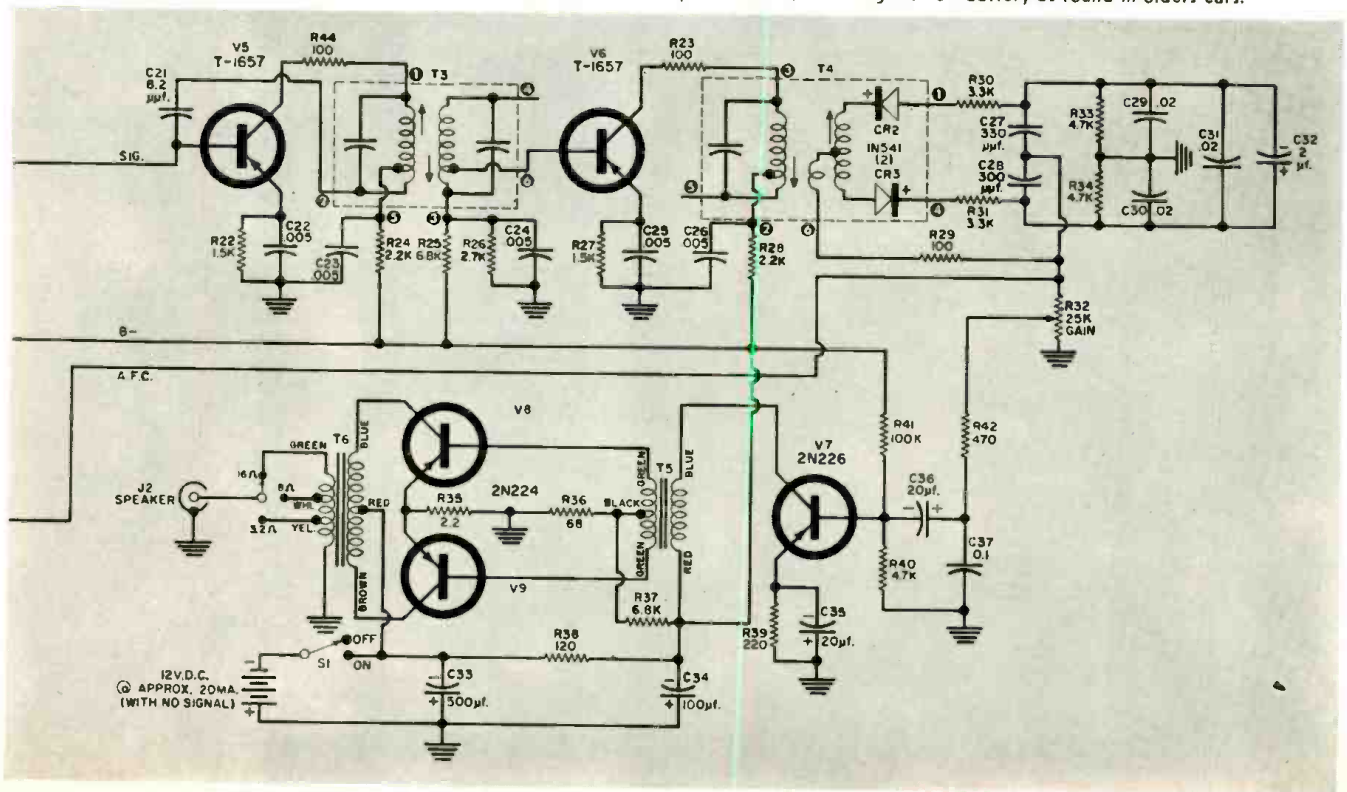
The author would like to thank the *J. W. Miller Company* and Mr. C. B. Simmons of *Philco Corporation* for their assistance in the preparation of this article.

-30-

COMPLETE CONSTRUCTION DETAILS

For those of our readers who are interested in further details on the receiver described here, the J. W. Miller Co. is making available complete construction details, testing and adjustment information, and alignment instructions. This data is available free from all major distributors or direct from the company, 5917 S. Main Street, Los Angeles 3, California. In addition, arrangements have been made with the Philco Corp. to distribute the special r.f. transistors as part of an "FM Portable Package." This package includes the six r.f. transistors, the tuning capacitor, three r.f. coils, and the four i.f. transformers. The transistors are not available separately. The "FM Portable Package" will be available at all major distributors for $36.80. If difficulty is encountered in obtaining this package, write the J. W. Miller Co. direct for further details on how the package can be obtained.

standard flashlight batteries may be connected in series to obtain the required operating voltage. When space and weight are not important considerations, two 6-volt lantern batteries (such as Burgess F4H, or equivalent) provide the longest life-per-dollar. The receiver will operate, at greatly reduced performance, on a single 6-volt battery as found in olders cars.



An Odd Sort of "Tube" Problem

By **GEORGE D. PHILPOTT** / **The case of the vanishing tubes: Is your service shop haunted by this type of inventory problem?**

"SOMEONE sure has taken Ace TV for a ride this time," Ray Warner, manager, announced grimly as he handed the yearly inventory sheet to Ann, the company's attractive office girl.

She studied the figures briefly, glanced at Ray, then ran a hasty column on the adding machine. "Six hundred tubes short," she stated. "This is serious, Ray. What are you going to do?"

"Find the thief—and fire him!" was his flat reply.

"Let the insurance company handle things," she suggested, fingering through the index file for their phone number.

The expression on Ray's face seemed to darken. "Not yet . . . there could be a mistake," he said, adding, "It's not good business to stir up suspicion among employees . . . not until I've made a re-check, at least." Sharpening his pencil in the device near the door, Ray took a new inventory blank, dated it, and then disappeared into the service department again. Alone, Ann closed her eyes and tried to visualize the guilty employee. One of them was a systematic thief.

It was easy to eliminate old Doc Brennen: over six years with Ace; expert technician; a real gentleman and family man. If Doc had one doubtful habit it was taking a beer or two during his lunch hour. Certainly no crime.

Her mind jumped to the next suspect, Super-Sonic Smith. She pictured a young fellow from the trade-school set of technicians, a whiz-bang of complications who could zip through a TV set and find more things wrong than a stage director doing his bit at a dress rehearsal. Locating the basic trouble in a receiver was something again for Super-Sonic, however. She knew it was not at all unusual for him to become hopelessly involved in a routine repair. Some of his jobs bounced like rubber checks. He took his kidding like a man, though, and tackled each beef with renewed vigor, in an honest way. Ann, allowed him to slip from her mind.

She automatically skipped the boy, Ted. He was an after-school lad who dusted, polished cabinets, and burned the rubbish; a child, really, without a tarnished thought in his head.

This left Mr. Tish, the *new* man. According to Ray, he was the best bench man ever to work for Ace. Thinking back, she recalled the day five weeks ago when Mr. Tish had walked through the front door and asked to speak to Ray. The men talked a few minutes, disappeared into the service department, and the next thing she knew Mr. Tish was on the payroll. At the time she thought it was odd that he offered little in the way of information about himself except for his social security number—and then only after she asked him several times.

With a satisfied start, she straightened in her chair and returned to her work. Mr. Tish, with those dark, searching eyes, was the man!

Later that afternoon, when Ray returned from the tube shelves with a long face and verification of the shortage, Ann lost little time in making her suspicions known.

"Strange," Ray said, scratching his head. "when I took the first count this morning, before anything turned up, Mr. Tish came to the shelf for a tube and said something about a shortage. As I recall he asked if we had been robbing ourselves."

Ann's smile was not as sweet as it appeared: "He knows plenty," she fired.

"Maybe I'd better have a talk with *him!*"

"I think it's rather late just to talk," she remarked.

The manager shrugged his shoulders and turned to the door. It was only fair to let any man speak his piece before condemning him. With this problem weighing on him, Ray walked slowly back to the service department.

Mr. Tish retained his characteristic calm. When Ray had confronted him with the statistics and also asked for an explanation of the strange statement he had made earlier at the tube shelves, he unhesitatingly answered "Ray, I'm not at all surprised at the shortage. Before I came here, I was considering a new field. I did some study with an eye to becoming an efficiency expert. That training taught me to examine carefully many seemingly unimportant details of shop work. As a result I came to the conclusion that you actually were robbing yourself, literally speaking, because of your system for handling tubes and parts. With a little cooperation, I may be able to show you what I mean." He turned to Doc and Super-Sonic. "Will you fellows help us all out by giving completely honest answers to a few questions?"

Doc gulped, but returned an amiable grin. Super-Sonic hopped to a more restful perch on top of the bench. "I'm listening, for a change," he said, wondering how he fitted into the picture.

Mr. Tish turned to Doc first. "Any of us can occasionally forget to take out of a customer's receiver a new tube that was put in, presumably temporarily, for test purposes, or else slip up on marking down a new tube that was installed in place of a defective one when we make out bills. Just on a rough guess, Doc: about how many would you say you lose that way in a week?"

Doc reddened slightly, but he didn't waver. "Well, Ray," he admitted, "I guess I've left my share of 'em in sets. I get busy, or I'm called to the phone, or a customer interrupts in the middle of a job. Some guy may want a car radio installed right away in the middle of something else. I forget until it's too late, sometimes. I might forget a few tubes a week. I'm sorry. I'll try to be more careful."

"A few tubes," mused Ray. "That's not six hundred."

"The list adds up fast," Mr. Tish resumed. "You aren't figuring on one *broken* tube per week per technician. That's not an unreasonable figure. Then there's that seemingly insignificant number of 'new defectives' gathering dust up on that high shelf, instead of being returned for credit before they get out of warranty. Experience gives me a pretty good idea of losses that should be expected in a four-man shop such as this one—especially where no systematic attempt is made to charge tubes to the individual job.

"Let's do some conservative figuring. First, you usually have four men on the bench. That doesn't take into account you and the girl—and both of you sometimes check or otherwise

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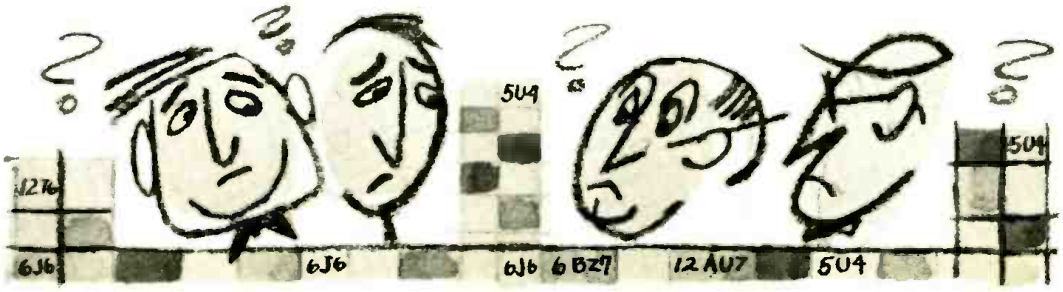
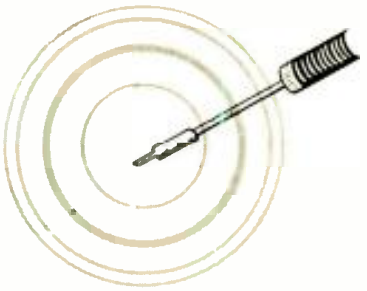


"Controlled-Heat" Soldering

By KENNETH BRAMHAM / **Iron temperature can be adjusted to the work with this adapter for service shop or industrial use.**

EDITOR'S NOTE: *There is no such thing as a single soldering tool that is satisfactory for all types of work. Even within the relatively narrow range of light-duty soldering, such as that involving printed boards, requirements can vary. Ken Bramham has interesting things to say about the parameters involved, and shows how control over just one of these can provide considerable flexibility. Developed for use in an industrial plant, the arrangement is equally useful to the service technician.*



FROM THE great deal of material that has been written on the problems of handling printed wiring, it is becoming clear that a large part of the difficulty stems from the use of soldering equipment not intended for such delicate work. Several considerations go into the determination of the right kind of equipment.

One such important consideration, the amount of heat needed to make or take apart a soldered joint, itself depends on three factors. These are the melting point of the solder being used, the amount of this solder that must be melted, and the materials being soldered (including their size and ability to conduct heat). These variables result in a very wide range of requirements. Taking extremes, we have, on the one hand, the copper strap that must be soldered to a grounding lug, and, on the other hand, the tiny transistor that must be soldered to the metal foil of a printed board. In the first case, a gas torch would be fine and an iron rated at a few hundred watts would get by. In the second situation, a gas torch would destroy the transistor, the printed foil, and possibly the entire board. The iron rated at a few hundred watts is little better. A 5-watt iron would be about right.

Even in printed-board soldering, there are times when 5 watts would be insufficient and times when 3 watts would be enough, depending on the amount of metal involved. If too little heat is applied when making a connection, there is the possibility of a "dry joint." Also the excessive time taken to melt the solder may allow greater conduction of heat to components than would occur with more heat applied for a shorter period. The application of *too much* heat will again cause excessive conduction to the components; other possible effects are the formation of oxide scale in the joint and destruction of the adhesive bonding the metal foil to the supporting board.

Soldering-iron tips are also important in confining the heat to a minimum working area. An excessively large tip will hold more heat than is needed and cover too large a working area; too small a tip may cool too fast to be useful. Generally it is better to use the smallest area of contact with the foil that will give a fast melt.

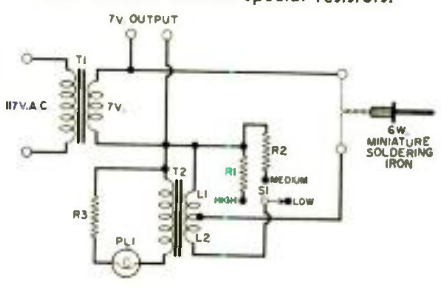
Rosin-cored solder is, of course, standard in radio-TV work; there are, however, various solder alloys of tin and lead, put up in this form, that have different melting points. A mixture of 60% tin and 40% lead, for example, melts at 375°F, while 40% tin and 60% lead melts at 460°F. The solder most used in printed-board manufacture and service is 63% tin and 37% lead, giving the lowest melting point possible with a combination of these two metals. This optimized or "eutectic" mixture melts at about 360°F. Alloys of other metals with melting points as low as 145°F are available for special applications, but are not found in normal service.

(While on the subject of solder mixtures it is interesting to see what can be done to prolong the life of soldering-iron tips. Solder alloys normally have an affinity for copper and tend to absorb copper from the tip. This can be prevented by the addition of a small quantity of copper to the mixture, and alloys of this nature are available. A more general method of tip protection is plating of the tip by metals not absorbed by the solder.)

VALUES OF R_1 OR R_2	VOLTAGE TO IRON	OUTPUT (watts)
Short	6.8	7.7
3.3 ohms	6	6
6.8 ohms	5.5	5
10 ohms	5	4
Open	4.3	3

Table I. Values for R_1 and R_2 in Fig. 1 to produce various heat output levels.

Fig. 1. Filament transformer enables heat control without special resistors.



R_1, R_2—See Table 1 for resistance, 1 watt units
R_3—10,000 ohm, ¼ w. res.
S_1—S.p. triple-throw toggle switch
PL_1—NE51 neon bulb
T_1—Soldering iron transformer (Oryx Type 54203)
T_2—6.3 volt c.t. filament trans. (Triad #F14X, see text)
Iron—Oryx Model 6 or 6A (6 v. @ 6 watts)

It will be seen from the foregoing that the requirements for good printed-board soldering include the lowest possible temperature for the shortest possible time, applied to the smallest possible area. This ideal can be most readily achieved with an eutectic solder alloy, an iron of the correct wattage, and a tip of suitable size for the job at hand. The iron requirements may be fulfilled by one of the miniature irons with interchangeable tips, along with some method of heat control. The one used by the author is the *Oryx* miniature, industrial, quick-heating iron.

Several ways of providing heat control will come to mind; variable transformers, multiple-tap transformers, dropping resistors, and so forth. Here is a low-cost and efficient circuit that has proved its worth.

The circuit of Fig. 1 shows a standard 7-volt, soldering-iron transformer supplying current to the 6-watt, 6-volt miniature iron through a variable reactor. The main feature of the circuit is the reactor itself, T_2—no special cores to buy, no coils to wind—just a conventional, 6.3-volt, center-tapped, filament transformer. One half of the 6.3-volt winding (L_2) is permanently in series with the soldering iron, and provides a reactance of about 4 ohms at 60 cycles, reducing voltage across the iron to 4.3 volts. S_1, a single-pole,

(*Continued on page* 125)

Stereo Microphone Techniques

By **HERMAN BURSTEIN** / **Information on mike placement to help make live tape recordings and to guide stereophile in speaker placement.**

AN ACQUAINTANCE with stereo microphone techniques can be useful to audiophiles in two ways. (1) It can assist the individual planning to make live recordings on tape. (2) It can guide the stereophile in the physical arrangement of his speakers inasmuch as certain microphone techniques are based upon a correspondence between microphone and speaker placement.

Stereo microphone techniques are based on general principles rather than hard and fast rules, because every recording situation has special characteristics and therefore a special solution. Nature of the sound source, acoustic characteristics of the performance site, and types of microphones employed are factors to be considered. Optimum results are thus obtained through a combination of experiment and adherence to general principles.

Binaural Recording

In the beginning, stereo was brought into the home on tape and was intended for reproduction *via* earphones. Therefore the early recording technique employed two microphones spaced about 8 inches apart and separated by a partition about the size and shape of the human head, as indicated in Fig. 1A. In effect, the microphones were an extension of the listener's ears. Since the microphone mounting method of Fig. 1A tends to be on the impractical side, arrangements such as that of Fig. 1B have been employed instead.

While binaural reproduction (*via* earphones) has given way commercially to stereo (*via* speakers), it is quite possible that some individuals

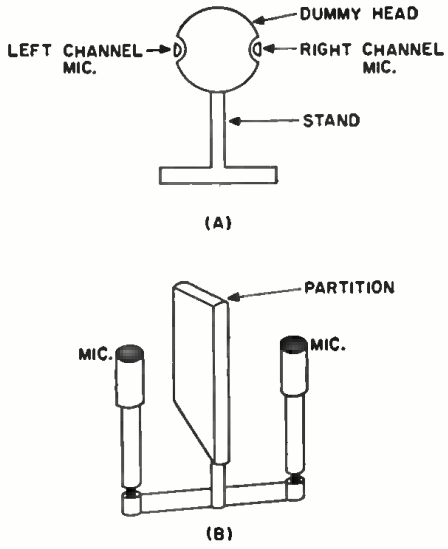


Fig. 1. (A) Dummy head for binaural recording. (B) A practical arrangement for such recording used in intensity-difference setup.

recording for their own pleasure and for reproduction through earphones—considered by many to provide a more realistic stereo illusion than speakers—will wish to use the microphone technique of Figs. 1A and 1B.

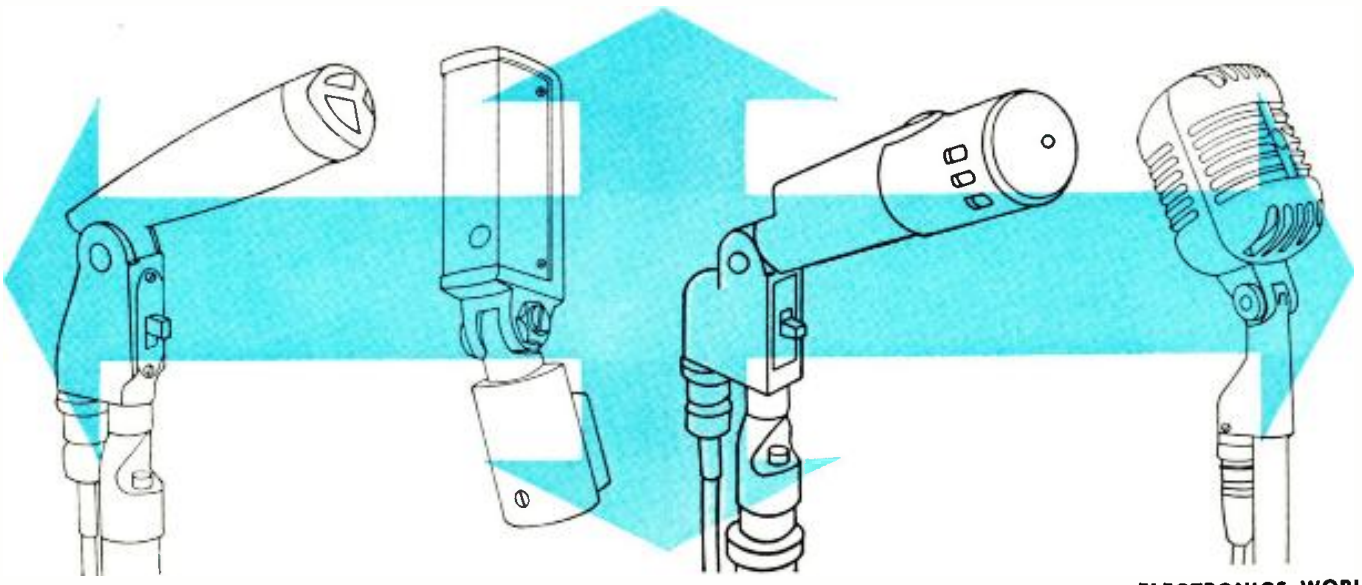
Time-Intensity Technique

When it became evident that the general public would not accept stereo through earphones but insisted on speakers, the microphones were spaced a matter of feet rather than inches apart. Spacing varied from about six to thirty feet. This is referred to as the "time-intensity" technique because it results in a difference in both the arrival time and the intensity of the sound at each microphone employed.

An early form of the time-intensity technique is referred to as "classical recording," where the microphones and the speakers were to be spaced about the same distance apart, with the distance depending substantially upon the breadth of the sound source, as represented in Fig. 2A. Actually, this is an application of the "curtain of sound" principle, where the sound source is spanned by a number of microphone-speaker links, each link covering a portion of the sound. In the case of Fig. 2A, the number of microphone-speaker links is limited to two.

The classical recording technique raises obvious difficulties. Because various sound sources differ in width, strict application of the technique would require not only the distance between microphones but also the distance between speakers to be constantly changing. The latter, of course, is impractical. However, the classical recording *principle* has been applied in a loose sense; microphones have been spaced in accordance with the nature of the sound source, without attempting to maintain the same spacing for the speakers.

Haphazard spacing of microphones along the source has given way to logical procedures which maintain left-right orientation and, at the same time, achieve a blend of the music as a whole. This can be achieved through the "listening-angle" principle, which involves a systematic relationship among microphones, speakers, and listener, as shown in Fig. 2B. The principle assumes an angle between approximately 30° and 45°, formed by a listener at the original performance



and the extremes of the sound source. The stereo microphones are mounted on the sides of this angle, and it is intended that in reproduction the listener and the two speakers shall form more or less the same angle.

The microphones can be placed at various points on the sides of the listening angle, so that their distance from the source and from each other

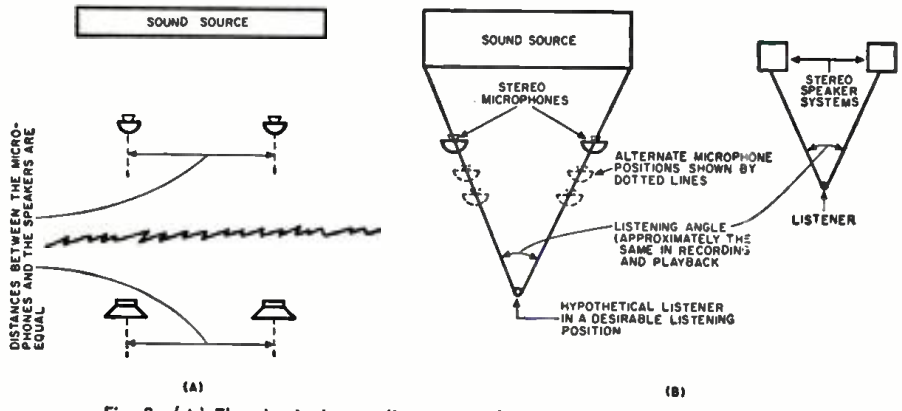


Fig. 2. (A) The classical recording setup. (B) The listening-angle principle.

will vary. Bringing them close to the source spreads them far apart, producing a marked left-right distinction, but creating the danger of a "hole-in-the-middle." Also, there will be a low ratio of reverberated-to-direct sound, with consequent loss of the effect of spaciousness. If the microphones are too far from the source, there will be little sense of directionality and the pickup of reverberated sound may be excessive, with consequent loss of clarity and definition. Between these extremes of microphone placement lies an area of satisfactory stereo results.

It might at first seem that the listening angle would be substantially different for a small sound source, such as a chamber group, than for a large one, such as an orchestra. However, a desirable listening position would ordinarily be much closer to a chamber group than to an orchestra, so that the angle between the listener and the source tends to be more or less the same in each case.

As a result of the distance between stereo microphones, there is a difference in arrival time of the sound at each microphone. In reproduction, according to expert opinion, this difference will produce the effect of directionality provided it is greater than 3 milliseconds, hence the microphones should be spaced at least three feet apart because sound travels approximately 1100 feet-per-second. On the other hand, it is possible for the difference in arrival time to be excessive. The ear tends to interpret differences above 50 milliseconds as two separate sounds rather than as a matter of directionality. Thus, if one is recording in a large hall, spacing of more than 50 feet between microphones is to be avoided.

When stereo microphones are placed far apart, there is apt to be a hole-in-the-middle, as previously noted, hence professional recording companies frequently employ a third microphone, whose output may either be blended with the outer microphones through mixers, as shown in Fig. 3A, or fed to the third channel of a three-channel tape recorder. In the latter case, the sound engineers can subsequently mix the center channel of the tape with the other two channels in the studio, which allows more time for achieving optimum results. Since three-channel tape machines are as yet far too costly for the average amateur, he must do his mixing at the recording stage.

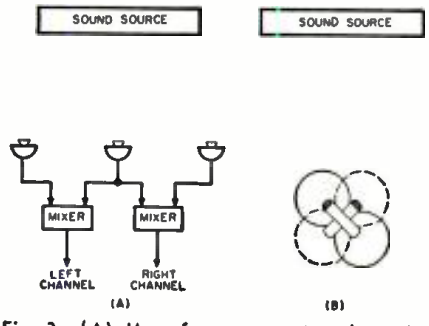


Fig. 3. (A) Use of a center microphone for stereo recording. (B) Stereosonic method.

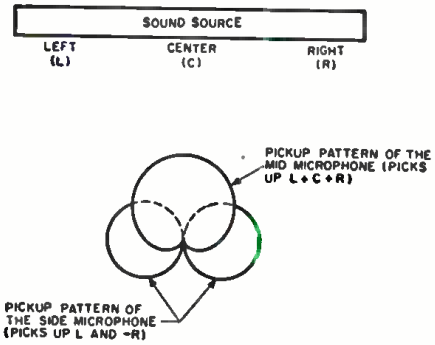


Fig. 4. Polar patterns of the two elements employed in the mid-side (M-S) microphone.

Intensity Difference Technique

The "intensity difference" technique relies upon differences in signal amplitude at each microphone, but not on differences in arrival time. The microphone setup is essentially similar to that for binaural recording, with the microphones but a few inches apart, as was shown in Fig. 1B. Generally, microphones with a figure-8 polar characteristic are employed; these are most sensitive to sound arriving from the front and rear but not from the side. One microphone is pointed to the right side of the sound source and the other to the left side. The angle at which they are pointed is such that, between them, they also cover the center of the source. Since the microphones are closely spaced, the predominant difference in the signals arriving at each is one of intensity rather than arrival time. Use of a partition between them, as in Fig. 1B, increases the intensity difference.

A specific form of the intensity difference technique, called "Stereosonic" recording, utilizes two bi-directional microphones placed in the same vertical axis and arranged so that their polar characteristics are at a 90° angle to each other, as shown in Fig. 3B.

Mid-Side Recording

A technique that has been widely used in Europe is known as "mid-side recording" and employs a specially designed microphone, the *Neumann* SM-2, which is known in the United States under the name of *Telefunken*. The SM-2 comprises two condenser microphones in a single housing. The "mid" microphone has a cardioid (heart-shaped) pickup pattern and is pointed at the sound source. The "side" microphone has a figure-8 pattern and is placed parallel to the source, so that the front receives sound from the left and the rear receives sound from the right. The total pickup pattern with this technique is shown in Fig. 4.

The mid microphone picks up all the sound, namely from the left, right, and

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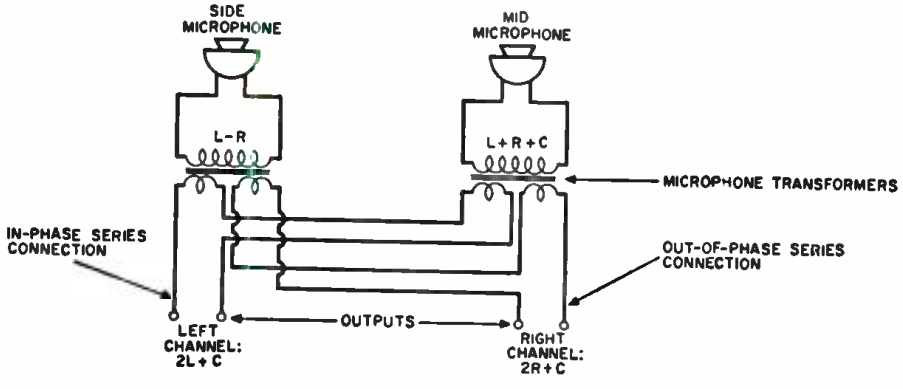
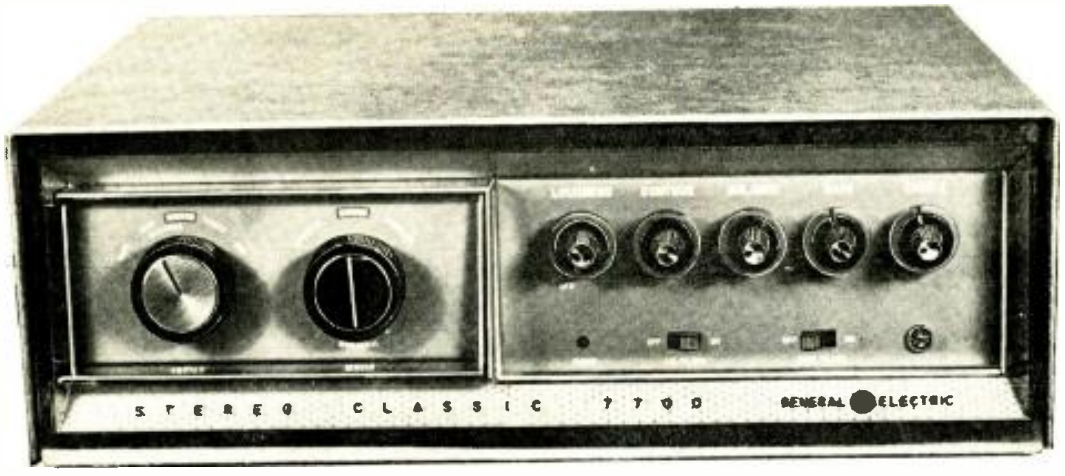
Fig. 5. Matrixing circuit for the signals generated by the mid-side (M-S) microphone.





The "Stereo Classic" Hi-Fi Amplifier

ELECTRONICS WORLD LAB TESTED

G-E's Model G-7700 is conservatively rated and will provide top quality hi-fi reproduction.

THE advent of the stereo disc in 1958 presented a serious problem to high-fidelity component manufacturers. They felt that the initial equipment cost to provide dual-channel operation would be beyond the reach of most high-fidelity enthusiasts. With this thought in mind the design engineers went to work and the integrated stereo amplifier system evolved. By combining dual preamplifiers and power amplifiers on a single chassis the cost of the system was reduced materially. However, many manufacturers went beyond this point and reduced the available power output. Most of us will recall that prior to the stereo disc, amplifiers as high as 50, 60, and even higher wattages were not unusual, but in the early days of integrated systems the usual power ratings were between 12 and 20 watts per channel, or even lower. The industry's goal of reducing cost was achieved but, in many instances, it was at the expense of power along with increased harmonic and IM distortion.

Out of some half a dozen different integrated amplifier systems we have checked in recent months, the *General Electric Company's* Model G-7700 comes as close to pre-stereo performance as one could hope. Cost-cutting was not the major factor in the design of this unit and when compared to other units its price is not among the lowest. However, as *G-E* puts it, this unit has been designed for the group of high-fidelity enthusiasts who put greater emphasis on quality than on reduction of cost. The company has, in fact, other integrated amplifier designs at various price levels, but its G-7700 is at the top of the list as far as performance is concerned.

The unit combines all the major functions required in as simplified and compact form as possible. In addition to the conventional volume, loudness, balance, bass, treble, and low- and high-frequency filters, it has two selector switches, one to control the type of input and the other to select the output or speaker operation. Dual inputs are provided for tape head, magnetic phono, tuner, and auxiliary. In addition, the unit has a single input jack for use with monophonic magnetic cartridges. Output selection is for stereo, reverse stereo, and parallel speaker operation. When the monophonic phono input jack is used, this same front-panel selector switch provides a choice of either the left or right speaker or both in parallel. Output jacks are provided for recording stereo tape and a separate phase reversal switch is mounted on the rear panel.

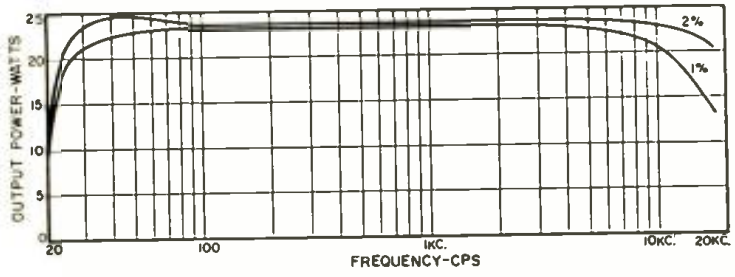
These are the various functions which this integrated amplifier system will provide. The only ones that seem to be omitted are provisions for third or center-channel speaker operation and provisions for selecting phono input equalization curves. The design of this unit provides a fixed equalization curve, NARTB for tape input, and RIAA for all phono operation.

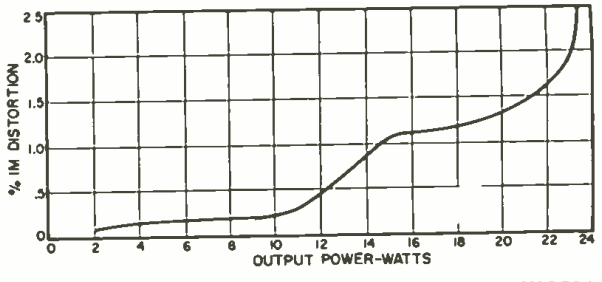
For anyone to really appreciate the performance of this amplifier as far as

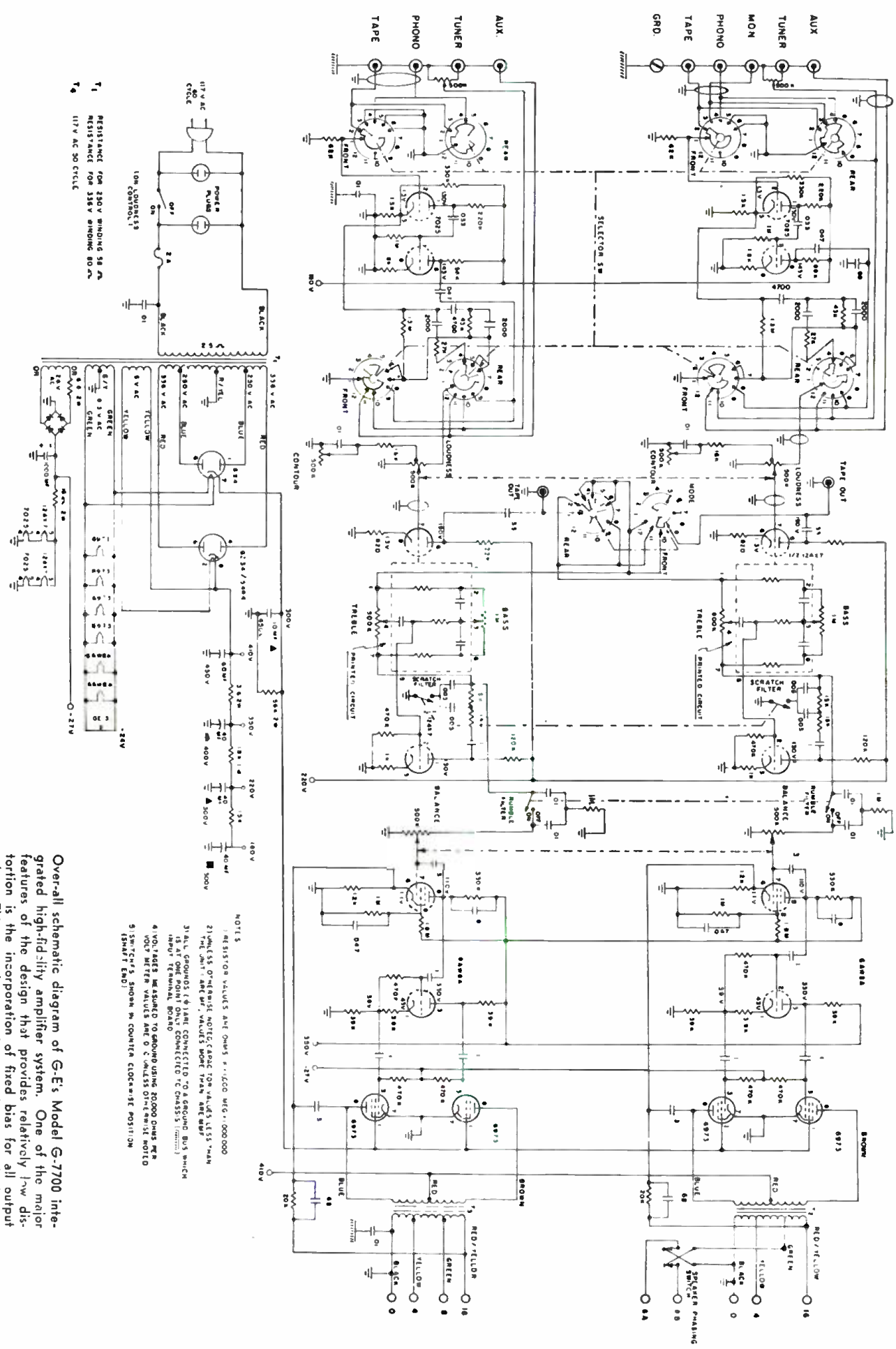
(*Continued on page* 138)

Fig. 1 (Left). Harmonic distortion vs power output curves. According to the Institute of High Fidelity Manufacturer's power-bandwidth standard, G-E could have rated this unit at 24.7 watts from 20 cps to approximately 25,000 cps at 2% harmonic distortion.

Fig. 2 (Right). IM distortion performance of integrated amplifier system. A distortion of 1.32% is obtained at rated power output of 20 watts. 60 and 6000 cps at a ratio of four-to-one respectively were used in making this test.







Over-all schematic diagram of G-E's Model G-7700 integrated high-fidelity amplifier system. One of the major features of the design that provides relatively low distortion is the incorporation of fixed bias for all output tubes. This same bias supply is used to provide heater power for the input stages. The retail price is $189.95.

Converter is mounted in small box and is connected to the transistor radio by means of 4-pin connector.

Transistorized Citizens Band Converter

By SOL LEISE, 4W0385

Build this single-channel crystal-controlled converter to be used with a broadcast band transistor receiver.

MOST of the articles which have been written about receiving equipment for the Citizens Band have dealt with superregenerative receivers. The reason for this is that the superregenerative circuit uses a minimum of parts yet provides good sensitivity. Such a circuit, however, has a couple of disadvantages, including annoying hiss when no station is being received and also changes in frequency when the hand is brought near it—due to the capacity effect of the hand. The amount of regeneration must be varied for stations having different signal strengths.

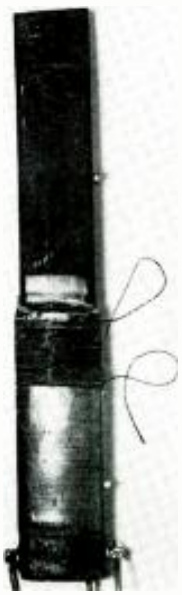
The superheterodyne converter described here is designed to feed into a transistor radio and, while no more sensitive than the superregenerative detector, does have the advantage of freedom from the hiss associated with regeneration. Since it is crystal-controlled, the circuit provides excellent frequency stability. Also, no adjustments are needed for different signal levels except the conventional use of the regular volume control on the transistor radio.

An interesting feature of this converter-radio combination is that the radio provides sufficient selectivity so that no trouble is experienced in separating adjacent channels, yet the converter's selectivity is sufficiently broad so that several channels to either side of the desired one can be received by merely tuning the transistor radio dial. The lead photograph shows the converter installed in a *Bud* #3001 "Minibox" and connected to a "Knight" transistor radio. The converter uses two transistors which draw a total current of 2 ma. at 9 volts. This converter was designed to be used with any popular transistor radio but can, of course, be used with a larger, tube-type receiver.

Circuit Description

The converter, whose schematic is shown in Fig. 1, consists of an *RCA* 2N384 transistor which is used as a mixer and a *Texas Instrument* 2N248 unit which is used as a crystal-controlled oscillator. Neither of these transistors is cheap, the 2N384 selling for about $6.50 and the 2N248 for $4, but they do give good results since the 2N384 has a cut-off frequency of 100 mc. while the 2N248 cuts off at 50 mc.

Mixer coil around rod antenna.



The antenna feeds into a high-impedance parallel-tuned circuit because, for the sake of portability, a vertical antenna of 1½- or 2-foot length is used. Such a short antenna presents a high-impedance input to the tuned circuit. A slightly longer antenna can be used without changing the input circuit, but if a full length, quarter-wave antenna or a beam is used, then the input circuit should be changed from parallel-tuned to series-tuned. Coil L_1 is tuned to the desired frequency in the Citizens Band. L_2 is a low-impedance, untuned winding which is used to couple the high-impedance antenna circuit into the low input resistance base of the 2N384. The output circuit of the 2N384 mixer is tuned to a quiet spot in the broadcast band and is fed into the transistor radio which is used as an i.f. and audio amplifier. The coil is wrapped around the ferrite rod antenna of the transistor radio. Details of this coil are given later.

The oscillator circuit uses a *Texas Instrument* 2N248 transistor and is crystal-controlled, using an *International Crystal* Type FA-5 third-overtone crystal. The circuit has been designed for maximum output while, at the same time, protecting the 2N248 in case oscillation stops because of improper tuning of L_5—in which case the collector current will not exceed 4 ma. Since the maximum permissible collector current is 5 ma., a fair safety margin is provided. During normal operation, the 2N248 oscillator draws about 0.8 ma. of collector current and the 2N384 mixer about 0.6. The output of the oscillator is coupled to the mixer by L_4.

From Figs. 1 and 2, it can be seen

that the 2N384 transistor has four leads instead of the usual three. This fourth lead is a shield connection and attaches to the transistor case. Besides providing shielding, it also reduces interelectrode capacitance for more efficient operation. In this converter, however, it was found that the use of the shield lead made no noticeable difference in the operation of the unit. It was used anyway, just to be on the safe side.

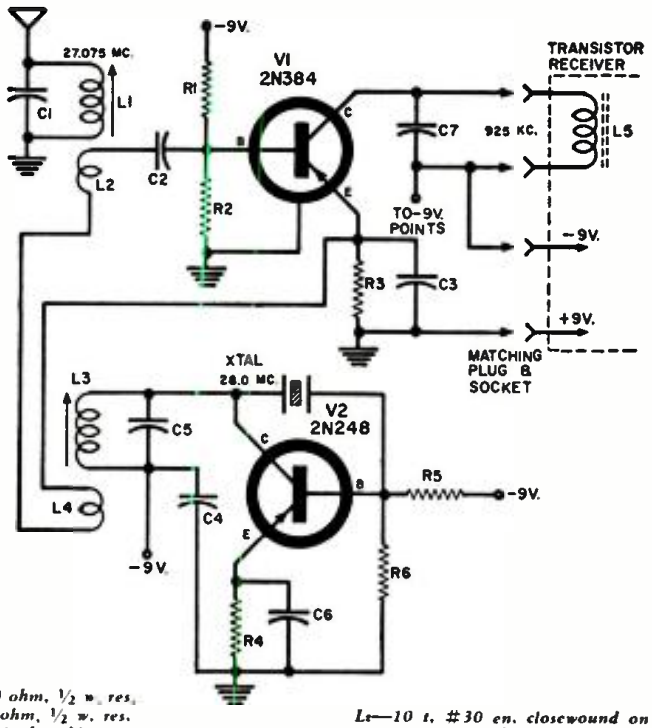
It may be noticed that the output circuit of the mixer has no r.f. bypass capacitor to ground. The reason for this is understood when it is seen that C_4 performs this function when all of the points receiving "minus 9 volts" are tied together.

The Oscillator Crystal

As mentioned previously, a transistor radio is used as an i.f. and audio amplifier. Since it should permit broadcast reception when not required as a converter, pick a frequency spot somewhere near the center of the broadcast band where no stations are heard. The center of the band is preferable because the receiver will probably have the best sensitivity at this point. Any other portion of the band can be chosen, however, in order to get a frequency clear of broadcast stations. Once the broadcast-band frequency setting has been determined, you should next decide what Citizens Band frequency you wish to receive. The crystal frequency required for the oscillator is then equal to the Citizens Band frequency minus the broadcast-band frequency. You can also use a crystal frequency equal to the sum of the two frequencies. This will work equally well except that if it is desired to listen to a channel lower in frequency than the normal channel, the radio will have to be tuned to a higher frequency. Using the first method of determining the crystal frequency will result in having to tune lower in frequency when wishing to listen to a lower channel. The second method was used in building this particular converter, only because a crystal was already on hand.

Construction

It can be seen from one of the photographs that the components are mounted on a small fiber board which has been liberally supplied with small holes. These holes were drilled in the board to facilitate the original layout of parts. A suitable board material would be Bakelite panel 1/16" thick or one of the many commercially available "breadboards" designed for transistor and miniature equipment construction. Since most builders do not have facilities for processing printed circuits, this circuit was wired with regular #20 solid, bare wire except where one wire crosses or gets too near another. All holes were drilled with a #56 drill, except those for the coil terminals which require a #48 drill. Since some of the holes are quite close to each other, extreme care should be



R_1—470,000 ohm, ½ w. res.
R_2—10,000 ohm, ½ w. res.
R_3, R_4—1000 ohm, ½ w. res.
R_5—430,000 ohm, ½ w. res.
R_6—68,000 ohm, ½ w. res.
C_1, C_3—10 μμf. tubular ceramic capacitor
C_2, C_5, C_6, C_8—500 μμf. disc ceramic capacitor
C_7—100 μμf. disc ceramic capacitor
L_1—19 t. #30 en. closewound on ¼" dia. form (Cambridge Thermionic #2271-2 or equiv.)
L_2—10 t. #30 en. closewound on same form as L_1, spaced ⅛" from ground end of L_1
L_3-L_4—Same as L_1-L_2 except L_3 has 18 t. (see text)
L_5—Mixer coil (see text)
V_1—"p-n-p" transistor (RCA 2N384)
V_2—"p-n-p" transistor (Texas Instrument 2N248)
Xtal.—Third overtone crystal (International Crystal Type FA-5, see text)

Fig. 1. Complete schematic diagram and part listing for single-channel converter.

used, both in layout and drilling.

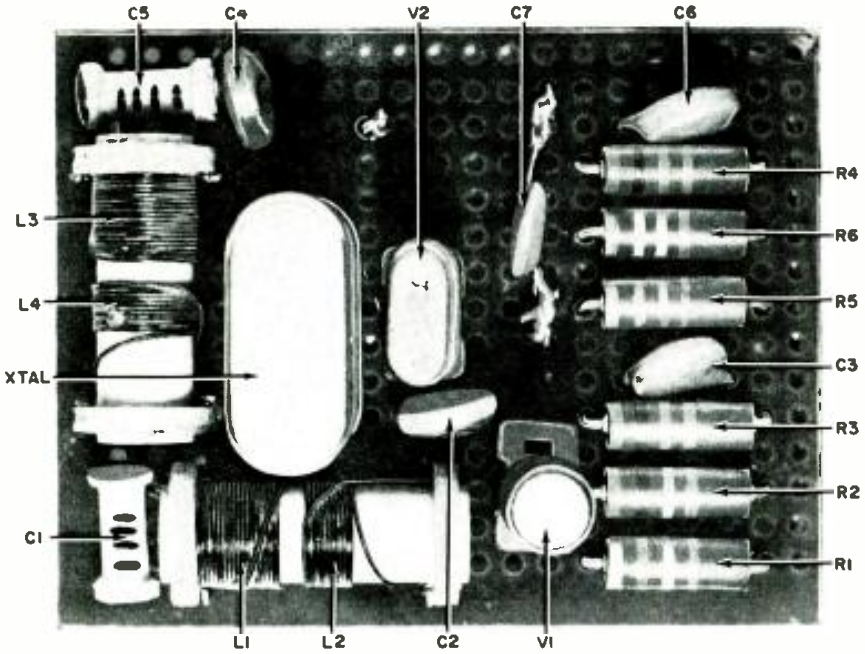
The crystal mounts directly on the board and its pins should be shortened unless it is planned to use the crystal in another project later on. Scrape the crystal pins before inserting the crystal into the board in order to make sure that they will take solder with a minimum of heat. To insert the resistors, bend the leads very close to the bodies. Be sure to leave the leads of the components at full length until the correct length can be determined during the course of the actual wiring.

Coils L_1-L_2 and L_3-L_4 are wound on *Cambridge Thermionic* coil forms #2271-2. Of course, any quarter-inch diameter coil form can be used, but these forms mount very easily on the board. L_1 and L_2 are closewound with #30 enameled wire with L_2 spaced ⅛" from L_1. Coil L_3-L_4 is wound the same way. L_1 has 19 turns, L_3 has 18 turns and L_2 and L_4 each have 10 turns. No thought need be given as to what end of a coil winding goes to what pin as long as one coil connects to the two terminals on one end and the other coil to those terminals on the other end. Of course, the number of turns specified for L_1 is for 27.075 mc. and those for L_3 are for 28.0 mc. with the slugs half way into these coils. The slugs can raise or lower the frequency approximately 0.5 mc. The number of turns of L_2 and L_4 are not dependent on frequency.

Capacitors C_1 and C_3 are tubular ceramic capacitors, *Centralab* Type TCZ 10. Tubular capacitors were used here because they are smaller than disc ceramic capacitors and thus allow room to tune the coil slugs. Refer to Fig. 2 to see the orientation of the two transistor sockets. The pins will have to be bent only slightly to fit them into the holes in the board. The two transistor sockets are *Elco* Type #770 BC. As mentioned before, the 2N384 mixer has four leads. The lead positioning is shown in Fig. 2. The shield lead and the base lead have to be bent to get them arranged as shown in the diagram. Make sure that these two leads do not touch each other. For ease of mounting, unused pins in the sockets are removed by straightening them and slipping them out of the socket body. Cut the leads of both transistors to about ¼ inch.

Coupling to Antenna

The output signal of the mixer stage is fed into the transistor radio by winding the mixer output coil around the ferrite rod antenna. This not only acts as a coil slug and increases the inductance of the coil, but it provides a convenient means of coupling from the mixer to the radio. It will be noticed that the capacitor, C_7, which resonates the output circuit, disconnects from the coil when the converter is unhooked from the radio. It was found that if the resonant circuit is left connected to the antenna, it absorbs sufficient energy so that if the radio is to be used to receive broadcast stations, its sensitivity will be impaired. But, by removing the capacitor when the converter



The placement of the components are shown in this view of the converter unit.

is disconnected from the radio, the mixer coil wrapped around the rod antenna is open-circuited and has no effect on the radio reception.

The winding of the mixer coil should be done with the rod antenna entirely disconnected from the radio circuit so that no false resonant points are obtained. The easiest way to determine the number of turns of wire to be used is by means of trial and error and the use of a grid-dip meter. But grid-dip meters which tune down to the broadcast band are not too plentiful and another method of resonating the coil will be described. Fig. 3 shows the setup for resonating the mixer coil. A photograph of the ferrite rod antenna shows how the coil is wound on it. The antenna in the "Knight" radio required 63 turns of #30 enamel wire, close-wound. The rod antenna shown in the photo is not the one from the "Knight" radio but is similar to the type used. Since the size of the rod antenna varies with different receivers, no specific number of turns can be given.

To use the alternate method, first wind the mixer coil, putting about 80 turns on. Place a 100 $\mu\mu$f. capacitor in parallel with the winding. Next, wind a temporary coil, of about 20 turns, on the rod antenna and connect a v.t.v.m. across it. Set the v.t.v.m. to its lowest negative voltage scale. Use an r.f. probe or make one as shown in Fig. 3. Attach a signal generator in parallel with the mixer coil, being sure to use the 15 $\mu\mu$f. capacitor in series with the hot lead so that the generator will not add too much capacitance to the circuit. Slowly vary the generator over the broadcast band or until the v.t.v.m. peaks. This will give the resonant frequency of the coil. Add or remove turns until the resonant frequency is what you want. Now, remove the temporary coil and place a layer of tape over the mixer coil, leaving about 8 inches of wire for each lead.

Replace the rod antenna in the radio. If sufficient room is available, a small 4-pin *Winchester* C4-20S socket can be mounted on the radio and the two rod antenna leads connected to it. If the *Winchester* socket is not available, an *Amphenol* #126-215 socket will work equally well. While the receiver is open, two wires should be connected so as to make the radio battery accessible for powering the converter, unless a separate battery is going to be used. If the radio battery is used, be sure to take one output from across the switch on the volume control so that the battery is disconnected from the converter when the radio is off.

Mounting the Converter

The converter can be mounted in any number of ways. The builder should give some consideration as to the best method and leave enough of the board for this purpose. One precaution should be taken if the battery in the transistor radio is used to power the converter. It does not matter if the radio uses *p-n-p* or *n-p-n* transistors as long as the battery polarity shown in the schematic is followed. However, if the transistor radio uses *n-p-n* transistors, and since the converter uses *p-n-p* units, then the converter circuit ground should not be allowed to come in contact with the radio circuit ground. This would only occur if the converter ground is connected to a metal case, and the radio has a metal case to which its ground is connected.

A mating connector similar to the one used on the receiver was attached to the "Minibox" and the converter was mounted inside. Its circuit ground was not connected to the "Minibox." A test jack on the top of the box finishes off the unit. A 1½-foot piece of bus wire is used for the antenna of the unit.

Testing Procedure

After carefully checking over the wiring of the converter, connect it to a 9-volt battery, observing the correct polarity. Using a receiver with a signal-strength meter and tuned to the oscillator frequency, adjust the slug in coil form L_3-L_4 until oscillation occurs and then adjust the slug for maximum output.

Tuning will be very broad. A wooden match, shaped at one end, can be used to turn the slug. A metal screwdriver will give false results and also damage the tuning slug. Next, connect the converter to the transistor radio which is tuned to the previously selected vacant spot on the tuning dial. A signal generator tuned to the selected frequency in the Citizens Band will tell you if the mixer is working. Adjust the slug in coil L_1-L_2 for the loudest signal. The tuning will be broad, but not as broad as that of the oscillator.

Performance and Summary

Because the converter uses a short antenna, does not have an r.f. amplifier, and feeds into a radio whose gain may not be too great, it was not anticipated that stations more than a mile away could be received. To test the converter-radio combination, a 5-watt transmitter was placed in an automobile and connected to a quarter-wave antenna. As the distance between the transmitter and receiver increased, the received signal decreased until it could just be heard at a distance of 8/10ths of a mile. True, this is not a very great distance, but with a longer receiving antenna and a transistor radio having two i.f. stages, the distance should increase. Because of its low current drain and portability, this setup, along with a small, transistorized transmitter should make a good short-haul contact with a fixed station. -30-

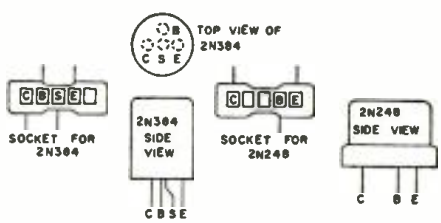
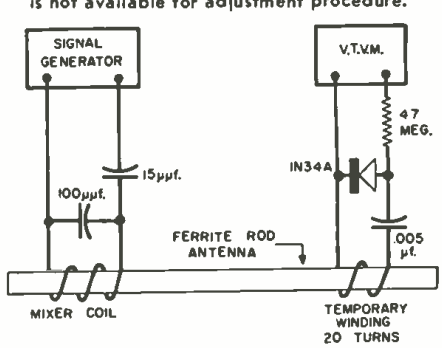


Fig. 2. The two sockets and transistors used in converter. Unused pins in sockets have been removed for mounting ease. Notice bending of leads of 2N384 so that it fits into the Elco #770 BC socket.

Fig. 3. Setup for alternate method of resonating mixer coil if grid-dip meter is not available for adjustment procedure.



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Hi-Fi-Audio Product Review

SPEAKER BALANCER

Kinematic Inc., 1616 N. Damen Ave., Chicago 47, Ill. has developed a twin-

signal tone generator which is designed to aid in balancing speaker outputs in stereo music systems.

Trade-named the "Twin-Tone," the new unit is completely transistorized and permits balancing speakers in only seconds when used with a balance meter. Even when used alone, the unit eases the balance problem and eliminates the need for a stereo test record, according to the company.

The signal generator is simply plugged into unused input channels A and B of the amplifier and is ready for use. By means of a sliding switch located on the front panel of the unit, a constant 1000-cps tone is produced. Volume controls on the amplifier are then adjusted until the needle on the balance meter is centered—indicating identical speaker output. When used alone, the 1000-cps tone can be used to adjust the speaker systems by ear.

STEREO "KONNECTOR KIT"

Rek-O-Kut Company, Inc., 38-19 108th Street, Corona 68, N. Y. has recently introduced a complete "Stereo Konnector Kit" which has been designated as the KK-1.

The new unit features color-coded wires in a single sleeve to eliminate the "spaghetti bowl" look. The kit is designed to be used with any tone arm. In addition, the KK-1 offers quick, easy, and accurate connections between the stereo tone arm and the amplifier, according to the company.

Dealers are being offered this new item in lots of 18, complete with a free counter display rack. Contact the manufacturer for details.

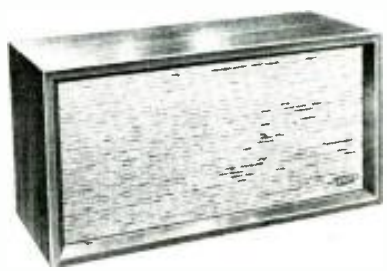
"SEMI-KIT" SPEAKERS

EICO, 33-00 Northern Blvd., Long Island City, N. Y. has announced the availability of three new high-fidelity speaker systems which are being offered as "semi-kits."

The HFS-3 and HFS-4 are three-way systems while the HFS-5 is a two-way bookshelf-size unit. The HFS-3 and HFS-4 are identical except for the tweeter; the HFS-3 incorporates a $3\frac{1}{2}$" cone tweeter with level control for those who prefer a softer, more delicate quality in the highs while the HFS-4 has a compression-driver horn tweeter with level control for those liking highs with brilliance and projection. Both of the systems are supplied with a 12" bellows suspension woofer and a 8" closed back mid-range speaker.

The HFS-5 uses an 8" bellows-suspension woofer and a $3\frac{1}{2}$" closed-back tweeter. The enclosure is tuned to 45 cycles by a tuhular ducted port. This model is completely factory constructed.

The two semi-kits are available in



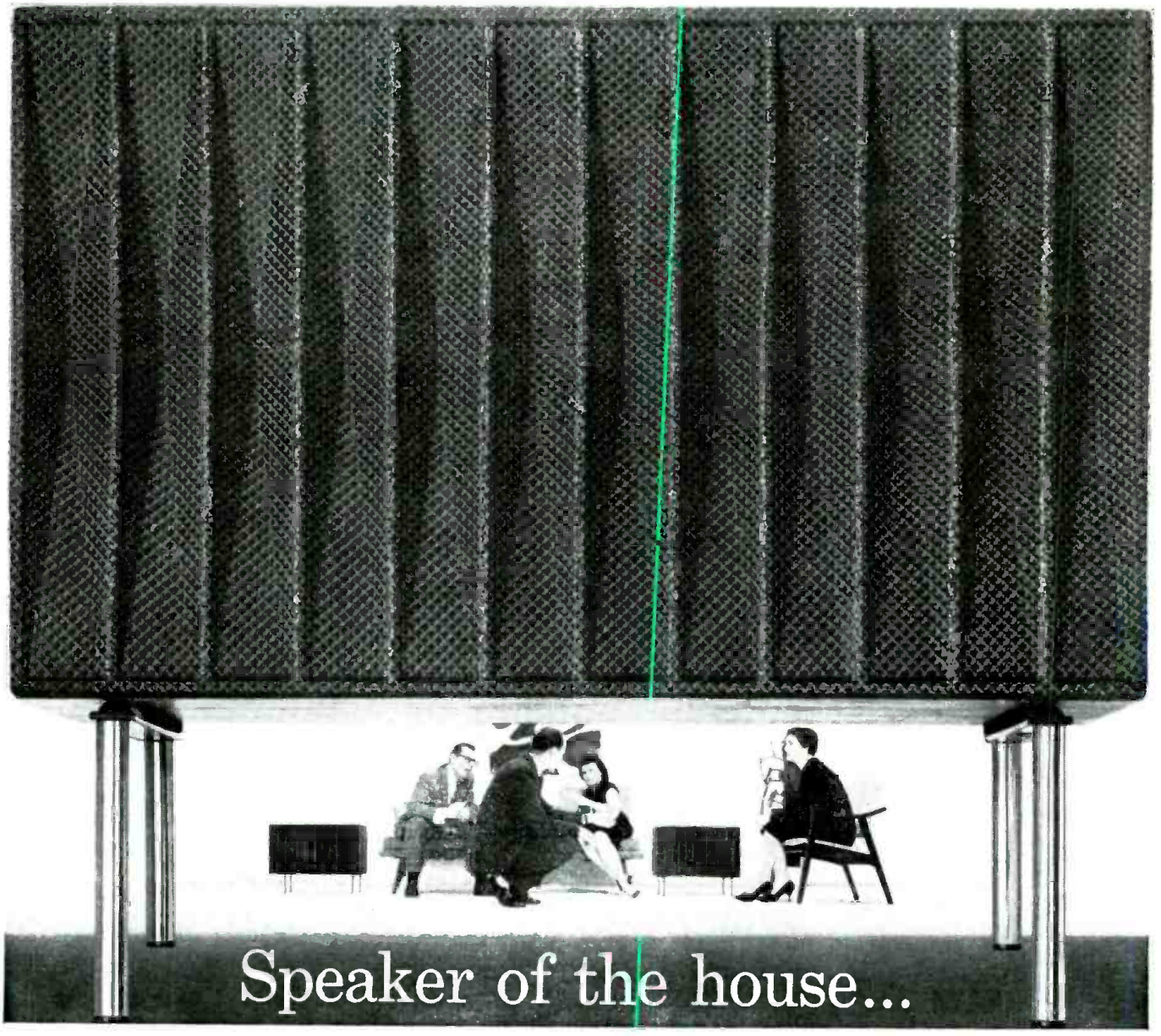
unfinished birch, oiled walnut, satin mahogany, or oiled teak. The HFS-5 is offered in the same finishes but completely assembled.

5-WATT STEREO AMP

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y., is now offering a fully wired 5-watt stereo amplifier as its "TruTest Stereo/5."

The new unit features individual ste-

reo volume-balance controls, separate stereo/mono control, plus "on-off" switch and tone control. Provision is made for crystal or ceramic cartridges. The 4-ohm output terminals will handle most speakers. The circuit uses one 12AX7, two 35C5's, and one 35W4. It operates from a 115-volt, 60-cycle power source.



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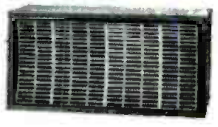

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RA 13

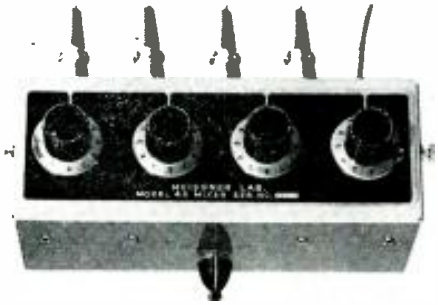
Export: Morhan Corp., 458 Broadway, N.Y. 13 • Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto

The unit measures 4½" x 5½" x 4½", making it suitable for use in the conversion of existing portables or as the basis of a low-cost stereo system.

TRANSISTORIZED MIXER

Meissner Lab., 22 N.W. 9th Avenue, Portland, Oregon is now offering two four-channel transistorized mixers which have been designed for use with professional-type tape recorders.

The Model 4A and Model 4AL units



are designed to provide up to four low-impedance microphone inputs for single-input professional units such as the *Ampex* 600, 601, A Series, and the *Magnecord* PT6-JAH, etc. They can also be used to increase the inputs available on a p.a. amplifier. Each input has a transistor amplifier so mixing takes place at a high level, eliminating noise.

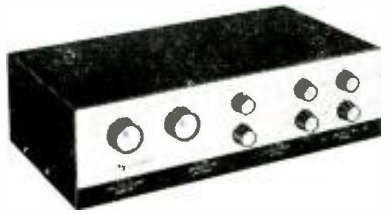
The units are small and lightweight, weighing less than three pounds each. They are housed in gray hammertone aluminum cases. The 4A has high-impedance output while the 4AL is designed for low-impedance output.

Complete specifications are available upon request to the manufacturer.

STEREO PREAMP

Dynaco Inc., 3916 Powelton Ave., Philadelphia 4, Pa. has introduced a new stereophonic preamplifier, the PAS-2, which is available in both kit and wired versions.

This deluxe stereo control unit will handle up to seven stereo or fourteen monophonic inputs. The inclusion of the "*Dyna* Blend Control" permits variation of the stereo effect to eliminate possible "hole-in-the-middle." This con-



trol can also be used for mixing two monophonic sources so that a microphone, for example, can be dubbed over a recording.

Construction of the kit is simplified by the use of two factory assembled printed circuit boards which include three-fourths of the components. Average construction time is about 8 hours. The built-in power supply (including d.c. heater supply) permits operation with any power amplifiers.

The PAS-2 measures 13" x 8" x 3¾" and weighs 11 pounds. It is available with either bone white or charcoal brown textured vinyl finish and includes cover, connecting cables, and built-in power supply.

Full details are available from the company's distributors or the manufacturer direct.

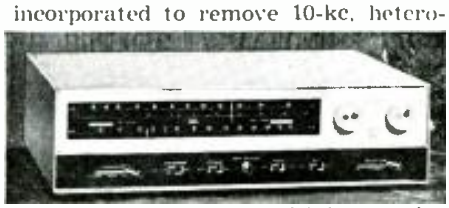
STEREO FM-AM TUNER

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Illinois is currently offering a deluxe stereo FM-AM tuner as its "Knight KN-125" model.

The tuner incorporates adjustable dynamic sideband regulation for precise correction of carrier modulation level—a feature that permits distortion-free reception of weak and over-modulated signals. Designed for future multiplex conversion, the unit has a front-panel control for an adapter.

To permit noise-free FM reception in fringe areas, the tuner has a 50-ohm input for shielded antenna lead-in. Employing a dual-limiter discriminator circuit, the FM section provides a sensitivity of 2½ microvolts for 20 db quieting. The section has a tuned r.f. stage and a.f.c.

Also employing a tuned r.f. stage, the AM section of the tuner has a 3-position AM bandwidth switch. A filter is incorporated to remove 10-kc. hetero-



dyne whistle. The sensitivity of this section is 4 microvolts for 20 db signal-to-noise ratio.

The KN-125 is supplied in a metal case with bonded beige vinyl covering and a control panel of gold and charcoal-beige anodized aluminum. For details on this completely assembled tuner, write the company direct.

DYNAMIC HEADPHONES

The *Permadyne Division* of *Melody Master Mfg. Co.*, 2149 W. Roscoe Street, Chicago 18, Ill. is now in production on a new line of extended-range dynamic headphones which has been especially designed for high-fidelity applications.

The current line includes four monaural and two binaural headphone models and three extended-range earphones. The headband is adjustable and ear cushions (#1505) are available if desired.

For a list of the available units, with impedance data, cord length, plug, and price, write the company for a copy of its two-color data sheet.

HEATH MULTIPLEX ADAPTER

Heath Company, Benton Harbor, Michigan has added a multiplex adapter to its line of audio and high-fidelity equipment in kit form.

The MX-1 allows owners of FM radios and tuners to enjoy multiplex FM stereo broadcasts. The adapter kit is designed to receive multiplex stereo programs transmitted in accordance with the *Crosby* system of stereo broad-

casting. Among the features of the new unit are a self-contained power supply, stereo dimension control, channel balance control, function selector switch, phase-reversal switch, inputs for FM (main channel) and multiplex (sub-channel), and cathode-follower outputs for both channels.

The function switch on the adapter provides for stereo, main channel, or multiplex channel modes of operation.

AUDIO CATALOGUES

HI-FI GLOSSARY

Minnesota Mining and Manufacturing Company has re-issued a revised glossary of high-fidelity and tape-recording terms in response to popular demand.

Called "99 Tape Recording Terms," the glossary is free upon request to Dept. E9-520 of the company at 900 Bush Avenue, St. Paul, Minn.

Numerous words added to the English language as a result of magnetic tape's widespread acceptance throughout the recording industry prompted the compilation of the glossary. The concise, easy-to-understand definitions apply to recording tape as well as to tape recorders and hi-fi in general.

SPEAKER ENCLOSURE PLANS

Audax, Inc., 38-19 108th Street, Corona 68, N. Y. is currently offering a 12-page booklet entitled "How to Build Your Own *Audax* Paraflex Speaker System" for 25 cents in coin.

This detailed booklet, profusely illustrated, contains plans for six speaker enclosures. Included in the booklet are full descriptions and specifications on the company's entire line of component speakers and speaker systems.

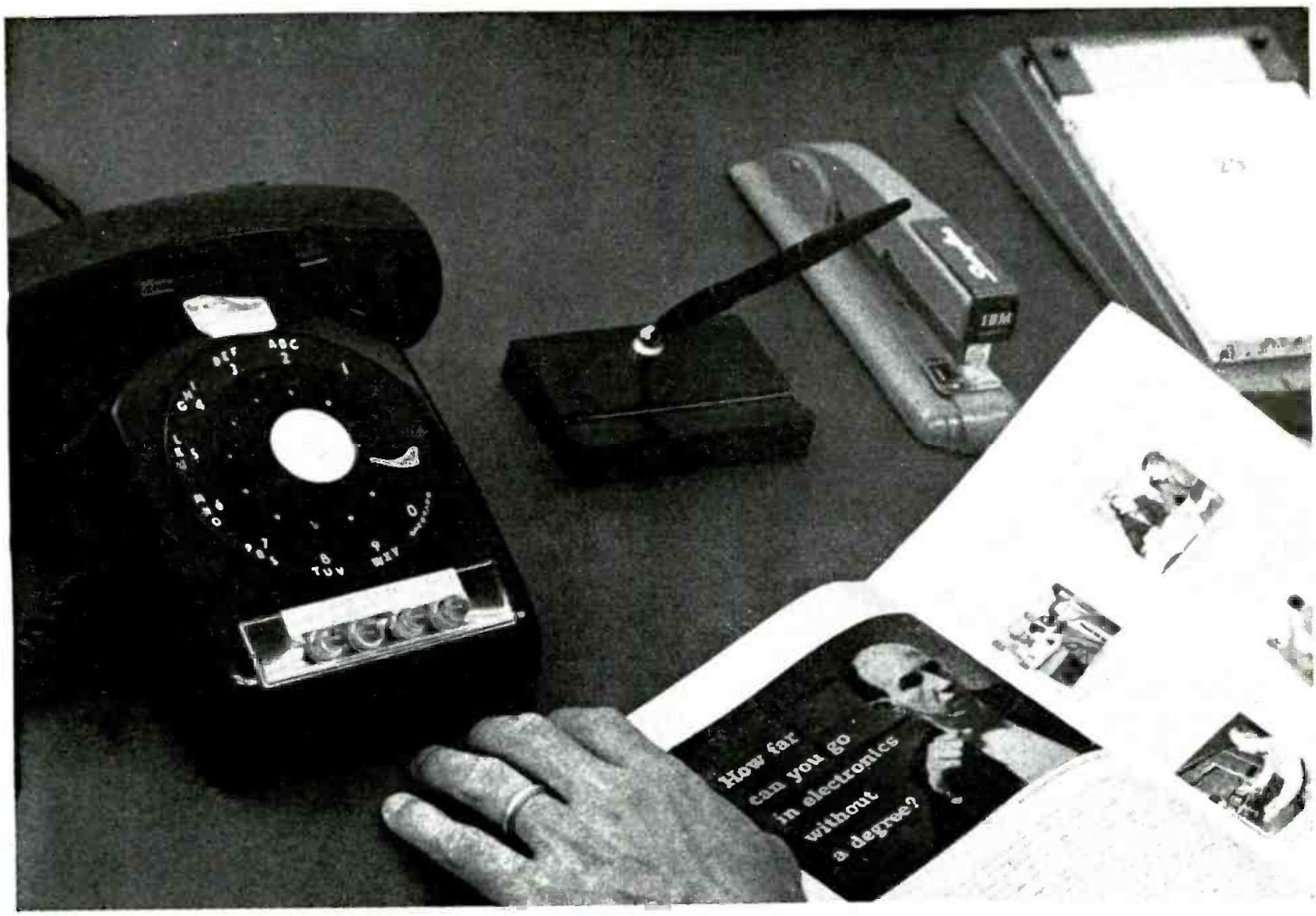
Orders for the booklet and payment should be sent direct to Department 37 of the company at the Corona address.

NEEDLE WALL CHART

Duotone Company of Keyport, N. J. has announced publication of its 1960 Replacement Wall Chart.

This new chart is a little over 20 inches wide and 31 inches deep and lists over 700 needles for both mono and stereo—osmium, sapphire, and diamond—with cross-reference information on cartridges and record speeds. There is a clear-cut illustration of each type of needle for quick visual identification.

Brand names of phono cartridges with model numbers are listed alphabetically in one column; record speeds in the next; then *Duotone* replacements follow, column by column, according to type. The chart is organized so that customers as well as the dealer may use the information. —30—



How far can you go in electronics . . .

Two years ago, Field Engineer William G. Miles was asked to outline *his* thinking on how far he could go in electronics at IBM . . . without a degree. Now, he reviews the progress he's since made. His present position: Group Manager, responsible for keeping one of America's largest electronic computers in top operating condition. Here's his story.

HURDLING THE DEGREE BARRIER. "A few years ago," recalls Bill Miles, "I felt that I'd gone about as far as a technician could without a degree. I just couldn't hurdle that education barrier. Now, thanks to IBM, I have a solid electronics education. I'm a Group Manager on the SAGE project, responsible for 20 field engineers. My future looks brighter than it ever did. I don't know of another company where a technician can go farther or receive more recognition, without a degree, than at IBM."

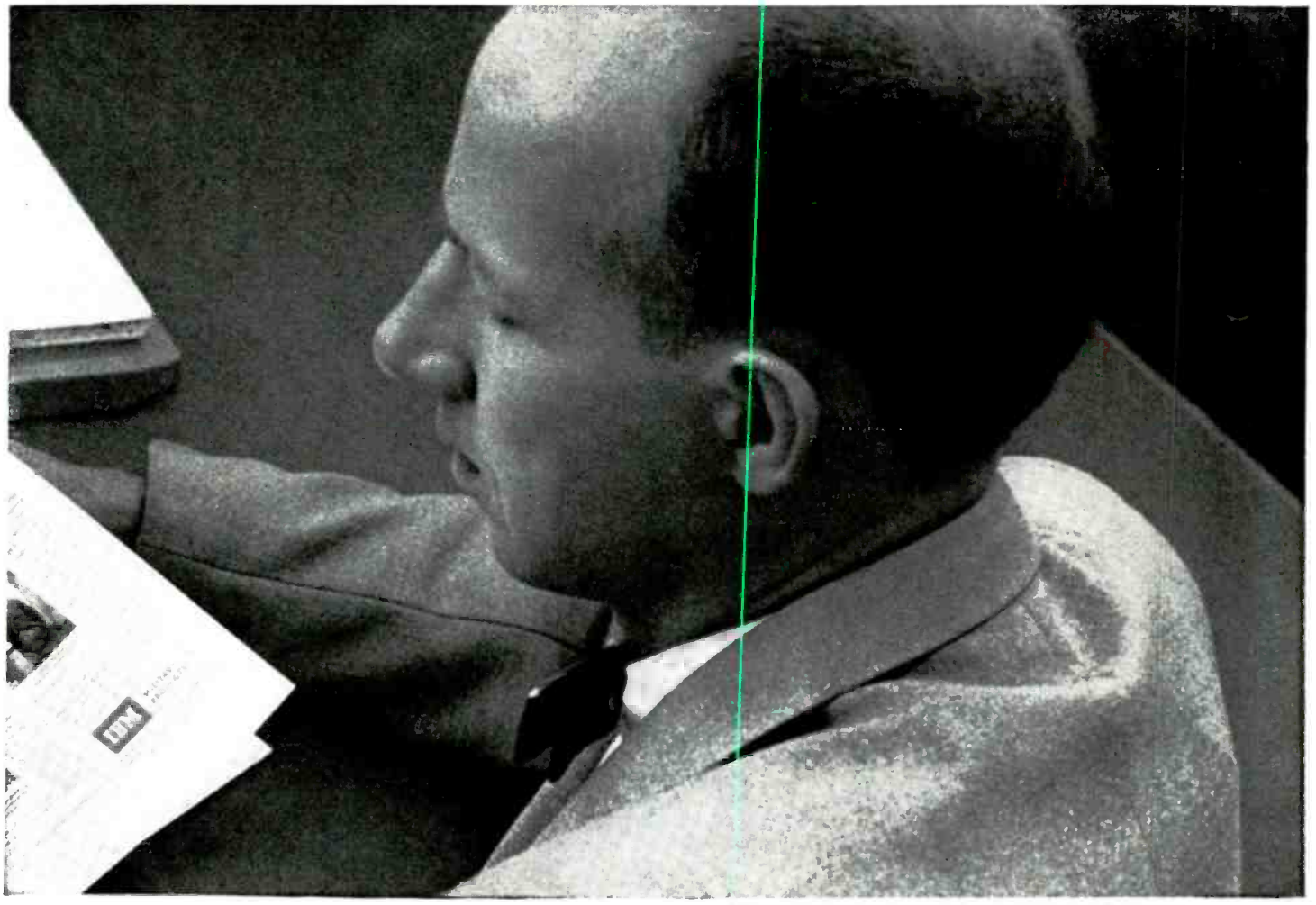
UTILIZING HIS NAVAL TRAINING. Bill Miles spent three years as a Naval Aviation Radar Technician. After discharge from service, he worked as a TV serviceman, at the same time pursuing an engineering education at night. "I knew there were good career opportunities around somewhere, but I couldn't find them," Bill Miles says. "I investigated several big companies. They were impressed with my ability, but my lack of a degree kept me from the kind of a career I wanted. Then I answered an ad similar to this."

EXTENSIVE ELECTRONICS SCHOOLING. In May, 1955, he joined IBM and began an extended training course. "The teaching was as technically advanced as I could ask for. Each day, I gained a deeper knowledge of electronics and added to my professional stature. IBM shows real interest in you as an individual: what your goals are, what plans you've made to reach your goals, how the company can help speed you toward them or even higher goals."

ASSIGNED TO SAGE SITE. After his training, Bill Miles was assigned to a SAGE site. SAGE is an important link in America's air defense, and the heart of SAGE is a real-time computer made by IBM. The SAGE computer analyzes radar data with uncanny accuracy, checks it against available air traffic information, and presents visual displays to assist the Air Force in identifying flying objects as friend or foe.

UPGRADING TECHNICIANS. "The job of IBM field engineers is to keep SAGE computers running," he explains. "This involves maintaining, testing, and checking computer units. It means anticipating trouble before it occurs. The work turned out to be exactly what I was looking for. I had a chance to do work ordinarily done by graduate engineers . . . work usually denied to men without a degree. Of all the companies I know, IBM appears to be one of the few which upgrades technicians to levels of engineering responsibility . . . levels dictated not by your formal education but by your native talents."

MANY EDUCATIONAL OPPORTUNITIES. "SAGE field engineers have many opportunities for education beyond the 'basic' training, which lasts 20 weeks," says Bill Miles. "After a year or two in the field, they may be selected for further training to learn how the complete SAGE electronic computer system works. To



Bill Miles reviews two-year-old article about his IBM career.

without a degree?

keep up with the most advanced electronic developments. they may also attend classes during working hours."

RAPID ADVANCE TO GROUP MANAGER. In his four years with IBM, Bill Miles has received several promotions. He is now Group Manager at a SAGE site. "My advancement is an example of IBM's policy of promoting from within," he says. "The company is quick to recognize a man's contributions and quick to reward him. This means lots of opportunities for new men who show potential for advancement along clearly defined routes—both in the technical and managerial areas. There are no limits set on your future. Everything IBM has ever promised about advancement in field engineering, I've seen happen—either to me or to someone I know."

* * *

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A Practical Transistor Tester

By ROY A. McCARTHY, K6EAW

A relatively simple unit checks current gain and collector-base leakage without auxiliary equipment.

IN COMMON with most persons who come in contact with transistors on a regular basis, the author has long desired a practical instrument which would be handy for obtaining relatively definite data on a transistor's basic parameters. By "practical" in this case is meant a small, self-contained unit which would not require external signal generators or indicators (Fig. 1).

The information most often needed is the collector-to-base leakage, I_{co}, and grounded-emitter current gain, *beta* or h_{FE}. The basic circuits for measuring I_{co} directly and current gain, h_{FE}, are really quite simple; the parts required can generally be found in a good "scrounge box." The meter can be obtained surplus, if it is necessary to buy one for this project. In order to keep the unit self-contained, the author suggests that your multimeter's basic meter not be used as the indicator. Besides it might take a beating with shorted transistors, although protective resistors are used on all measurements.

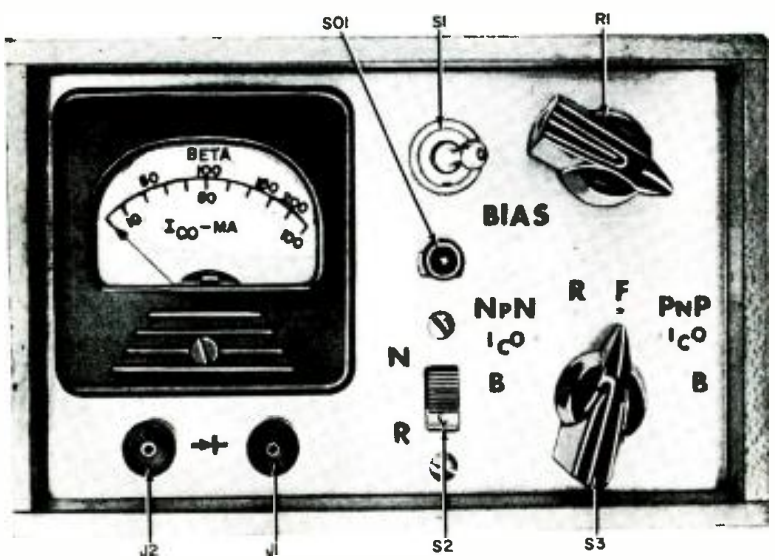
It may he noted that the scale is calibrated direct in I_{co} and *beta*, rather than being marked "Good-Bad." This has its advantages. For instance, if, on occasion, someone asks you to check a transistor for him you can say, "Well, it has an I_{co} of so many microamperes and a d.c. gain of so much." In other words, you are off the hook with respect to deciding whether it's good or bad. You give him the facts and he decides. After all, a transistor that is good for use in one circuit may be a poor choice for another.

The complete schematic appears in Fig. 2. In Fig. 3 the simplified partial schematics show the operation of the circuit under various conditions at the individual positions for measuring I_{co} and *beta* of *p-n-p* transistors and for checking diodes. For *n-p-n* transistors, the battery and meter are simply reversed automatically by the switch position.

As an example, suppose we had a *p-n-p* transistor with an I_{co} at room temperature of 6 microamperes. This reading would be taken with S_1 open (Fig. 3A). On the 100 μa. range this would be shown as 3 divisions of deflection in the first test, since meters are usually marked off in 50 divisions full-scale. After taking this reading, the bias switch (S_1) is then closed and the bias potentiometer (R_1) is adjusted to give an additional 4 microamperes, for a total reading of 10 microamperes on the meter. Then we switch to the *beta* position on S_3 and the *beta* schematic (Fig. 3B). Since we still have the 10 microamperes flowing through the base-to-emitter junction, this current is multiplied by transistor action to give us an indication of the d.c. current gain. A 2-milliampere scale allows testing up to a *beta* of 200. For transistors with an I_{co} greater than 10 microamperes, we simply use the bias adjustment to set up a leakage of 20 microamperes and divide the reading on the *beta* scale by a factor of two.

As shown, the circuit will test popular, low-power *p-n-p* or *n-p-n* transistors intended for r.f. or audio use. As an extra feature, a reversing switch, S_2, inverts the transistor for a quick measurement of its reverse characteristics for use in low-level switching circuits; that is, the collector and emitter connections may be interchanged. This is also handy for reversing the transistor without removing it from the socket, if you happen to have plugged it in backwards, as may be the case with the triangular JEDEC bases. To measure the current gain of an inverted transistor, in which the gain probably will be from 2 to 20, the bias is set up

Fig. 1. The finished unit was mounted in a small, wooden box. Note calibration of the meter scales to provide direct rather than relative gain readings.



for 100 microamperes and the *beta* scale reading divided by 10.

In addition to testing transistors, the unit also checks diodes for shorts or burnout or excessive leakage. For these tests, clip leads are attached to the diode under suspicion from J_1 and J_2 and the tester is used as a simple ohmmeter with built-in reversing feature. The I_{co} scale is used for the direct reading of reverse leakage of the diode (Fig. 3C), and an uncalibrated 10-ma. range is used to give an indication of forward conduction (Fig. 3D). The diode circuitry can, of course, be used to test the individual diode sections of power transistors to obtain some information on their condition, but generally in-circuit testing is preferred for higher-powered units.

Naturally, various sources of error may be present in a simple instrument such as this: for instance, d.c. current gain may not truly reflect small-signal a.c. gain. Also the current-limiting resistors involve voltage drops that alter measurements. However, these factors do not detract from the practical usefulness of the instrument. A glance at the spread of values on the data sheet for almost any type of transistor will show that only relatively accurate data is all that is necessary.

Construction and layout will depend on the individual's preference and the particular size of the components used. The author built his tester in a small wooden box. Wiring was simple and point-to-point. The aluminum front panel was marked with decals and the panel and box treated with a few thin coats of plastic spray. The meter scale was removed from the meter, the numerals were erased, and new figures were hand-printed with ordinary black ink. Perhaps India ink would have been preferable. (A bit of talcum powder lightly dusted on the scale helps to ink in the lettering without smearing!) The author used an "in-line" transistor socket, since the new multi-purpose sockets were not available. Phone tip jacks served as connectors to the diode-testing circuit.

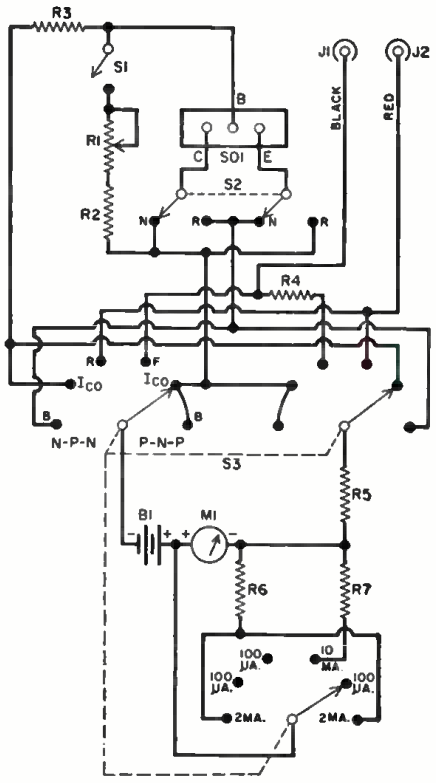
Values of the meter shunts (R_6 and R_7) will have to be determined for the particular meter used and are therefore given only as a guide. Five percent tolerance resistors should be used if available. Before calculating the shunt resistor values, it is necessary to determine the internal resistance of the meter. There are two convenient ways to do this. If a calibrated low-impedance millivolt source is available, the meter simply can be driven to full scale and the internal resistance calculated by Ohm's Law.

Alternatively, the meter can be connected in series with a battery and a rheostat (or other d.c. variable-voltage source), and again the current is adjusted for full scale. Then a separate potentiometer is connected across the meter. The latter is adjusted so that the meter reading is brought down to half scale. At this point the in-circuit resistance of the potentiometer is equal to meter resistance. The portion of the potentiometer that is in the circuit can now be measured directly on a resistance bridge or with an accurate ohmmeter.

Shunt resistors needed (R_6 and R_7) may then be determined by relatively simple calculation. To determine the value of the shunt needed for a 2-milliampere full-scale reading, divide the meter resistance by 19. The value shown on the parts list, for a meter resistance of about 815 ohms, is 43 ohms for R_6. The figure of 19 is arrived at as follows: The meter itself reads 100 microamperes full scale. If we wish to get a full-scale reading with 2 milliamperes (2000 microamperes), the shunt resistor must absorb 1900 microamperes. Since the shunt must pass 19 times as much current as the meter, the shunt resistor must be 1/19th the value of meter resistance R_m.

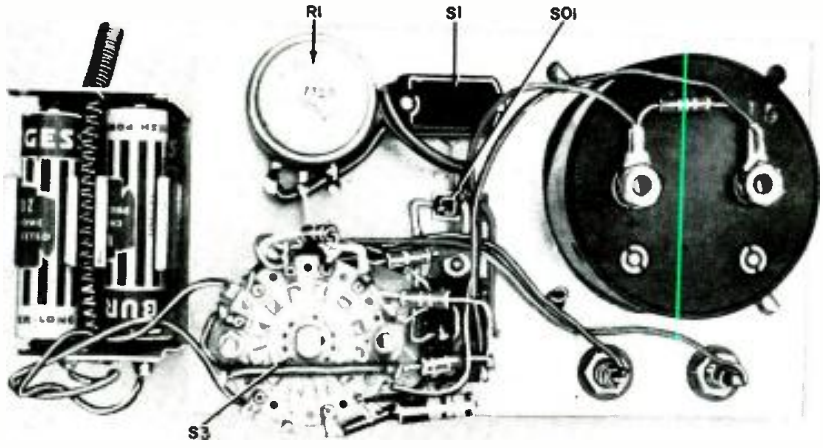
Determination of the value needed for R_7 is similar. To get a full-scale reading on the meter with 10 ma. (10,000 microamperes) applied, the shunt must absorb 9900 μa. while 100 μa. is passed to the meter. This is a 99:1 ratio. Thus the resistance of the shunt must be 1/99th that of the meter, and R_m is divided by 99. For the meter whose resistance is 815 ohms, R_7 therefore becomes 8.2 ohms.

With a little experience in using it, the completed tester becomes a very simple unit to operate. —30—



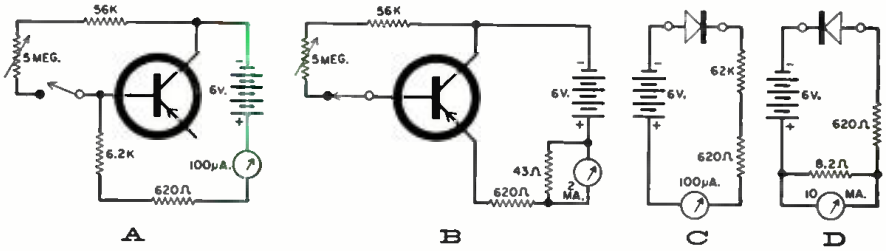
R1—5 megohm pot (Bias)
R2—56,000 ohm, ½ w. res.
R3—6200 ohm, ½ w. res.
R4—62,000 ohm, ½ w. res.
R5—620 ohm, ½ w. res.
R6—Meter shunt (approximately 43 ohms, see text)
R7—Meter shunt (approximately 8.2 ohms, see text)
S1—S.p.s.t. toggle switch
S2—D.p.d.t. slide switch
S3—3-pole, 6-position rotary switch
M1—100 μa. meter
SO1—Transistor socket (see text)
J1, J2—Phone tip jack
B1—6-volt battery (four 1.5 volt penlight cells in series)

Fig. 2. Switching permits test versatility with a battery and output meter.



Rear view of front panel, removed from box, with battery holder swung to one side to expose parts. The layout is fairly simple and uncluttered.

Fig. 3. Partial schematics show test circuits for (A) leakage current and (B) gain. Reverse (C) and forward (D) diode characteristics can also be checked.



Transistor Radio Circuits

Part 5. Covers the push-pull audio output stage and transistors as replacements for standard vibrators.

EDITOR'S NOTE: *This material on transistor circuits, appearing here and in subsequent issue, is being reproduced with the kind permission of the* Delco Radio Division *of* General Motors Corporation. *Although originally prepared and distributed to those servicing* Delco *auto radio receivers, much of the information is also applicable to other types of transistorized radios and we believe it worthwhile to present this material to our readers.*

P-P Audio Output Stage

Fig. 9 shows two 2N173 power transistors in a push-pull class AB amplifier circuit. The transistors are connected in a common-emitter arrangement which takes advantage of the tremendous power gain potential of the units.

The emitter-base circuits of each of these transistors are biased in the forward direction by the action of the positive 12 volts being applied directly to the two emitters. A voltage-divider network, inserted between the 12-volt line and ground, consists of a 4.7-ohm resistor, a 39-ohm resistor, and a 150-ohm resistor. The base of each transistor is connected back to its emitter through one half of the input transformer (T_2) secondary winding and the 4.7-ohm resistor. Current flow through the 4.7-ohm resistor produces a voltage drop across the resistor which is applied to the base elements of each transistor. Thus the base elements are kept about .2 volt less positive than the emitters for forward bias. The collector of each transistor is connected to ground through one half of the primary winding of output transformer, T_3. The collectors are negative with respect to the emitters by almost 12 volts, producing a strong negative field at the collector for good attraction of emitter holes.

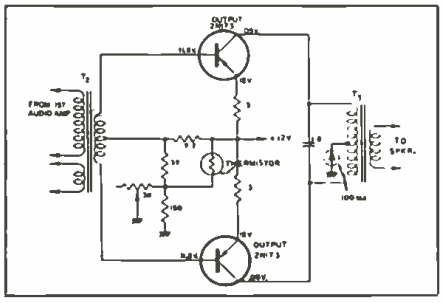


Fig. 9. Two 2N173 power units used in a push-pull class AB amplifier circuit.

By inserting a milliammeter in series with the center-tap lead of the output transformer, the amount of total collector current may be read. This may be changed by varying the ground return resistance for the base voltage divider and a potentiometer is sometimes provided for this purpose. The proper point for setting the static collector current is specified in the service data for each particular model, a typical figure being about 100 ma. for class AB operation.

The audio signal from the previous stage is coupled into the output stage through input transformer T_2, which has an impedance step-down for proper matching between stages. As the base of one transistor is driven positive the other base is driven in a negative direction. The base that is driven negative has increased forward bias and a resulting surge of collector current is produced. The base that is driven positive receives a decrease in forward bias and the collector current of that transistor greatly decreases. In fact, depending on the amplitude of the input signal, the collector current is completely cut off during part of this half cycle when the signal cancels all forward bias and sends the base-emitter diode into a reverse bias condition.

On the other half cycle of the audio signal, the operation is reversed and the transistor that was sent into cut-off will now be driven forward and produce a strong surge of collector current while the other transistor will be driven into cut-off. This is typical of class AB operation where collector current of a transistor is shut off for part of each half cycle while the other transistor conducts. This results in push-pull operation similar to the conventional vacuum-tube push-pull circuit.

The 2N173 transistors in this circuit are bolted to the chassis to dissipate collector heat. However, since the transistor case is connected to the collector element internally, the two transistors cannot be mounted on the same chassis without insulation for this would completely short out the output transformer primary winding. A thin mica insulator is used between each transistor case and chassis and this provides electrical insulation but still allows heat to be transferred to the chassis. The .3-ohm emitter resistors also help to stabilize collector current and prevent thermal runaway.

In addition, a thermistor may be used to stabilize current. This device, which is usually found mounted on the chassis close to the transistor, varies in resistance as the temperature changes. In Fig. 9, a thermistor is connected across the 4.7-ohm and 39-ohm base voltage-divider resistors and changes the base-emitter voltage to compensate for temperature increases which would otherwise cause increased collector current.

Vibrator Circuit

Transistors can be used in a special circuit to produce a square-wave output to replace the standard vibrator in automobile radios. This is especially

useful where the receiver is designed to use standard tubes in some stages and "B+" voltage is required for them.

A relaxation, or blocking, oscillator is shown in Fig. 10. It employs two 2N174 *p-n-p* transistors. The circuit oscillates at a frequency of 20,000 cps which is atop the audio range so that no hum or buzz can be heard. The frequency of oscillation is determined by the inductance of the transformer primary. As one transistor conducts through L_1, the other is cut off. Then, after the collector current of the con-

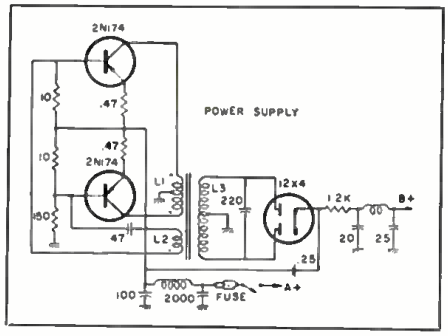


Fig. 10. Transistors in lieu of vibrator.

ducting transistor reaches saturation, the field collapses, inducing a voltage in the opposite direction in induction winding L_2 and driving the other transistor into conduction and the first one into cut-off. Since the second transistor conducts in the opposite direction through L_1, a square wave is produced. Through voltage step-up winding L_3, the voltage is increased to 200 or 250 volts a.c., then rectified by the 12X4 tube. After suitable filtering, a d.c. "B+" voltage is available.

The a.c. voltage can be measured across winding L_3. If not present, it is very probable that the 2N174 transistors are not oscillating. This can be caused by circuit troubles in the oscillator, such as a defective 2N174 transistor or power transformer or by excessive loading of the circuit caused by a short in the "B+" line of the receiver. *(Concluded next month)*

TVI FROM PHILCO FM

By DAVID T. GEISER

SEVERE Channel-6 interference can be caused by oscillator radiation of Philco 49-1606 and 49-1607 combination consoles when used in the FM function. In one known case, more than 50 TV sets were affected. Filtering and shielding techniques proved ineffective. However, by removing the rear plate of the FM oscillator's variable capacitor, the oscillator trimmer could be re-adjusted so that tracking was 9.1 mc. above station frequency instead of below it (9.1 mc. is the i.f. used in this design). Squeezing the oscillator coil together slightly restored reasonable tracking and dial calibration. A slight drop in sensitivity could be measured, but this was not noticed even in reception of weak FM stations. However, this cure is not recommended if local airport communications involve frequencies about 17 or 19 mc. above desired FM stations, as interference to FM may result. —30—

By
BERT WHYTE

CERTIFIED RECORD REVUE

LAST month I related to you some of the ills that have been besetting the stereo industry. Now the Christmas season is over and it is possible to more accurately assess what the stereo picture is like at present. It can be said at once that although stereo made some gains percentage-wise, there was not the anticipated landslide. And rather than resolve itself into any sort of a pattern, the stereo sales picture is more confusing than ever.

The package manufacturers took a real beating in several areas. For the most part, the larger console-type units selling in the $400 to $500 range simply did not move. Evidently most prospective buyers felt that while there were undeniable attractions from the cabinetry and decor angle, the stereo sound quality offered was only marginally, if at all better, than stereo units in the $200-$300 class.

The really cheap stereo units selling up to $125, never reached the anticipated volume. Here it would seem that so little was offered in stereo quality that many people simply dismissed the whole thing as a gimmick.

The largest percentage of units sold was in the $150 to $300 class. Evidently there are the beginnings of modest stereo quality in this range, which enough people can appreciate to the extent that they are willing to "take a fling" and "go stereo" without investing a great deal of money.

To round out the package sales, it was reported that the highest priced units, $600 and up, were enjoying brisk sales. These are the always-to-be-expected "prestige" sales which, unfortunately for the package people, constitute a very small portion of their market.

The components people enjoyed a steadier market, but here, too, there were odd stratifications in the types of units sold. Kit stereo sold well, but the very lowest price assembled units were off. In the medium-price field, especially in the case of integrated stereo preamplifiers and the complete tuner, preamp and amplifier units, some manufacturers sold all they could make and others met more sales resistance than had been anticipated. This is to be expected in this, the most hotly competitive of any components. And those manufacturers which sell the very top components enjoyed a market in which their products were always in short supply.

In spite of this generally good components market there were some rather shocking events that occasioned a good deal of heavy thinking and soul-searching. In Chicago, the *last major dealer* for components in the downtown "Loop" area, *Lyon and Healy* music store, gave up the battle and surrendered to the package boys! The consternation here was somewhat softened by the fact that this is a "class" store and a lot of their "package" sales are of the *Fisher-Ampex* variety.

More shocking is the case of *Newark Radio*, also in the downtown Chicago area. This is one of the oldest and most respected radio parts and supply houses in the Midwest —pioneers in the sale of high-fidelity components to the public. They always had a well-manned demonstration facility complete with comparator switchboard, etc. When stereo came along it was just a natural transition for them and their sales efforts continued. Now *Newark* has given up on the direct sale of components. What is the reason? Well, it seems there is a choice of reasons, ranging from the fact that it became increasingly difficult to combat the mass discounting that was rife in their area, and yet maintain some reasonable standards of service, and that under these circumstances it was impossible to sell stereo to a confused public that needed more education than time and profits would permit. Whatever the actual reasons, the withdrawal of an audio components dealer as old and wise in the field as *Newark* is indeed the reason for a lot of head-shaking.

I have reported in times past on the basic evils of discounting as applied to high fidelity and in stereo these evils are compounded. Stereo is still obviously quite confusing to a great many people. It takes time and patience and good honest demonstration. In other words stereo must be *sold*, in the fullest sense of the word. Now this customer can't be sold properly at discount prices, there simply isn't enough profit incentive. And so the responsibility of avoiding such loss of outlets and sales belongs to the manufacturer and his associations. It is they who must ultimately police their retailers regarding discounting and they who must undertake some form of educational program to explain stereo to the public. As this column has warned and reiterated . . . the package manufacturers are formidable foes, not to be lightly dismissed. If stereo is to grow and become as it must, ultimately, the major source of musical enjoyment, it is up to the components boys to show the way, just as they did in the hi-fi era. There is no reason why the components industry should not continue to expand, especially if the lessons of the Chicago story are well learned and proper remedial measures are taken to make certain that this does not happen again.

BRAHMS
SYMPHONY #4
Philharmonia Orchestra conducted by Otto Klemperer. Angel Stereo S35546. Price $5.98.

This is one of Klemperer's readings which lend strength and luster to his reputation which, on some recent recordings, has shown a tendency to tarnish. Here is a dedicated performance, that throbs with vitality and yet has exalted moments rarely heard on rec-

ords, or in concert for that matter. He is somewhat deliberate in the way he shapes his phrases, but this suggestion of mannerism vanishes with the noble sonorities he derives from this molding.

His style of performance is matched in this MS style stereo recording . . . in other words this is the striving for a "concert-hall" sound —a full, rounded sort of sound which you might encounter in the 20th row or so. Smooth to be sure, with the typical good middle of this technique, but perhaps a little lacking in the type of directionality favored by Americans. This also affects orchestral detail which, while not altogether diffuse, is considerably less than on most recordings.

SCHUBERT
SYMPHONY #9 IN C
Boston Symphony Orchestra conducted by Charles Munch. Victor Stereo LSC 2344. Price $5.95.

It might be thought that Munch would give a very lyrical reading to the Schubert 9th, but surprisingly, the result is just the opposite. He takes a very forceful, spirited view of the work, whipping up the climaxes quite unlike any other reading that I have ever heard. An oblique approach to be sure and for the purist not to be compared with the Krips or Szell versions.

The big attraction here is the sound, which is some of the finest stereo I have heard from *Victor*. The Boston Symphony is miked just right, with superb orchestral detail and instrumental separation, a good directional feeling and the Symphony Hall acoustics affording an unusual degree of depth perspective.

TCHAIKOVSKY
SYMPHONY #6
Vienna State Opera Orchestra conducted by Vladimir Golschmann. Vanguard Stereo demo SRV112SD. Price $2.98.

This is another in *Vanguard's* excellent series of demo stereos. This is a maiden effort with newly acquired Golschmann and it turns out to be very good indeed. Golschmann gives this a noble reading with moments of great passion and, at the same time, imbues the over-all score with a brooding sort of quality that is, at times, most intense. The recording is top notch stereo of immense power. The sense of depth is particularly notable, as is the fine directionality and definition afforded by the good instrumental separation. At regular price it would be a good buy . . . at $2.98, it's a real bargain.

RAVEL
DAPHNIS AND CHLOE (Complete) London Symphony Orchestra and Chorus of Royal Opera House, Covent Garden conducted by Pierre Monteux. London Stereo CS5147. Price $5.95.

Herewith Papa Pierre's debut on the *London* label (*via* their new tie-up with *RCA*) and an auspicious one. As you might expect from his long association with this music, this is a superlative performance, although rather surprisingly less passionate and intense than one would believe possible with Monteux. This is a very cleanly delineated reading, with expressive phrasing and dynamics richly detailed yet with a beautifully modulated flowing line of supremely lovely music.

Monteux has a flair for extracting the best that is in the London players and here he takes them to new heights. This is top drawer music-making on a par with any orchestra in the world. The sound, in general, is good but unfortunately is also of the new *London* type, which I find to be at too low an over-all level and thus dynamics which are out of proportion to the scale of this level. The score does call for some very soft *pianissimo*, but here it is so far down that surface noise masks it to a degree. Otherwise all is

clean, stereo directionality is satisfyingly realistic, and the fine acoustic climate lends a particularly good feeling of depth.

I do hope *London* will either modify or re-evaluate and change back to their old techniques of recording. To this ear, at least, the new technique has thus far failed to better the sound of the old.

MUSIC OF BERLIOZ
Paris Conservatoire Orchestra conducted by Jean Martinon. London Stereo CS6101. Price $5.98.

Here is something to the taste of Martinon, who conducts the overtures to "Benvenuto Cellini," "Le Corsaire," "Beatrice and Benedict," and "Le Carnaval Romain" and winds up with the "Rakoczy March." These are readings of great drive and spirit—one could almost say lusty. His pacings are on the rapid side, but the music can stand them.

The gem here is the oft played "Le Corsaire," which receives the best performance I've heard since Sir Thomas Beecham did it some time ago. There is sound to match the conductor's enthusiasm . . . it is big and brash and very bright. Again wide dynamics are featured and this time finely proportioned. Stereo effects are all one could desire and, in all, a pleasant record.

BEETHOVEN
VIOLIN CONCERTO IN D MAJOR
Isaac Stern, violinist, with New York Philharmonic Orchestra conducted by Leonard Bernstein. Columbia Mono ML-5415. Price $3.98.

A particularly effective combination is Stern and Bernstein. You may quibble that Bernstein takes things at a somewhat faster tempo than most other conductors, but Stern is equal to the challenge and the result is a very spirited and exciting reading. Stern is at his best and along with a lovely rich tone displays almost flawless technical mastery. A listen to his playing of harmonics will be very convincing . . . they are wondrously steady and have a pure unstrained quality that is lovely to hear.

The sound is big and robust in the orchestral part and the violin, miked fairly close, has plenty of presence. All is clean and the frequency response and dynamics are gratifyingly wide. Add a good acoustic perspective and you have a first rate mono from *Columbia*.

KHACHATURIAN
VIOLIN CONCERTO
SAINT SAENS
INTRODUCTION, RONDO CAPRICCIOSO
Mischa Elman, violinist with Vienna State Opera Orchestra conducted by Vladimir Golschmann. Vanguard Stereo VSD2057. Price $5.95.

This is the debut of Mischa Elman on the *Vanguard* label and he chose the flashy Khachaturian concerto as a vehicle. If I am correct, this marks the 50th year of concertising for the fabulous Mischa, a record of which any artist should be proud.

With this in mind I feel most unhappy in having to report that this performance is something less than a success. No one has to make apologies for an artist like Elman, yet it would be foolish not to point out that no one is immune to the ravages of age and I am afraid that is the case here. The famous Elman tone, now seems thin and unsteady, there is a good deal of rhythmic insecurity and his phrasing is clumsy at times. This is most noticeable in the "Concerto" and less in the Saint Saens work.

It is a pity, for otherwise this is a good sympathetic accompaniment from Golschmann and the stereo sound is excellent. Mr. Elman's Strad stays put nicely between the

two speakers and a fine balance is maintained between violin and orchestra. So an "A for effort" but perhaps next time Elman will be in a work in which he feels more comfortable.

ARIAS IN THE GREAT TRADITION
Eileen Farrell, soprano with orchestra conducted by Max Rudolf. Columbia Mono ML5408. Price $3.98.

I don't know why, but nowhere on this otherwise excellent recording is the name of the orchestra listed. No matter, the important thing here is the incredible artistry of Eileen Farrell. Here is one of the truly great voices of the past two decades, which alas, took a long time in getting recorded, which accounts for the slim catalogue of Farrell records. Here she sings such items as Beethoven's "Ah, Perfido and Abscheulicher," two Weber arias from "Die Freischutz," her famous "Solo un pianto" from "Medea" and the "Grands Dieux" aria from "Alceste."

Whatever it is, she sings it with a beauty of tone, a mastery of breath control and phrasing, and dynamics that are almost unbelievable. When she makes her debut at the Metropolitan soon and becomes more widely known, I predict she will occupy the exalted status of Tebaldi and Callas. The good clean sound does justice to the beauty of the voice.

POPOVERS
Eastman Rochester Pops Orchestra conducted by Frederick Fennell. Mercury Stereo SR90222. Price $5.95.

This record is destined to be another Fred Fennell hit, in the manner of his LeRoy Anderson album. Here he runs the gamut of pop concert favorites such as the rollicking "Schwanda, Polka and Fugue," with a tremendously sonorous finale replete with huge organ, drums, and cymbals; a lovely "Clair de Lune" "and "Libestraum"; a really rousing "Finlandia" and "Russian Sailors Dance"; and a sardonically humorous "Age of Gold" polka.

The performances are all first rate, done with great style and a sure sense of balance. The sound is varied as suits each work, from the delicate string traceries of "Clair de Lune" to the raucous bassoons and xylophones of the "Age of Gold."

CARAMBA!
Richard Hayman and his Orchestra. Mercury Stereo SR60103. Price $4.98.

Every once in a while a "pop" record comes along that is an outstanding item for demonstration of stereo sets. Such an item is "Caramba." It frankly combines a number of corny tunes either Spanish of themselves or of Spanish derivation but they are handled so expertly as music by Dick Hayman and are such sonic blockbusters that you forget the corn and enjoy yourself.

Hayman has combined the rousing "Prelude and Conquest" music from the picture "Captain from Castile," with such diverse items as "La Virgen de la Macarena" (the traditional "Brave Bulls" music), LeRoy Anderson's "Saraband," "Jalousie," and others into a sort of suite.

There is a certain order and reason to the numbers, but the main thing is that they are all expertly played in stereo of astonishingly vital quality. Here is directionality perhaps a mite exaggerated, but good for this music . . . a good sense of depth, highly detailed instruments. The brass is ultra brilliant, woods very pure toned, huge percussion (especially bass drum and cymbal in "Conquest"), all wrapped up in acoustics which add measurably to the realism. This is guaranteed to give any stereo system a good workout.

—30—

A 14-foot parabolic dish antenna scans the sky while inside the trailer-housed station Army Ballistic Missile Agency engineers receive "Pioneer IV's" signals.

Parametric Amplifier Tracks Space Probes

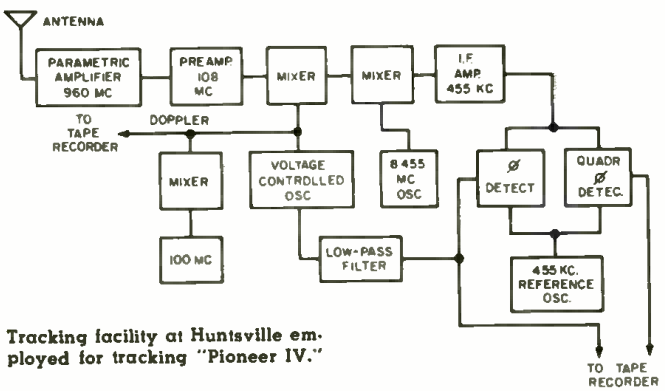
New, experimental amplifier aids in picking up signals from "Pioneer IV" at great distance of 200,000 miles.

A SPACE-AGE hearing aid—the parametric amplifier—is enabling Army missilemen to track space vehicles at incredible distances from the earth.

In the recent "Pioneer IV" space-probe launching, engineers at the Army Ballistic Missile Agency tracked the probe out to a range of 200,000 miles, even though signal power at this extreme distance was only 18 thousandths of a watt.

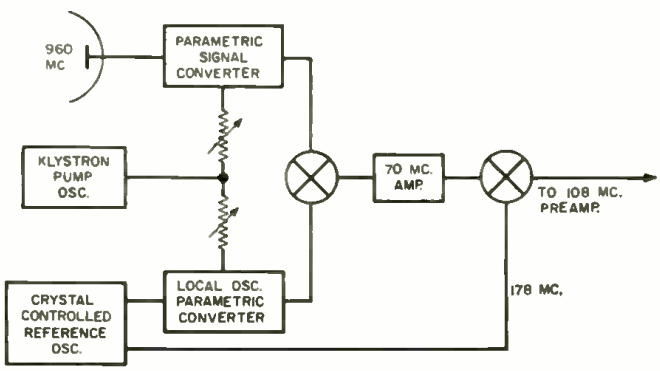
This tremendous feat in space communications was made possible by "pepping up" standard receiving equipment with a new experimental parametric amplifier. The receiving equipment consisted of a 14-foot parabolic dish antenna, a modified microlock tracking receiver, and a 108-mc. preamplifier. The experimental parametric amplifier was provided by *International Telephone and Telegraph Corp.*

Not only did the amplifier greatly intensify the signal, but it did so with great clarity—in fact, 85 per-cent more clarity than could have been provided by using standard amplifiers with electron tubes.



Tracking facility at Huntsville employed for tracking "Pioneer IV."

Modified parametric amplifier employed at tracking station.



Thomas A. Barr (right) of the Army agency, and Robert A. Felsenheld of ITT discuss the experimental low-noise parametric amplifier.

The Experimental Amplifier

The parametric amplifier is a relative newcomer in the field of electronics. Its ability to amplify is dependent on making certain variations in a parallel electrical circuit at the most opportune moment. A reduction of capacitance is accomplished when the voltage across the circuit is either at maximum positive or maximum negative value. This gives a sudden increase in voltage, causing the charge variation in the circuit to oscillate with increasing amplitude, providing the desired amplification.

The principle of parametric amplification has been known for many years. In fact, the system was analyzed in the last century by the English physicist and mathematician John William Strutt (Lord Rayleigh).

However, until recently, only unreliable and difficult mechanical means were available to create the required capacitance variations. The recent development of highly dependable and accurate electrical means to create the necessary variations has led the way to perfecting the parametric amplifier into a useful electronic tool which will play an important role in man's exploration of the vast reaches of outer space. -30-

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Now is the time to build marine equipment and Heath brings you a new 3-band direction finder kit

Featuring a nine-transistor circuit . . . flashlight battery power supply . . . preassembled, prealigned tuning section . . . three bands (beacon and aeronautical, broadcast, and marine-telephone) . . . and a new "sense" antenna system that eliminates 180° ambiguity in bearings . . . this beautifully styled, splash-resistant, rugged instrument is an incomparable value at its low Heathkit price. 13 lbs.

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10. **Heathkit Service is Customer Service**—Our staff of technical experts is always ready to answer your questions or help you if you have any difficulty.

HEATHKIT DS-1 $69.95

For boatsman, fisherman or skindiver a new, low-cost, depth sounder kit

Completely transistorized, this invaluable marine accessory enables you to detect submerged objects and their depth as well as to gauge the depth of the water and the nature of the bottom from 0 to 100 feet. Self-contained power supply uses 6 standard flashlight cells and 1 long-life 9 V. battery. Attractively styled, two-tone marine-green cabinet uses "tongue and groove" joints for splash protection: all metal parts treated to resist corrosion. Transducer may be mounted permanently through hull or temporarily outboard. 10 lbs.

HEATHKIT EK-1 $19.95

HEATHKIT HW-19 (Ten Meter) $39.95
HEATHKIT HW-29 (Six Meter) $39.95

A wonderful addition to the "ham shack" two new 6 and 10 meter transceiver kits

They're combination transmitters, designed for crystal control, and variable tuned receivers operating on the 6 and 10 meter amateur bands (50 to 54 mc from HW-29 and 28 to 29.7 mc for HW-19) in either fixed or mobile installations. Highly sensitive superregenerative receivers pull in signals as low as 1 microvolt: low power output is more than adequate for "local" net operation. Other features include: built-in RF trap on 10 meter version to minimize TVI: adjustable link coupling on 6 meter version: built-in amplifier metering jack and "press-to-talk" switch with "transmit" and "hold" positions. Can be used in ham shack or as compact mobile rigs. Not for Citizens Band use. 10 lbs.

HEATHKIT AD-10 $33.95

HEATHKIT AA-20 $34.95

HEATHKIT XR-2L $34.95
HEATHKIT XR-2P $29.95

Wherever you are . . . wherever you go you can carry your music with you 6-transistor portable radio kit

Assembled in only a few hours, both of these models incorporate superior design features that will give you portable listening enjoyment day after day. Vernier tuning control gives smooth, easily-separated station tuning. Large 4" x 6" PM speaker with heavy magnet provides "big set" richness of tone. Operates on standard size "D" flashlight batteries. Six Texas Instrument transistors.

XR-2L (simulated leather and plastic) 7 lbs.
XR-2P (high-impact plastic) 6 lbs.

HEATHKIT AA-30 $45.95

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Here it is! A new manual stereo record player kit

Made by famous Garrard of England, the AD-10 is a compact 4-speed player designed to provide trouble-free performance with low rumble, flutter and wow figures. Rubber matted heavy turntable is shock-mounted, and idler wheels retract, when turned off, to prevent flat spots. Powered by line-filtered, four-pole induction motor at 16, 33⅓, 45 and 78 rpm. Supplied with Sonotone STA4-SD ceramic stereo turnover cartridge with .7 mil diamond and 3 mil sapphire styli. 10 lbs.

It's easy and economical to go stereo with these two Heathkit "compatibles"— stereo preamp kit (AA-20)

Made for each other, either of these components can be incorporated with your present stereo system. The preamplifier (AA-20) features 4 inputs in each stereo channel and gives you a choice of 6 functions. It will accommodate a magnetic phonograph (RIAA equalized), a crystal or ceramic phonograph, and 2 auxiliary sources (AM-FM tuners, TV, tape recorders, etc.), and is completely self-powered. 8 lbs.

Hi-fi rated 14/14 watt stereo power amplifier kit (AA-30)

Two 14-watt high fidelity amplifiers, one for each stereo channel, are packaged in this single, compact, handsomely styled amplifier (AA-30). Ideal for use with the AA-20, any stereo preamp or with a pair of monophonic preamps, it features individual amplifier gain controls and speaker phase reversal switch. Output terminals accommodate 4, 8 and 16 ohm speakers. 21 lbs.

HEATHKIT TT-1

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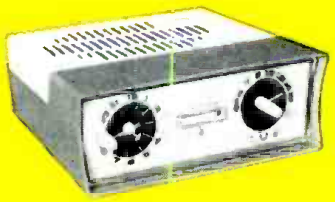
Outstanding professional quality . . . mutual conduction tube tester kit

An impressive list of electronic and mechanical features make this tube tester one of the finest values in the industry. Tests Gm (amplifiers) from 0-24,000 micromhos, Emission, Leakage, Grid current (¼ microampere sensitivity), Voltage regulators (Built-in Variable DC Power Supply), low power thyratron and eye tubes. Features 300, 450 and 600 ma constant current heater supplies, Life test, Hybrid tube test, built-in switch operated calibration circuit. Large easy-to-read meter, constant tension free rolling roll chart mechanism. Includes 7 wiring harnesses. Assembly skill of technician or higher recommended. Assembly time, 40 hours average. Black leatherette case with white trim, nylon feet, removable top. (27 lbs.)



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Completely portable . . . superb modern styling in high impact plastic . . . powerful 6-transistor circuit operating from long-life mercury batteries or ordinary pen-light cells. Does everything you expect from a clock-radio—and costs you so little! Handsome cabinet measures only 3½" H. x 8" W. x 7½" D. for ease of placement anywhere in the home. Batteries not included. 5 lbs.

HEATHKIT GC-1

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New, all transistor "Mohican" general coverage receiver kit

The "Mohican" is the first all transistor communications-type receiver in kit form and first to use ceramic IF transfilters. Covers 550 kc to 30 mc on five bands, with five separately calibrated bands to cover amateur frequencies (including 11 meter citizens band). Powered by 8 standard size "C" flashlight cells. Built-in 54" whip antenna, flywheel tuning, tuning meter, and headphone jack. Truly an outstanding receiver! Batteries not included. 20 lbs.

HEATH COMPANY Benton Harbor, Michigan

New Tube Tester Data

Owners of Triplett tube checkers will want this list of settings for more than 35 new tube types.

TRIPLETT MODEL 3413B

Tube Type		Knobs A Clr	B Fil	C Load	Lever Position Up	Down
1G3		1	1.4	98	0	1345678
		(Good=26)			(For Element Test, use lever "7" & "0" only.)	
2ER5	†	2	2.0	20	256	147
3CY5		2	3.15	21	156	247
3DK6		2	3.15	20	1567	24
3ER5	†	2	2.5	20	256	147
4ES8		2	4.2	20	12	35
4ES8	Test 2	2	4.2	20	67	58
4EW6		2	4.2	20	1567	24
5CR8		2	5.0	20	19	58
5CR8	Test 2	2	5.0	19	267	35
6AQ8/ECC85		2	6.3	21	12	35
6AQ8	Test 2	2	6.3	21	67	58
6CR4/A2521	†	2	6.3	18	134569	28
6DA4		3	6.3	16	5	37
6DA5/EM81	†	1	6.3	22	17	25
6DA5	Test 2	4	6.3	0	3789	125
		(Eye Closed.)				
6DA5	Test 3	4	6.3	0	389	1257
		(Eye Open.)				
6DE4		4	6.3	18	5	38
6DJ8/ECC88		2	6.3	21	67	58
6DJ8	Test 2	2	6.3	21	12	35
6DN7		2	6.3	24	45	68
6DN7	Test 2	4	6.3	18	12	38
6DR7	†	2	6.3	21	123	59
6DR7	Test 2	1	6.3	20	67	58
6DT5	†	3	6.3	18	1369	57
6DT8		1	6.3	19	12	35
6DT8	Test 2	1	6.3	19	67	58
6EA7		0	6.3	60	45	68
6EA7	Test 2	3	6.3	16	12	38
6EB8		0	6.3	63	23	15
6EB8	Test 2	2	6.3	21	789	56
6EF6		4	6.3	18	345	78
6EH5	†	3	6.3	17	2567	14
6EH8	†	2	6.3	21	789	156
6EH8	Test 2	2	6.3	21	23	156
6ER5	†	2	6.3	20	256	147
6ES8		2	6.3	20	12	35
6ES8	Test 2	2	6.3	20	67	58
6EU8		2	6.3	19	179	58
6EU8	Test 2	2	6.3	19	23	56
6EX6		3	6.3	15	580	37
6FH6		3	6.3	15	450	78
6FM8		0	6.3	60	2	35
6FM8	Test 2	0	6.3	60	6	15
6FM8	Test 3	0	6.3	64	89	57
8BQ5	†	1	9.45	20	1279	35
8CS7		2	7.5	26	67	58
8CS7	Test 2	2	7.5	22	13	59
9BR7	*	2	5.0	18	12	345
9BR7	Test 2	2	5.0	21	6	458
9BR7	Test 3	2	5.0	21	7	458
11CY7	†	1	12.6	21	67	58
11CY7	Test 2	1	12.6	20	123	59
12AE7	*	0	6.3	62	12	345
12AE7	Test 2	0	6.3	62	67	458
12AF3	†	4	12.6	18	29	50
12DL8		0	12.6	62	367	25
12DL8	Test 2	0	12.6	94	9	58

† For special shorts test on tubes with internal connections, refer to 3413B Instruction Book.
* Denotes tapped filament.

Room Acoustics for Stereo

(*Continued from page 60*)

paths and diffraction paths around the doors. Because of the direction and extended reflections of such paths, the stereo effect is obtained. For optimum effect from such a system, not only will the entire back wall have to be live but a good part of the side walls of the room must be live in order to produce the reflected rays that will convey the stereo effect to the listener.

Single Satellite System

The system of Fig. 20F can now be analyzed in terms of the systems just discussed. In this system, the lows are again blended in one system and the highs from one channel also radiate from that same system. The highs from the second channel, however, emerge from a single satellite speaker. This system may be considered as one-half of the system shown in Fig. 20C. The lows from the common woofer are psycho-acoustically bridged over to the highs of the satellite and the entire second channel thus appears to come from the satellite. The satellite may be considerably removed from the main enclosure before any disembodiment of the program content occurs. However, such disembodiment can be minimized by keeping the wall behind the main enclosure and the satellite live so that new low-frequency sound sources induced in the live wall between the woofer and the satellite may help bridge the lows to the satellite even though the satellite is considerably removed (within reason) from the main enclosure.

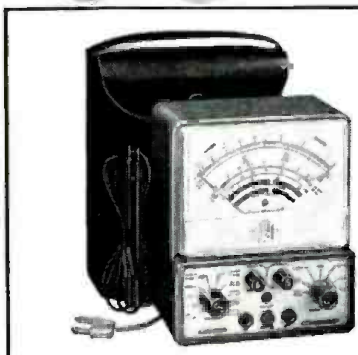
Thus we have analyzed various types of speaker systems and their effect on the listener and the effect of the acoustical condition of the room upon such speaker systems. The final article in this series will cover some actual room arrangements for optimum stereo reception. (*Concluded next month*)

"A radio is just like a television set if you cover up the screen. I saw one in my grandma's house."

EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship *at our risk* one or more of the testers described on these pages.

Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.



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Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to *any* peak-to-peak V. T. V. M. made by *any* other manufacturer at *any* price!

• Extra large meter scale enables us to print all calibrations in large easy-to-read type.

• Employs a 12AU7 as D. C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability. • Meter is virtually burn-out proof. The sensitive 400 micro-ampere meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts.

• **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS**: —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Comes complete with operating instructions, probe, leads, and streamlined carrying case. Operates on 110-120 volt 60 cycle. Only $42.50

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SUPER-METER

WITH NEW 6" FULL-VIEW METER

A combination VOLT-OHM MILLIAMMETER

Plus CAPACITY, REACTANCE, INDUCTANCE & DECIBEL MEASUREMENTS

Also Tests SELENIUM & SILICON RECTIFIERS, SILICON & GERMANIUM DIODES

The model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. It includes not only every circuit improvement perfected in 20 years of specialization but, in addition includes those services which are "musts" for properly servicing the ever-increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

SPECIFICATIONS:

• **D.C. VOLTS**: 0 to 7.5/15/75/150/750/1,500. • **A.C. VOLTS**: 0 to 15/30/150/300/1,500/3,000 • **D.C. CURRENT**: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes • **RESISTANCE**: 0 to 1,000/100,000 Ohms, 0 to 10 Megohms. • **CAPACITY**: .001 to 1 Mfd., 1 to 50 Mfd. • **REACTANCE**: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. • **INDUCTANCE**: .15 to 7 Henries, 7 to 7,000 Henries. • **DECIBELS**: —6 to + 18, + 14 to + 38, + 34 to + 58. The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings. **All Electrolytic Condensers** from 1 MFD to 1000 MFD. **All Germanium Diodes. All Selenium Rectifiers. All Silicon Diodes. All Silicon Rectifiers.**

Model 79 comes complete with operating instructions, test leads, and streamlined carrying case. Use it on the bench—use it on calls. Only $38.50

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!

- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Marker Generator
- Bar Generator
- Color Dot Pattern Generator
- Cross Hatch Generator

This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for servicing:

• A.M. RADIO • BLACK AND WHITE TV
• F.M. RADIO • COLOR TV • AMPLIFIERS

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

MARKER GENERATOR: The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc is the color burst frequency.)

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

The Model TV-50A comes complete with shielded leads and operating instructions. Only $47.50

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You are privileged to return any goods purchased from us—no explanation of any kind necessary. Just return our goods after 10 day free examination and we automatically cancel our invoice. *Request for permission to return is never required.*

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The simple order authorization included in this offer is all you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months.

Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months.

Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 82A

A truly do-it-yourself type

TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert 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.

• Tests over 600 tube types. • Tests OZ4 and other gas-filled tubes • Employs new 4" meter with sealed air-damping chamber resulting in accurate vibration-less readings. • Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence. • Dual Scale meter permit testing of low current tubes. • 7 and 9 pin straighteners mounted on panel. • All sections of multi-element tubes tested simultaneously. • Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

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

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 82A the noval is duplicated 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 82A comes housed in handsome, portable, Saddle-Stitched Texon case. Only $36.50

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL

TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.

• Uses the new self-cleaning Lever Action Switches for individual element testing. All elements are numberd according to pin-number in the RMA base numbering system. Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

• Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES

• Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Comes housed in a handsome, portable Saddle Stitched Texon case. Only $47.50

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 with no danger of cathode damage.

Housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only $38.50

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

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All prices net, F.O.B., N.Y.C.

Utility High-Voltage Supply

By ALVIN B. KAUFMAN

Complete construction details for adjustable 5000-volt d.c. general-purpose power supply suitable for cathode-ray and geiger tubes.

THE experimenter or technician will find the 0-5000 volt, low-current, d.c. supply to be described a convenient piece of auxiliary equipment which may be used to operate small electrostatic precipitators, geiger tubes, cathode-ray tubes, infrared "snooperscope" tubes, and to perform a variety of tests.

The power-supply circuit incorporates no startling innovations but there are a few pertinent observations that should be made. Its design is similar to the r.f. type of high-voltage supply found in some early model television receivers.

A meter is incorporated in the power supply for easy visual determination of the output voltage. The meter is a 50 μa. full-scale model with external multiplier and thus comparable to a 20,000 ohms-per-volt analyzer. It should be noted, however, that the use of a voltohmmeter to read the output voltage will lead to error unless the meter is left connected throughout the test, as the power supply has very poor regulation. The meter scale reads in volts when multiplied by 100.

To maintain 5000 volts, the load cannot exceed several hundred microamperes while for lower potentials several milliamperes may be drawn. In a typical application the author operated a 10-inch cathode-ray tube as an oscilloscope and with maximum brilliance was able to maintain over 4000 volts with both CR tube and internal meter load.

In the construction of any equipment employing radio-frequency energy at high potentials, care must be taken to eliminate sharp corners, solder spikes, or other conditions which will create corona discharge due to high-potential gradients. Construction and routing of wiring which is suitable for power-line-frequency high voltage is often inadequate for the r.f. range of frequencies. Rubber insulation, for instance, is not satisfactory; it will break down in short order. In general, the best insulation is air and plenty of it! The rectified d.c. may be handled by conventional means, but all leads with r.f. on them should use coaxial-type cable, feedthrough insulation, or be supported out in the clear.

Circuit and Operation

The circuit which *J. W. Miller Company* supplies with its #4525 coil has been modified by the addition of a 2500-ohm potentiometer in the cathode of the oscillator tube for output voltage control. The filter network has also been modified to a single high-capacity capacitor. This gives somewhat better regulation, eliminating the drop in the filter resistor.

Approximately the same circuit may be used and output voltage up to 10,000 obtained by using the #4526 coil instead of the #4525. At this higher voltage much greater care in spacing components must be taken to prevent corona or arc-over.

The output voltage is controlled by both the cathode potentiometer and the plate tuning of the oscillator. Normally the plate-tuning capacitor of this tuned-plate, tuned-grid oscillator is adjusted to give maximum output and the front-panel cathode resistor varied to control the voltage. Variation by tuning the capacitor is not satisfactory since when the oscillator goes out of resonance, excessive plate current will flow, with subsequent damage to the tube. It is important, therefore, to have a grommet-lined hole in the box through which a metal screwdriver may be inserted for tuning the capacitor after installation of the chassis in the box. It is interesting to note that the connections to either the grid or plate coils can be reversed without affecting operation of the oscillator. Feedback is through the grid-plate capacity of the tube and does not depend on the connections to the coil, as is the case with an Armstrong regenerative oscillator receiver circuit in which the coupling between plate and grid coils causes oscillation.

Maximum available voltage will also depend, to some extent, on the available "B" power. At 250 volts of "B", it may be possible to obtain only 4000 volts and with high voltage somewhat higher output potentials. With the power transformer specified in the parts list, approximately 4200 volts is available under the internal meter and external load of a cathode-ray tube or "snooperscope."

The output has the negative terminal of the supply and meter grounded. This must be done in order to keep the meter essentially at ground potential to prevent arcing through its case to the metal mounting panel. Switching of the output terminal to establish ground polarity is not satisfactory because with the series multiplier in one leg of the meter, one configuration would put the meter above ground. It

Front-panel view of the high-voltage power supply is shown in this photograph.

is possible to ground either polarity, but it is important that the meter multiplier go to the high-voltage line above ground, as shown in the schematic, irrespective of which meter terminal is grounded. The meter's series-multiplier resistance is of quite high value. The 20,000 ohms-per-volt times 5000 volts gives 100 megohms. Several companies manufacture such resistors but the author used ten 10-megohm, ½ w. resistors in series. Standard commercial-tolerance resistors were used. The internal meter's accuracy was checked by connecting a voltohmmeter as the load (on the 5000-volt scale) and comparing the readings. The accuracy was within 5% and was considered satisfactory. If out of tolerance too far, adjustment may be made by substitution of several resistors or by adding another series resistor, depending on the sign of the error that is found.

The *Miller* circuit used an 80, a 6V6, and a 1B3 rectifier tube. The author's version included a slight modification to permit the use of a 6X5 tube to incorporate a smaller power transformer and box. A much better layout or an even smaller unit can be constructed using miniature and subminiature glass tubes. The 6X4, 6AQ5, and *Sylvania* 5642 subminiature high-voltage rectifier tubes would have been used in this construction had they been on hand when the work was begun. These tubes have almost identical characteristics to the tubes used in the author's version and could eliminate the need for the feedthrough terminals—with the smaller oscillator tube either inverted or mounted horizontally. The smaller *Sylvania* rectifier would eliminate the knock-out required for the 1B3.

The rectifier tube filament pickup loop placement is not critical and, with adequate spacing, bare or enameled wire may be used. The tube filament operates at a dull red glow and at the lower output potentials this may become almost invisible. For long duration operation at low output potentials, under 2000 volts, it is a good idea to increase the single-loop pickup coil to two turns in order to provide better filament excitation, keeping in mind that an increase over this potential will likely injure the filament of the rectifier tube used in this construction.

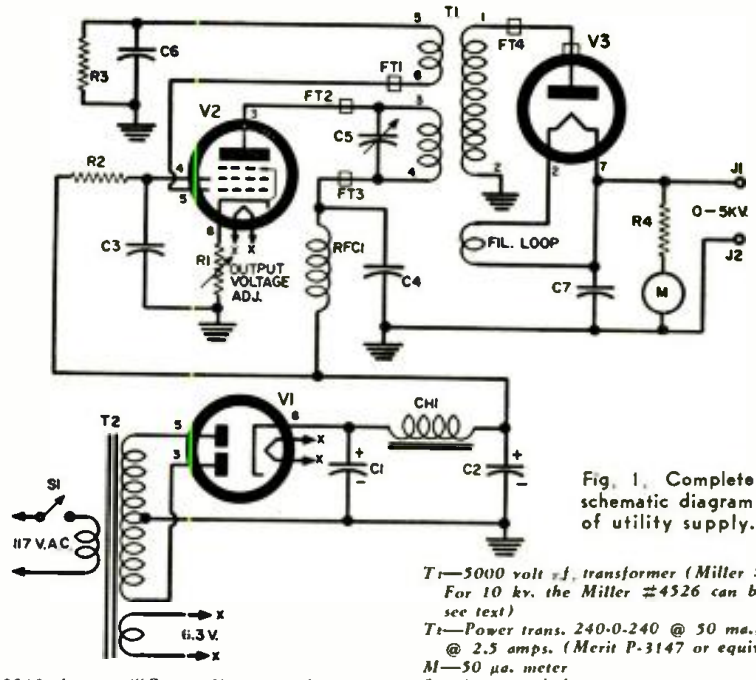
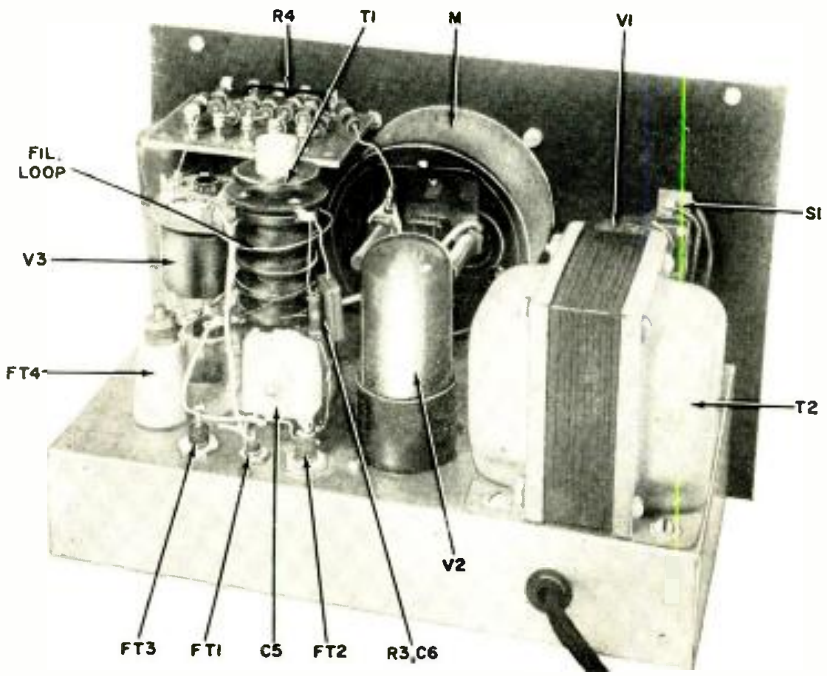


Fig. 1. Complete schematic diagram of utility supply.

R1—2500 ohm pot ("Output Voltage Adjust")
R2—40,000 ohm, 1 w. res.
R3—50,000 ohm, ½ w. res.
R4—100 meg. (see text)
C1, C2—15 µf., 450 v. elec. capacitor
C3—.05 µf., 400 v. capacitor
C4—.01 µf., 400 v. capacitor
C5—360-1000 µµf. mica padder
C6—.001 µf., 400 v. capacitor
C7—.01 µf., 6000 v. capacitor
CH1—40 ma. filter choke
RFC1—2.5 mhy. r.f. choke (Miller #4537)
T1—5000 volt r.f. transformer (Miller #4525. For 10 kv. the Miller #4526 can be used, see text)
T2—Power trans. 240-0-240 @ 50 ma.; 6.3 v. @ 2.5 amps. (Merit P-3147 or equiv.)
M—50 µa. meter
S1—S.p.s.t. switch
FT1—Feedthrough (Cambridge Thermionic 1795B)
FT2, FT3—Feedthrough (Cambridge Thermionic 1771B)
FT4—Feedthrough (Johnson h.v. type)
J1—Binding post (General Radio 938BR-red)
J2—Binding post (General Radio 938BB-black)
2—Jack assemblies (General Radio 938J)
V1—6X5 or 6X4 tube
V2—6V6 or 6AQ5 tube
V3—1B3GT or 5642 tube

Internal view of the high-voltage supply showing the layout of the components.



Construction

The power supply is built on a 4½" x 8" x 1½" chassis and attached to the panel of a 6" x 9" x 5" box. The handle on top came from the local hardware store. The engraving was purchased for about 10 to 15 cents a character and was well worth the expenditure. Of course decals or nameplates may be used if desired. In any case, the author recommends the use of aluminum chassis and box and replacement of the thin panel supplied with such boxes by a thicker aluminum panel. Aluminum is much easier to work and in drilling the meter cut-out with a hole saw or fly cutter, is much less difficult to handle.

In laying out the chassis be sure to leave space where the meter, power switch, and jacks overhang the chassis. In drilling and mounting the panel to the chassis remember that the chassis must be raised ½ inch in order to clear the ⅜-inch bottom flange of the box and centered to clear the flange on each side. The voltage control potentiometer must not exceed 1½ inches in diameter and its mounting hole must be centered to clear the top inside of the chassis and its bottom flange.

One last and very important construction note: If a heavier aluminum panel is used, as suggested previously, be sure to drill its mounting holes before attaching to the chassis. The old panel may be used as a template otherwise it is almost impossible to locate these "attach" holes. —30—

Custom Dials For Your Equipment

By **GENE BRIZENDINE**

Details on the use of a photographic method of making professional-looking dials for home-built equipment.

PRACTICALLY everyone has had the experience of finishing an excellent piece of electronic equipment only to find that his hand-lettered dial lacked that much-needed "professional" touch.

Since a surprising percentage of electronics enthusiasts are also "shutterbugs," the solution to be described is a "natural." In photography, the process is called "copying" and when it is combined with a few tricks of the lithographer's trade, professional-looking dials are easily produced.

Equipment Required

Almost any camera capable of accurate close-up focusing is suitable and one with ground-glass focusing is ideal. Two photoflood bulbs are desirable but less light will suffice, with a longer exposure being required. The slower films will produce best results. An exposure meter is useful but not mandatory if you're willing to risk a few negatives in trial exposures. An enlarger is also required, however, this portion of the job may be done inexpensively by your neighborhood photo finisher or else a photographer-friend.

Simply stated, we make an oversized "mock-up" of all the characters to appear on the dial, then reduce it photographically to the final size needed to fit the equipment.

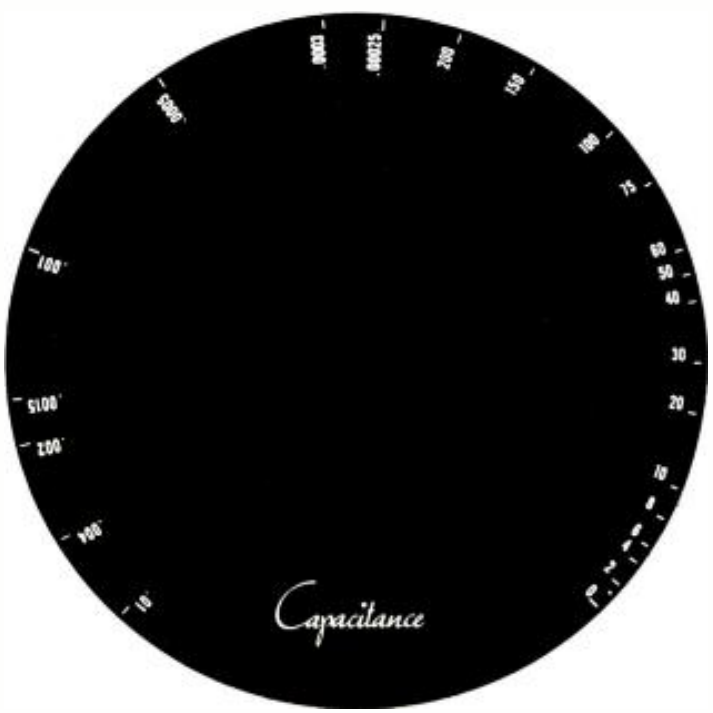
First, accurately calibrate your finished electronic equipment, using a sheet of paper temporarily taped to the dial. After all points are marked with a sharp pencil, remove the sheet and re-tape it on a larger, clean sheet of white paper. Tape both to a flat board.

The purpose now is to transfer the temporary calibration information accurately to the larger "mock-up" which is easier to handle and photograph.

With an ink compass and India ink, draw a half-circle for each range called for by the electronic unit. The exact center of the pointer shaft on the temporary markings is used as the center for the larger "mock-up" scales. The temporary calibration points are now transferred to the "mock-up," using a straight-edge and more India ink. Fig. 1.

Now for the lithographer's techniques. For all figures and the letter-

Black dials are obtained by placing the negative over unexposed film and exposing. Black and white are reversed in new negative.



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	1AX2	.62		4BZ7	.96		6BC7	.94		6K6	.58		12AZ7	.86		12U7	.62
	1B3GT	.79		4CB6	.59		6BC8	.97		6S4	.48		12B4	.63		12V6GT	.53
	10N5	.55		4CS6	.61		6BD6	.51		6SA7GT	.76		12BA6	.50		12W6	.69
	1G3	.73		4DE6	.62		6BE6	.55		6SK7GT	.74		12BD6	.50		12X4	.38
	1J3	.73		4DK6	.60		6BF6	.44		6SL7	.80		12BE6	.53		17AX4	.67
	1K3	.73		4DT6	.55		6BG6	1.66		6SN7	.65		12BF6	.44		17BQ6	1.09
	1L6	1.05		5AM8	.79		6BH6	.65		6SQ7	.73		12BH7	.73		17C5	.58
	1LA6	.69		5AN8	.86		6BH8	.87		6T4	.99		12BK5	.70		17CA5	.62
	1LC6	.79		5AQ5	.52		6BJ6	.62		6T8	.80		12BL6	.56		1704	.69
	1LN5	.59		5AT8	.80		6BK5	.80		6U8	.78		12BQ6	1.06		17DQ6	1.06
	1R5	.62		5BK7A	.82		6BK7	.85		6V6GT	.54		12BY7	.74		17L6	.58
	1S5	.51		5BQ7	.97		6BL7	1.00		6W4	.57		12BZ7	.75		17W6	.70
	1T4	.58		5BR8	.79		6BN4	.57		6W6	.69		12C5	.56		19AU4	.83
	1U4	.57		5CG8	.76		6BN6	.74		6X4	.39		12CA5	.59		19BG6	1.39
	1U5	.50		5CL8	.76		6BQ5	.65		6X5GT	.53		12CN5	.56		19T8	.80
	1X2B	.82		5EA8	.80		6BQ6GT	1.05		6X8	.77		12CR6	.54		21EX6	1.49
	2AF4	.96		5EU8	.80		6BQ7	.95		7AU7	.61		12CU5	.58		25AU4	.87
	2BN4	.60		5J6	.68		6BR8	.78		7A8	.68		12CU6	1.06		25BQ6	1.11
	2CY5	.71		5T8	.81		6BS8	.90		7B6	.69		12CX6	.54		25C5	.53
	3AL5	.42		5U4	.60		6BU8	.70		7Y4	.69		12DB5	.69		25CA5	.59
	3AU6	.51		5U8	.81		6BY6	.54		8AU8	.83		12DE8	.75		25CD6	1.44
	3AV6	.41		5V6	.56		6BZ6	.54		8AW8	.93		12DL8	.85		25CU6	1.11
	3BA6	.51		5X8	.78		6BZ7	.97		8BQ5	.60		12DM7	.67		25DN6	1.42
	3BC5	.54		5Y3	.46		6C4	.43		8CG7	.62		12DQ6	1.04		25EH5	.55
	3BE6	.52		6AB4	.46		6CB6	.54		8CM7	.68		12DS7	.79		25L6	.57
	3BN4	.63		6AC7	.96		6CD6	1.42		8CN7	.97		12DZ6	.56		25W4	.68
	3BN6	.76		6AF3	.73		6CF6	.64		BCX8	.93		12EL6	.50		25Z6	.66
	3BU8	.78		6AF4	.97		6CG7	.60		BEB8	.94		12EG6	.54		35C5	.51
	3BY6	.55		6AG5	.65		6CG8	.77		10DA7	.71		12EK6	.56		35L6	.57
	3BZ6	.55		6AH6	.99		6CM7	.66		11CY7	.75		12EZ6	.53		35W4	.52
	3CB6	.54		6AK5	.95		6CN7	.65		12A4	.60		12F5	.66		35Z5GT	.60
	3CF6	.60		6AL5	.47		6CR6	.51		12AB5	.55		12F8	.66		50B5	.60
	3CS6	.52		6AM8	.78		6CS6	.57		12AC6	.49		12FM6	.45		50C5	.53
	3CY5	.71		6AN4	.95		6CU5	.58		12AD6	.57		12K5	.65		50DC4	.37
	3DE6	.62		6AN8	.85		6CU6	1.08		12AE6	.43		12SA7M	.86		50EH5	.55
	3DK6	.60		6AQ5	.50		6CY5	.70		12AF3	.73		12SK7GT	.74		50L6	.61
	3DT6	.50		6AR5	.55		6CY7	.71		12AF6	.49		12SN7	.67		117Z3	.61
	3Q5	.80		6AS5	.60		6DA4	.68		12AJ6	.46						
	3S4	.61		6AT6	.43		6DB5	.69		12AL5	.45						
	3V4	.58		6AT8	.79		6DE6	.58		12AL8	.95						
	4AU6	.54		6AU4	.82		6DG6	.59		12AQ5	.52						
	4BA6	.51		6AU6	.50		6DQ6	1.10		12AT6	.43						
	4BC5	.56		6AU7	.61		6DT5	.76		12AT7	.76						
	4BC8	.96		6AU8	.87		6DT6	.53		12AU6	.50						
	4BE6	.54		6AV6	.40		6EU8	.79		12AU7	.60						
	4BN6	.75		6AW8	.89		6EA8	.79		12AV5	.97						
	4BQ7	.96		6AX4	.65		6EB8	.94		12AV6	.41						
	4BS8	.98		6AX7	.64		6H6GT	.58		12AV7	.75						
	4BU8	.71		6BA6	.49		6J5GT	.51		12AX4	.67						

Brand New JAN 3BP1 Cathode Ray Tube

6.3V @ .6A electrostatic focus, deflection. Sensitivity x.127. Y.172 mm/v.

$1.25 Lots of 3

Single, $1.45

RAD-TEL TUBE CO.

55 Chambers Street
Newark 5, N. J.
DEPT. EW 360

TERMS: 25% deposit must accompany all orders — balance C.O.D. $1 HANDLING CHARGE FOR ORDERS UNDER $5
Subject to prior sale. Please add postage. No C.O.D.'s outside continental U.S.A.

(Advertisement)

MEMORY UNLIMITED

I JUMPED into the first railway compartment which seemed empty: my eyes fell on a book left on the seat opposite by a previous passenger.

I took it up absent-mindedly and ran through the first lines. Five minutes later I was reading it as eagerly as a clue to a hidden treasure. I learned that everyone's memory is capable of fantastic feats; that an ordinary person if he has taught himself to control the way in which his brain stores impressions can memorize accurately long and complicated lists of facts after reading them over only once or twice. I thought I would test the truth of the statement.

I took a timetable out of my suitcase and began reading quietly in the manner prescribed, the names of about one hundred railway stations. I observed that, after reading them over a few times, I could recite the whole list off with hardly a mistake. With a little more practice I found I had committed them so completely to memory that I could remember them in the reverse order and even pick out one station from the list and say which number it was, and what were the names of the towns before and after it.

I was astonished at the memory I had acquired and spent the rest of my journey on more and more difficult experiments in memory, and reflecting how this new control I was achieving over my mind would materially help me to a greater success in life. After this, I worked hard at this wonderful memory system, and within a week I found I could recall passages from books and quote them with ease: names, addresses and business appointments were remembered immediately; and in four months I had succeeded in learning Spanish.

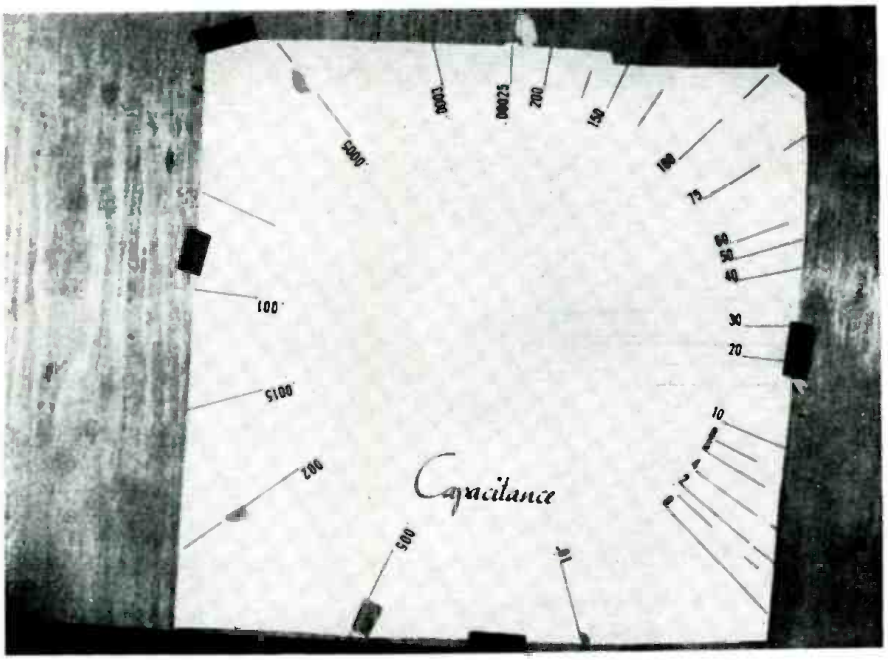
If I have obtained from life a measure of wealth and happiness, it is to that book I owe it, for it revealed to me the workings of my brain.

Three years ago, I had the good fortune to meet its author, and I promised him to propagate his method, and today I am glad of this opportunity of expressing my gratitude to him.

I can only suppose that others wish to acquire what is, after all, the most valuable asset towards success in life.

Borg's address is: E. F. Borg, c/o Aubanel Publishers, 14 Highfield Road (Rathgar), Dublin, Ireland. Apply to him for his little book, "The Eternal Laws of Success," It is free to all who wish to develop their memory.

F. ROBERTS.

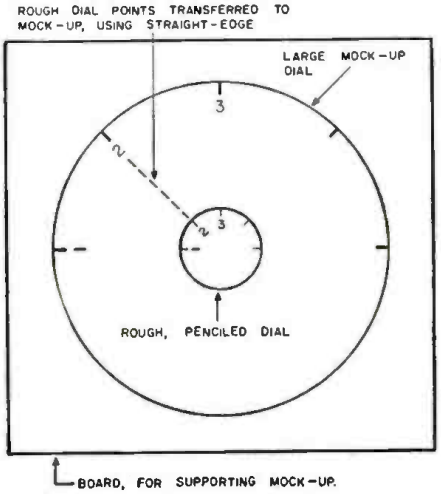


Mock-up is taped to plywood board shown ready for the camera.

ing, purchase from your stationer sheets of "Artype." These are very accurate black letters, printed on thin transparent plastic sheets, with pressure-sensitive adhesive backing. Included below each character is a thin guide line which is useful in obtaining accurate alignment on the "mock-up." The guide line is removed with a razor blade after final positioning. "Artype" comes in many styles, the figures illustrated being No. 1126, which is about the optimum size for most purposes.

In use, individual characters are transferred to the "mock-up," using any pointed instrument, such as one point of the drafting compass or even milady's hat pin. With just a bit of practice, the knack is quickly acquired of separating the desired character by means of the sharp point. Next "spear" it, move into position on the "mock-up," and smooth down with a fingertip. Continue until the figures and any lettering have the desired arrangement. Conveniently, the "Artype" may be lifted and re-positioned, to correct any mistakes.

Fig. 1. The rough penciled markings are projected to the larger mock-up as shown.



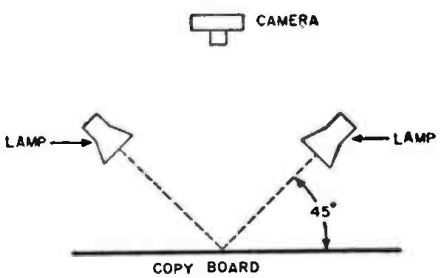


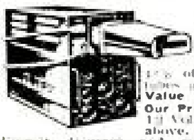
Fig. 2. Photographing oversized mock-up.

The completed "mock-up" is placed in position for photographing, after masking the surplus white border with any dark material. This will prevent stray reflected light from reaching the negative and help produce sharper characters. The camera distance should be close, filling the negative as completely as possible. A tripod, or other steady support, is required. Lights should now be positioned for most uniform lighting of the subject—while, at the same time, avoiding reflections. The best position is about 45 degrees from the plane of the subject, the lights and subject forming a right triangle. The negative should parallel the subject in order to produce over-all "in-focus" results. Stopping down sharply will help here. (See Fig. 2.)

After a sharp, "contrasty" negative is obtained, it is easy to enlarge to any size required by the equipment. By making the negative "contrasty," the final print should come out a crisp black-and-white.

Making dials this way is much simpler than this rather elaborate description might indicate. Irrespective of whether your newest electronic creation must "pass muster" with the boss or the spouse, a snappy dial can go a long way in gaining approval. —30—

LORAN R-65/APN-9 RECEIVER & INDICATOR



Used in ships and aircraft. Determines position by radio signals from known transmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.
Value $1200.00
Our Price ... $79.50
12 Volt Inverter Power Supply for above. BRAND NEW ... $32.50
Circuit diagram and connecting plugs available.

AN/APA-38 PANORAMIC ADAPTER

And Wave Analyzer. 30 Mc Center Frequency, 2 Mc Band Width. Total scan 10 Mc at one clip. Regular saw-tooth sweep. Variable sweep freq. control 1600 cycles. Use it as regular service scope! Including 11 tubes and 3 scope tube type 3DF1. LIKE NEW ... $19.50

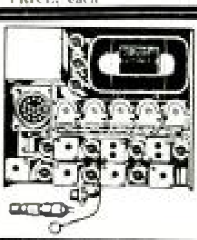
ASB-5 'SCOPE INDICATOR

BRAND NEW, including all tubes, together with 5BP1 'Scope Tube. Originally used in Navy Aircraft RADAR equipment. Easily converted for AC operation.
VALUE $250.00!
OUR LOW PRICE ... $16.95

GOLD PLATED SPECIAL! TS-1/ARR-1 TEST OSCILLATOR

Portable, complete with two 955 tubes, cavity and antenna. BRAND NEW, in metal housing 6¾" x 6¾" x 7" high. OUR LOW PRICE, each ... $3.45

RADIO CONTROL RECEIVER 30-42Mc.



Rid ARW-17. Small size lightweight FM radio Receiver for 3 control channels. Signal outputs actuate sound relays up to 3 channels simultaneously. Complete with 10 tubes: 3—6AK5, 1—6J6, 1—6AS6, 1—6AL5, and dynamotor for 24V DC.
BRAND NEW ... $12.95

MICROPHONES

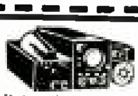
Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike		$5.45
T-30	Carbon Throat Mike	$ .34	.74
T-45	Army and Navy Lip Mike		1.25
TS-9	Handset		3.88
TS-11	Handset		3.95
TS-13	Handset		4.25
RS-38	Navy Type		4.75

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.65
HS-33	Low Impedance	2.69	4.65
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW, PER PAIR ... $3.25
CD-307A Cords, with PL55 plug and JK26 Jack ... .99
Earphone Cushions for above—pair ... .50

LORAN APN-4



FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes. Exc. used ... $49.50
Receiver-Indicator as above, BRAND NEW ... $69.50
Inverter for above unit available from stock.

LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.

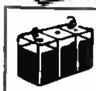
Completely Assembled

LIKE NEW: Supplied with 5" Scope, type 5CP1 only ... $14.95
Brand New ... $19.50

BC-906 FREQ. METER—SPECIAL

Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE ... $10.88

WILLARD 6-VOLT MIDGET STORAGE BATTERY



3 Amp. Hour, BRAND NEW. 3⅝" x 1-13/16" x 2⅜". Uses Standard Electrolyte ... Only $2.95

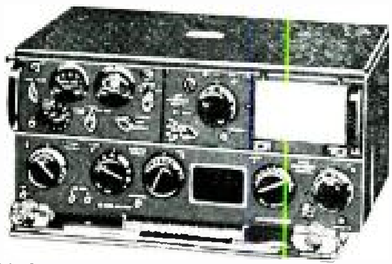
2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 5⅛" high ... $2.79
1—2V. 7 prong Synchronous Plug-in Vibrator ... 1.49
1—Quart Bottle Electrolyte (for 2 cells) ... 1.45
ALL BRAND NEW! Combination Price ... $5.45

SCHEMATIC DIAGRAMS For any equipment on this page, each ... 65c

SEND FOR FREE CATALOG, many more Wonderful Surplus Buys!

AN/ART-13 100-WATT XMTR



11 CHANNELS 200-1500 Kc 2 to 18.1 Mc

$48.50 Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP813s modulate 813 in final up to 90% class "B". A Real "HOT" Ham buy at our low price! Orig. cost $1800. Exc. Used ... $48.50
0-16 Low Freq. Osc. Coil for ART-13 ... 7.95
24V Dynamotor for ART-13 ... 11.95
Accessories available for xmtr. Inquiries invited.

SPECIAL FOR MARCH! APR-5A UHF RECEIVER

The APR-5A is a superhet receiver with 2 frequency ranges: (1) from 1000 to 3100 megacycles. (2) from 3000 to 6000 megacycles continuous by means of interchangeable mixers using a single dial tuning control. It has a 10 meg I.F. band width of 30 megacycles center. Operates from 80-115 V 1 phase, 60-2600 cycles. Variable I.F. gain by use of a pot. Use for frequencies above 1000 megacycles to supplement range of APR-4 receivers. Brand new in original cases with technical manuals and all tubes ... $69.50

SCR-522 2-METER RIG!

Terrific buy! VHF Transmitter-receiver, 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION ... Special $32.32
Transmitter Only, with all tubes ... $17.50
Accessories for above available.

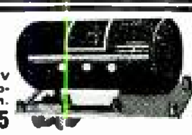
BC-314-F 4-BAND RECEIVER

150 to 1500 kc Continuous tuning, complete with self-contained dynamotor for 14V DC. Like New ... $55.00

TG-34A CODE KEYER

Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.
BRAND NEW $22.50
Checked out, exc. used $17.95

MOBILE-MARINE DYNAMOTOR



Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE ... $6.45

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.95
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A / 28V 7A	575V .16A / 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	7.95	10.50
PE-86	28V 1.25A	250V .050A	2.75	3.85

MOBILE DYNAMOTOR SPECIAL

INPUT: 9 Volts DC @ 7.5 Amps.
OUTPUT: 405 Volts DC @ .095 Amp.
May be used for 6 volt operation. BRAND NEW in original carton ... $3.95

PE-103 DYNAMOTOR. INPUT: 6/12 Volts DC. OUTPUT: 500 V. @ .160 Amps. BRAND NEW, complete with filter base, shock mount and cables ... $24.50

STANDARD TUBES

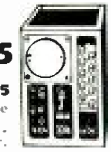
Removed from Brand New Gov't Equipment

RECEIVING					
6AG5	.35	6AC7	.55	815	2.15
12AT7	.45	6J6	.32	837	.85
6AK5	.35	SPECIAL PURP.		1625	.29
6C4	.25	3E29	4.25	1629	.29
6AL5	.33	807	.95	2013	.39
6J4	.59	813	6.95	2014	.39
6X5	.35	814	2.25	4X-150	5.95
				38P1	1.49

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G Radio Supply Co.
Telephone: CO 7-4605
51 Vesey St., New York 7, N. Y.

BC-603 FM RECEIVER



20 TO 27.9 MC.
Excellent Used ... $14.95
BRAND NEW ... $16.95
Convert to 20-50 Mc., and A.M.! (See CQ Sept. '58.) 10 Channel, pushbutton tuning or continuous tuning. Complete with speaker, tubes, squelch.
12 or 24V Dynamotor for Above
Exc. Used $1.25 ... Brand New $5.50
BC-683 same as above except 27 to 38.9 Mc. Used ... $23.50
Brand New ... $27.50

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-off Switch. NO RELAY, CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps. ... $10.49
Complete 240-page Technical Manual for BC-603, 604 ... $2.95

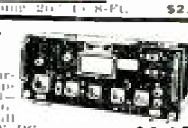
BC-604 TRANSMITTER—Companion unit for BC-603 Revr above. With all tubes. BRAND NEW ... $10.95

BC-684 TRANSMITTER—Companion unit for BC-683 Revr above. Complete with all tubes.
Like NEW ... $7.95
BRAND NEW ... $12.95

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify ... $8.95

BC-659 TRANSMITTER & RECEIVER
27 to 38.9 Mc. FM. Two preselected channels crystal controlled. 5 to 10 watts. Complete with speaker, tubes, Exc. Used ... $11.95
Less tubes, Exc. used ... $7.95
Antenna for BC-659, Telescoping 20" to 8-Ft. ... $2.95

FM TRANSMITTER-RECEIVER



APN-1. 420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4—955, 4—12SJ7, 1—12SH7, 2—12H6, 1—VR150. Complete with all tubes and mount. For 27 V DC.
BRAND NEW ... $8.95
Original operating manual for above ... $1.00

BC-733 VHF 10-TUBE AIRCRAFT RECEIVER. 6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks!
Exc. used. Complete with tubes ... $7.95
Brand New complete with tubes ... $8.95
Dynamotor for above 24 V. New ... $5.95

NAVY AIRCRAFT RADIO RECEIVER

ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning. AVC. CW. Illuminated dial. Complete with tubes and dynamotor, used ... $17.95
Like New ... $26.50
Power Supply 110 V. AC. Wired ... $8.50

ARC-5/R28 RECEIVER

2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes BRAND NEW $24.45
110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW ... $21.50
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes ... $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW ... $9.95

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes ... $16.95
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal $12.45
MODULATOR for above, new with tubes ... $5.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC.	$14.50	$16.50
BC-454	Receiver 3-6 Mc.	9.45	12.45
BC-450	3-Receiver Control Box	1.29	1.75

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions ... $7.95
Factory wired, tested, ready to operate ... $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only ... 49c

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW ... $7.85
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW ... $9.75
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal. ... $13.95
ARC-5/T-19 TRANSMITTER—3 to 4 Mc. BRAND NEW complete with all tubes & crystal ... $10.95
BC-456 Modulator ... USED 3.45 NEW 5.95
BC-451 Transmitter Control Box ... 1.25 NEW 1.49
ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

234-258 MC RECEIVER

AN/ARR-2

BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price!
Complete with tubes $8.88

Service Industry News

NEW BLOOD for the service industry is receiving increased attention from organized groups throughout the country, although attitudes vary. Just as there is increasing concern over part-timers, who are relative newcomers, by and large, there is also a recognition of the need for adequate training facilities to insure the availability of satisfactory manpower reserve. These two interests are not in conflict. Shops in many parts of the country have trouble obtaining and keeping good men, who are also in demand by large companies. On the other hand, service can only be hurt when it is judged by improperly qualified individuals who represent it in the eyes of the public.

Last month, we took note of the training and accreditation program underway in North Carolina. Presently being contemplated by TESA of Milwaukee is an apprenticeship program, to be undertaken in cooperation with the Milwaukee Vocational School and the Industrial Commission, that would provide students and graduates with on-the-job training.

According to this association's "TESA News," "The whole service industry is badly in need of good technicians. Students who have had two years of day-school training or four years of night-school training would make ideal material. These students have a good theoretical background and generally need only the experience of the shop and field service to make them well-rounded television service technicians. It is also an opportunity for TESA members to give training other than technical. Business management, advertising, and proper customer relations can be made a part of the training project." Major objections involve the length of time and cost that would be incurred by members who undertake to train apprentices.

Robberies Continue

Breaking and entering of service shops is getting to be an increasing problem throughout the country—an indication of sorts that the service industry itself is not an unimportant factor, although a rather unfortunate indication. More thefts of receivers and equipment are being reported in the Miami area, one of the most heavily hit in the nation. The St. Louis area is also being affected. The robberies give every sign of being the work of systematic, professional criminals rather than the efforts of indiscriminate vandals. All shop owners are being asked to notify local authorities and association leaders whenever they are approached with suspicious-looking "bargains" in equipment or merchandise, or whenever they hear of such bargains. This should be done even though your own area has not been subjected to thefts. There may be an attempt to dispose of material stolen in one area in another part of the country.

New Awards Program

A new Achievement and Awards Program, patterned after that used by Optimist International, has been adopted by NATESA to help strengthen and solidify organizational growth and growth of affiliates. Local groups will be rated on their performance in many areas, such as activity and membership participation.

Quotas have been determined for each item in the program to make it equally possible for all associations, whether large or small, to win awards. The program is regional as well as national, and all winners are to be announced at the next annual NATESA convention. The competition is intended to promote more active participation in association affairs by the individual members as well as to instill a feeling of pride in their organizations.

Mid-State ESDA Elections

Charles E. Ross III of *Colonial Park Radio & TV* was elected president of the Mid-State Electronic Service Dealers Association. He succeeds Wayne Prather of *Wayne Electric* who was recently elected president of the State Federation to finish the unexpired term of Dave Krantz. Mr. Prather was also elected chairman of the board of directors.

Other officers named include Don Billow, *Billow Television*, vice-president; Arthur Mottern, *Partang Appliance & TV*, secretary; and Oscar Stroup, *S & W Radio & TV*, treasurer. Mr. Ralph D. Potteiger of *R. D. Potteiger Television* was elected to the board of directors for a two-year term and Joseph Macko of *Macko Radio & TV*. John Boglovitz of *Keystone Electronics*, and Harold Stubblefield of *State Electronics* were elected for three years.

Indiana Elections

Dean R. Mock of *Mock's TV Sales and Service* was elected president of the TV Bureau of Elkhart. Other officers are LaMar Zimmerman, *Zimmerman's Service, Inc.*, vice-president; Wayne L. Clem, *Clem's TV and Appliance Service*, secretary; and Harry Carmien, *Carmien's Radio and TV*, treasurer.

ARTS of St. Joseph Valley selected the following new officers to head their association: William Rapport, *Kordona Radio-TV*, president; Lewis Wood, *Marquette TV-Radio*, vice-president; Harold Rhodes of *The Electric Company*, vice-president; Jack Cook., *Electronic Service Co.*, secretary; Richard Tepe of *Tepe TV Sales & Service*, treasurer; James Russell, *Russell's TV Service*, sergeant-at-arms; and Russ Bills, *Bills Television Service*, chairman of the board of directors.

Part-Timers

The eternal discussion on the role of the part-timer goes on, this time with a more tempered attitude than usual. James W. Baker, chairman of Indiana's IESA, asks, "What is a part-timer? . . . I would rather look at it from this angle: What is a legitimate service technician? He will be honest and ethical in all of his business practices. He should maintain a service shop with adequate equipment . . . He will charge a just and fair price for services rendered . . . In this business there are many good, legitimate, part-time service shops that are a credit to the industry. On the other hand, there are some full-time operators that should not be in business . . . In the future, let's all refrain from using the words 'part-timer' and instead talk about legitimate shops."

Training by Delco

In thirty *General Motors* Training Centers located throughout the country, the *Delco Radio Division* is offering a one-week course in advanced training to electronic technicians who wish to keep up to date. Working in small groups, technicians will cover transistor fundamentals, signal-seeking radio tuners, hybrid auto radios, automatic head-lamp dimmers, garage-door operators, and other devices related to automotive electronics. Practical work and troubleshooting techniques are also in the curriculum. Interested technicians should apply to their local *Delco* electronic distributors. They will be notified as to when courses will be given at the training center nearest them. The courses are scheduled two or three times a year at each center. There is no charge for tuition or textbooks.

Kansas City Licensing

As a result of litigation instituted by The Electronic Association of Missouri to block the TV licensing ordinance, the Kansas City law is not being enforced. In order for the law to be effective, a board of examiners for which it provides must be set up. Mayor H. Roe Bartle has indicated that he will not appoint that board while the ordinance is in litigation. Anti-licensing forces have at least won a delaying action. Meanwhile, there is some evidence that licensing in this municipality may become something of an issue in partisan politics. It has become the subject of charges of corruption and the matter for newspaper editorials. —30—

(Continued from page 46)

watching Westerns while the teacher is out of the room. Connection to a closed-circuit TV system is also made possible without rewiring. Other *Hoffman* receivers include a saddle-stitched, leather-covered portable and a series of consoles with provision for use of the sound channel as a stereo amplifier.

Magnavox

This year *Magnavox* has added a wireless remote-control system, similar to that of *RCA*, *Olympic*, and others, which use a transistor oscillator. A 17-inch table model and a number of 21- and 24-inch sets are offered, all using hand wiring and a conservative circuit design. Stereo combinations and a number of deluxe cabinet arrangements are the main features of the line.

Motorola

This is one of the manufacturers who has taken note of the service technicians' problems with printed wiring. The *Motorola* board can be partially removed from the set while connected but, while this can be done simply enough, the crowding of the components on the board, and the use of color-coded conductors still require some effort to trace out a particular circuit. The complete wiring pattern is reproduced in color on both sides of the board. This helps, but one must always refer to the layout drawing to follow a particular conductor. The board itself is fiberglass-re-inforced and the printed wiring has been carefully engineered to avoid pealing, cracking, and the various other troubles that can befall printed wiring.

Olympic

This manufacturer specializes in console and combination models of conservative design. Hand wiring and established circuitry are combined in a line of receivers that includes a remote-control system similar to the transistor oscillator featured by *RCA* and *Philco*.

Packard Bell

One of the features of the 1960 *Packard Bell* receivers is the "computer dial" channel selector. As shown in Fig. 4 (lower right), this consists of a deck of 12 dial lights which are placed behind a rectangular panel. The lamp corresponding to the selected channel lights up, illuminating the dial number in front of it. This system is combined with a power-tuning circuit that operates from a 3-transistor remote-control unit or from the wired "Control Master" which includes a small, remote speaker. The acoustic remote control operates in the 40-kc. range and uses four separate tuned circuits in the receiver to determine which of the four control relays should be activated.

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OZ4	3BC5	6AB4	6BA6	6C16	6S8GT	7B5	12AT7	12SJ7	38
1A7GT	3BN6	6AC7	6BC5	6CM6	6SA7	7B6	12AU6	12SK7	39/44
1B3GT	3BZ6	6AF4	6BC8	6CM7	6SD7GT	7B7	12AU7	12SN7GT	41
1C6	3CB6	6AG5	6BD6	6CN7	6SF5	7B8	12AV6	12SQ7	42
1C7	3Q4	6AH4GT	6BE6	6CQ8	6SF7	7C4	12AV7	12V6GT	43
1F4	3S4	6AH6	6BF5	6CR6	6SG7	7C5	12AX4GT	12W6GT	45
1F5	3V4	6AK5	6BG6G	6CS6	6SH7	7C6	12AX7	12X4	50A5
1G4	4BQ7A	6AL5	6BH6	6CU5	6SJ7	7C7	12AZ7	14A7/12B7	50B5
1H5GT	4B58	6AM8	6BJ6	6CU6	6SK7	7E5	12B4	14B6	50C5
1L4	4BZ7	6AN8	6BK5	6D6	6SL7	7E6	12BA6	14Q7	50L6
1L6	4CB6	6AQ5	6BK7	6DE6	6SQ7	7E7	12BA7	19	56
1N5GT	5AM8	6AQ6	6BL7GT	6DG6GT	6SR7	7F7	12BD6	19AU4GT	57
1R5	5AN8	6AQ7	6BN6	6DQ6	6T4	7F8	12BE6	19BG6G	58
1S5	5AT8	6AR5	6BQ6GT	6F5	6U8	7G7	12BF6	19J6	71A
1T4	5AV8	6AS5	6BQ7	6F6	6V6GT	7H7	12BH7	19T8	75
1U4	5AZ4	6AT6	6BR8	6H6	6W6GT	7N7	12BQ6	24A	76
1U5	5BR8	6AU4GT	6BS8	6J4	6X4	7Q7	12BR7	25Z6GT	77
1V2	5J6	6AU5GT	6BY5G	6J5	6X5GT	7S7	12BY7	26	78
1X2	5R4	6AU6	6BZ6	6J6	6X8	7X6	12CA5	27	80
2AF4	5U4	6AU8	6BZ7	6J7	6Y6G	7X7	12CN5	35	84/6Z4
2BN4	5U8	6AV5GT	6C4	6K6GT	7A4/XXL	7Y4	12D4	35A5	117Z3
2CY5	5V4G	6AV6	6CB6	6K7	7A5	7Z4	12F5	35B5	
3A4	5V6GT	6AW8	6CD6G	6N7	7A6	12A8	12K7	35C5	
3A5	5X8	6AX4GT	6CF6	6Q7	7A7	12AB5	12L6	35W4	
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Philco

The most novel feature of the entire 1960 TV season is still the all-transistor portable TV set introduced last fall by *Philco*. It has been described in some detail in this magazine and no repetition is intended here. *Philco* has added an electric clock timer to its "Siesta" model and features remote control for almost every model. A simple remote-control system is offered at no additional charge for portable receivers. This turns out to be a length of plastic tubing and an air bulb, which simply pushes a micro-switch by air pressure. Once the set is on, the same push-button advances the channel selector. The set is turned off manually. On more elaborate receivers, *Philco* offers a variety of cabinet styles, including the separate picture-tube housing featured in last year's line. Those sets having the channel selector on the top have a pop-up arrangement that elevates the knob for tuning and returns it to a flush position when not in use.

RCA

While this manufacturer offers a full line of receivers, none is radically different from last year's models. Most of them incorporate the same circuit features and only the addition of two types of clocks is especially noteworthy. A regular clock timer is available on the Model 170-TV-094, while the 210-KA-465 has a 12-hour programming clock. This latter unit permits selection of any half-hour program on a particular channel during the programming period. Once set, the programmer will turn the set on or off and tune in the desired channels automatically over the next 12 hours. Remote control is again available in the form of a transistor oscillator, similar to last year's model.

Setchell-Carlson

This manufacturer belongs to the conservative group to the extent that it clings to the wired chassis. In addition, *Setchell-Carlson* continues to feature its distinctive unitized chassis, which permits servicing each separable subchassis section individually. One notable feature is the i.f. section, which contains a set of four tuned traps to take care of adjacent-channel and sound interference. This is a feature which can be of great help in difficult reception areas, but the traps must be aligned accurately since they could otherwise cut into the video i.f. response.

Sylvania

Sylvania has joined the clock-timer group, but offers this feature only on a portable 17-inch set. Unlike most manufacturers, however, *Sylvania* does not use power transformers, even on the 23-inch sets—which, by the way, use the new integral faceplate. Power tuning is available, but no remote-control units. To avoid separate fine tuning for each channel, a mechanical trimming adjustment is set by the installing technician for best fine tuning on each channel. As the tuner moves to a new station, the pre-set cam moves the fine tuning control into the correct position. This "Picture Prompter" may require re-adjustment when tubes and other tuner parts age.

Westinghouse

This manufacturer's receivers are distinguished by a new and complex tuning indicator and by the use of a more legible printed-wiring board. *Westinghouse* hopes to get real appreciation from service technicians for the inclusion of all parts values, tube-pin numbers, and test-point markings right on the "Seematic" printed wiring boards. (See "Printed Boards: Roadblocks or Road Maps?," November 1959.) The remote-control system adopted by *Westinghouse* uses a transistor transmitter and a discriminator circuit in the receiver. The novel tuning indicator permits the power tuning system to skip unused channels. Fig. 5 shows the internal portion of the mechanism. Channel numbers are displayed in a vertical line on the front panel and the indicator drum is located just behind them. The channel is indicated when a white square appears behind the corresponding numeral and makes it stand out from the rest. Service technicians will find this tuning mechanism one of those elaborate mechanical affairs that are well built but can require considerable effort in troubleshooting.

Zenith

Sticking to hand-wired chassis and its well-known acoustic remote-control system, *Zenith* has cautiously added the 23-inch, integral-faceplate tube to its line. To make certain that temperature changes do not cause a reduction in picture height, *Zenith* models with the 16D25 chassis use a thermistor in the deflection-yoke circuit, as shown in Fig. 3. As the yoke heats up and its resistance increases, the "B-boost" supplied to the height control normally drops in voltage. To compensate for this, a series resistance, which is reduced at higher temperatures, is inserted into that lead and mounted directly at the deflection yoke. When servicing the vertical circuit or replacing a deflection yoke, the presence and effect of this thermistor should be kept in mind.

Another unusual circuit in the *Zenith* models is the use of a small neon bulb in series with the brightness control to reduce the possibility of picture-tube spot burns. When the set is on, the neon bulb conducts and provides a complete return path. When the set is turned off, the neon bulb goes out with no voltage applied and opens the picture-tube circuit. *Zenith* offers a special TV set designed for hospital use. This is a portable that has provision for earphones or pillow speakers and can also be connected to a closed-circuit TV system.

Conclusion

As in many recent years, certain innovations are shared by several manu-

facturers. A number of them use the new 23-inch CRT with integral face-plate. Transistor oscillator types of remote-control systems are offered by many manufacturers, and a few are adding clock timers. While some years ago there was a great trend to series-filament receivers and away from power transformers, the movement now seems reversed. The controversy over printed wiring as against point-to-point wiring continues, with the larger manufacturers making a strong effort to help the technician in troubleshooting printed boards and improve the reliability of the product. —30—

Within the Industry

(*Continued from page 24*)

ZENITH RADIO CORPORATION has begun construction on a new million-and-a-quarter addition to its 1500 N. Kostner Avenue plant in Chicago. The new unit is scheduled for completion in June . . . **SLATE & COMPANY**, wholesale distributor of radio and TV supplies, has moved to new quarters at 3960 Merritt Ave., Bronx, N. Y. The 20,000-square-foot building will house sales, administrative, and warehouse operations with adjacent parking areas provided for customers.

* * *

CHARLES F. SCOTT has been named district sales manager for the eastern regional area of *Motorola's* Semiconductor Products Division. He will make his headquarters at the firm's eastern office in Ridgefield, New Jersey . . . **MARTIN DUBILIER** has been named general manager of *International Electric Corporation*, Paramus, N. J. division of *ITT* . . . **JAMES F. RILEY** has assumed the new post of field sales manager for *Corning Electronic Components*, a department of *Corning Glass Works* . . . *General Precision Laboratory Incorporated* of Pleasantville, N. Y. has named **JOSEPH M. KEES** manager of its Los Angeles regional office. He will maintain offices at 180 N. Vinedo Ave., Pasadena . . . *Utah Radio & Electronic Corp.* has upped **JEAN MUSSELMAN** to the post of chief engineer and named **HAROLD RICH** to the assistant chief engineer's spot. **MARLIN PRICE** was advanced to chief design and development engineer . . . **WILLIAM T. BUSCHMANN** is the new eastern regional distributor sales manager for *Sylvania Electronic Tubes* . . . *International Resistance Co.* has appointed **WALTER H. CANFIELD** promotion manager of its marketing division . . . **LEONARD G. TAGGART** has been named materials manager of the Special Products Division of *Stromberg-Carlson* . . . **DR. M. JOHN RICE, JR.** has been appointed manager of semiconductor material engineering for *CBS Electronics* . . . **WALTER G. PREE** is the new national accounts manager for mobile communications at *General Electric's* Communication Products Department, Lynchburg, Va. He was formerly a regional sales manager for *G-E* in Minnesota. —30—

Know Your Chemicals

(Continued from page 49)

important, because it will determine just how well a particular moving part can "float" in the lubricant. Light machine oil, for example, may be good for a shaft that turns rapidly in a sleeve bearing such as in an electric drill or saw, but, when used on a TV tuner shaft, the oil may simply run out and leave the bearing dry.

Still another consideration in choosing a lubricant is its temperature stability. Vaseline or petroleum jelly is an excellent lubricant for many wearing surfaces, but, in most electronic devices, the operating temperature is so high that Vaseline melts and loses its ability to "float" the moving part. Butter and lard are also excellent lubricants, but they melt and have the further drawback that they become rancid and deteriorate in a short time.

Lubricants for Electronics

All applications of lubricants in electronic equipment can be divided into those where purely mechanical action is involved and those in which an electrical function must also be considered. In that latter category fall such applications as those involving grounding springs, wiper arms, moving contacts in potentiometers, and all other places where electrical currents pass from a moving member to a stationary one. For all electrical lubricating problems of this type the lubricant should be electrically conductive in addition to meeting other requirements.

Typical of electrically conducting lubricants is graphite, which is available under such trade names as "Grafoline" and "Graphlube." This material is very good for larger power switches and power relays, since it has the ability to reduce arcing and thereby greatly prolong the life of the contacts. Another specially good lubricant for electrical contacts is "Lubriplate," made by *Walsco* or "Lube-rex," made by *General Cement*. These are pastes that have the right viscosity, electrical properties and temperature stability for use on the contacts of tuners and wafer switches. They tend to spread a film all over the contact area. After a relatively long period, these lubricants will turn black because of the silver oxides and the airborne dirt that they inevitably collect. Then they must be cleaned off and applied fresh.

Among the electrical types of lubricant we must also mention those that are part of the so-called contact-cleaner preparations. These materials have been discussed in the previous article because they are essentially part of the cleaner. The lubricant included in such a cleaner is responsible for the thin, residual film that forms after the cleaning agent has evaporated.

In choosing the right lubricant for mechanical parts, viscosity, temperature stability, and possible chemical reactions are the usual considerations.

"Lubriplate" or any of the other preparations already mentioned can be used in some applications where motion is not rapid or continuous, such as for the fine-tuning shaft in a TV tuner or on the idler pulley of a tuning-dial mechanism. For the moving parts of phonographs or tape recorders or the gearing of antenna rotators, different lubricants are recommended. *General Cement* offers a grease called "StaPut," which maintains constant viscosity over a wide temperature range. It is thus especially recommended for phonographs and the moving parts of tape recorders. A good grade of automobile grease can be used for most antenna rotators and for the gearing of power TV tuners. One of the really handy lubricants for all non-electrical use is *Dow-Corning's* DC-4 silicone grease. This material remains unaffected by most chemicals, is stable over a very wide temperature range, and lubricates equally well for plastics and all types of metals. It also serves as insulation on terminals exposed to the weather.

When lubricating any piece of machinery, the old lubricant should be thoroughly cleaned off before the new one is applied. Almost all lubricants can be dissolved by either alcohol, carbon tetrachloride, or benzene. Silicon greases, an exception to this rule, require special solvents.

Miscellaneous Chemicals

In addition to the most frequently used types of chemicals (cleaners, solvents, cements, or lubricants) the electronics parts jobbers also offer a few "special" chemicals that are required less frequently but are nonetheless useful. Into this group fall the enamel-wire stripping liquids, materials to prevent dial-cord slipping, silver pastes for preparing printed wiring, and other compounds. Enamel-wire stripping liquids will be particularly useful to the technician who winds his own coils. Silver paste is not an essential in ordinary service work, since broken conductors on printed-wiring boards usually can be bridged with solder and wire, but a non-slip compound is very handy. Wrinkle-finish enamel, label cement, color-coding enamels, and porcelain glaze are all chemicals that are more likely to be found on the experimenter's bench than in the average service shop.

A variety of plastic cements, each intended to hold specific plastics together, has been discussed. General-purpose types of cements and their mechanical-adhesion principles were described in some detail. From this we see that some thought is required *before* we can select and apply cement properly. Lubrication of electrical contacts and of mechanical parts requires different lubricants with different characteristics. Knowing the job that is to be done and what various preparations can do is essential in selecting the best "electronic chemical" from the jobber's shelf for any one of the many uses that come up. —30—

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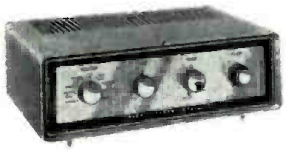

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A high-sensitivity do-it-yourself transceiver for efficient, economical 2-way radiotelephone communication. Any citizen, 18 or older, can get a license—no exam required. For mobile or stationary use. Covers up to 20 miles, depending on antenna height and terrain. Works just like an intercom, with talk-listen operation. Receiver is sensitive superhet; tunes all channels continuously. 5-watt transmitter section. Built-in AC power supply. With transmitting crystal (available for any channel from 1 to 22—specify preference) and doublet antenna. Extras available: Y-723, 6-12 v. DC power supply, $10.95; Y-729 vertical antenna, $6.50; Y-714 mobile mounting bracket, $5.35. Distinctive high-impact styrene case; 5 x 12 x 12". Shpg. wt., 20 lbs.

Model Y-712D. Superhet Transceiver Kit. **$5 DOWN**

CITIZENS BAND TRANSCEIVER KIT

Y-713D

$39.95

$2 Down

Low-cost super-regenerative receiver and 5-watt transmitter kit. Readily fits car, boat or desk. Simple, one-switch operation permits talk or listen. Receiver tunes all 22 channels continuously. Built-in AC power supply. With mike, transmitting crystal—specify channel (1 to 22) if you have a preference—and doublet antenna. Handsomely styled case; 6 x 10 x 8". Designed for easy assembly and dependable operation. Available extras: Y-723, 6-12 v. DC power supply, $10.95; Y-729 vertical antenna, $6.50; Y-724 mobile mounting bracket, $5.35. Shpg. wt., 10 lbs.

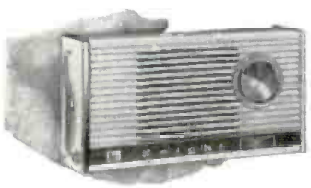
Model Y-713D. Transceiver Kit. **$2 DOWN**

dozens of exciting hobbyist kits available

"Span Master" 4-Band Radio Kit

Famous for world-wide short-wave and broadcast reception. True band-switching; continuous 4-band coverage from Broadcast to 30 mc. Sensitive regenerative circuit; 4" PM speaker. With cabinet. 8 lbs.

Y-258D. *$2 Down* Only..... **$25.95**



5-Transistor Portable Radio Kit

Popular, low-cost personal portable. Fun to build; superhet circuit; only 22 ounces; big 3½" speaker; built-in ferrite loopstick; phone jack. (Less battery, $1.30.) 2 lbs.

Y-771D. *$2 Down.* Only..... **$25.95**

"Ranger" Clock-Radio Kit

Easiest superhet of all to build—plug-in modules and printed circuit board eliminate small parts assembly. Excellent AM broadcast reception. Telechron clock has "sleep" switch. With appliance outlet. 6 lbs.

Y-737D. *$2 Down.* Only..... **$24.95**

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Y-611D

$285.00

(less preamps)

For the first time in easy-to-build kit form—a triggered sweep DC precision quality lab scope with plug-in **interchangeable vertical amplifiers (IVA).** Brilliantly engineered with an impressive array of professional features, including: crystal-controlled timing markers; DC amplifiers in both horizontal and vertical channels; electronically regulated power supply; sweep timing adjustable to 1%; built-in voltage regulated peak-to-peak calibrator. Three interchangeable vertical preamplifiers are available: high-gain differential, $35.95; wide-band (to 10 mc), $24.95; dual-trace, $48.95. **There is no other instrument like this in kit form**—here is laboratory precision quality and reliability at far less than the cost of any comparable factory-built unit. Shpg. wt. 50 lbs.

Model Y-611D. Lab DC Scope Kit. **$10 DOWN**

LAB AUTOMATIC AC VTVM KIT

Y-608D

$99.50

$5 Down

A major achievement in instrumentation! This all-new AC VTVM features **automatic range selection**—by means of an electronically-actuated self-seeking mechanism which **automatically** selects the proper range when you touch probes to the circuit under examination. Simultaneously, a front panel light indicates the range in use. Covers 11 ranges from 3 millivolts to 300 volts full scale; frequency response to 2.5 mc. Reads as low as 100 μv. Highly stable 3-stage amplifier has cathode follower output; ideal for use as preamp for other test equipment or for connection to scope for simultaneous wave form observation. Includes precise trigger circuits; regulated power supply; latest printed circuitry for easy assembly and quality performance. An exclusive Knight-Kit development—there is no other instrument like it on the market, in any form or at any cost. Shpg. wt. 13½ lbs.

Model Y-608D. AC VTVM Kit. **$5 DOWN**

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Famous-Value VTVM Kit

Measures DC voltage (11 meg. input) and resistance; AC voltage, rms and peak-to-peak. 4½" meter. Push-pull balanced bridge circuit. 7 lbs.

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Checks over 700 receiving type tubes. 16 filament voltages. Tests cathode emission as well as shorts, open elements, etc. 15 lbs.

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T-400 AMATEUR 400-WATT TRANSMITTER KIT

Y-716D
$395.00
400-Watt CW Transmitter

Truly the "dream" transmitter—has what it takes to punch out a QRM-busting SSB, AM, or CW signal. 600 watts P.E.P. input on SSB; 400 watts on AM and CW. Covers 80, 40, 20, 10, and 15 or 6 meter bands. Start with the basic CW kit— then add AM and SSB accessory units and other "add-ins" whenever you wish. Has heterodyne VFO to assure a signal which "stays put." Tremendous 14" dial is precision-calibrated for all bands, 80 through 6 meters. SSB features: front panel controls—VOX, anti-trip and adjustable speech compression. Smooth, chirpless screen-clamp keying, plus VFO keying for complete CW break-in. Has 7034/4X150A final—coasts along well within its CCS ratings; silicon rectifier power supply runs cool. Dozens of advanced features put this job in a class all its own. Shpg. wt. 140 lbs.

Model Y-716D. T-400 CW Transmitter Kit. **$10 DOWN**

"Add-In" Accessories: SSB Generator Kit, $69.95 • AM Modulator Kit, $24.95 • Speech Amplifier Kit, $9.95 • Monitor Scope Kit, $37.95 • 6-Meter Conversion Kit, $7.50.

R-100 AMATEUR RECEIVER KIT

Y-726D
$104.50
$5 Down

Incomparable receiver kit with all the features, selectivity and sensitivity of high-priced commercial units. Tunes 540 kc to 30 mc in 4 bands; calibrated bandspread on all Ham bands; 300 cps to 4.5 kc selectivity; exclusive printed-circuit bandswitch; built-in Q-multiplier; constant-running HFO—dozens of other professional features. Truly superior kit value. 30 lbs.

Model Y-726D. R-100 Receiver Kit. **$5 DOWN**

Y-727D. S-Meter Kit for above, only..... $10.75
Y-728D. 4" Matching Speaker, only..... 7.50

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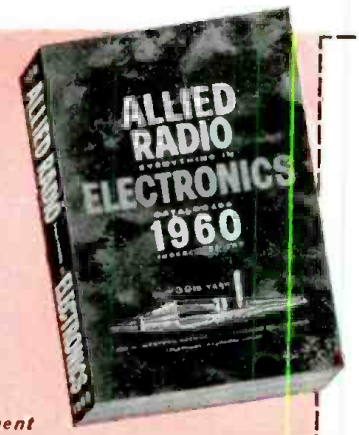

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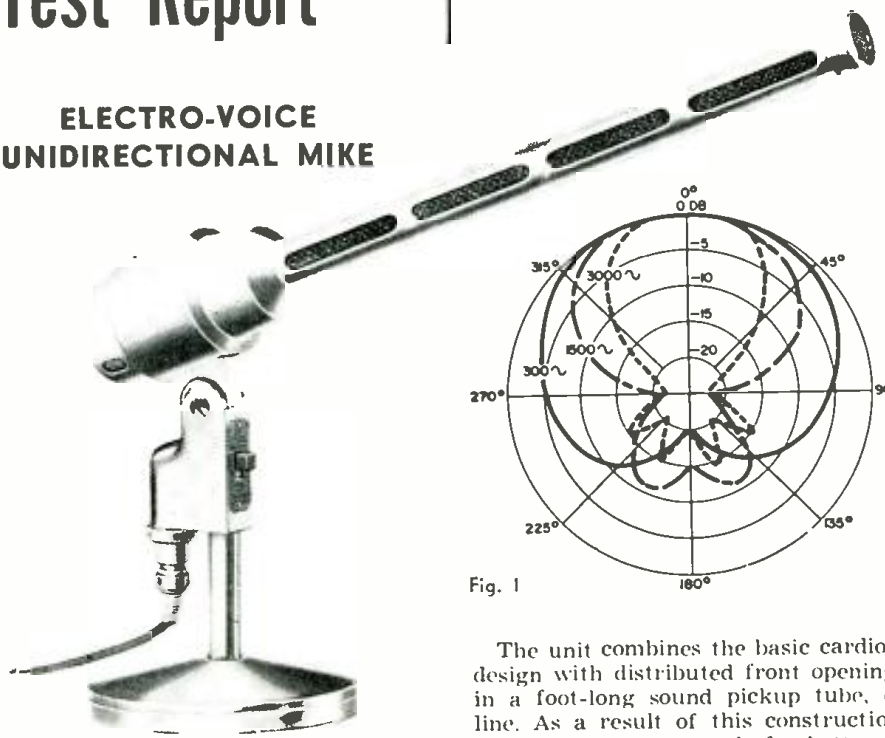


Fig. 1

A RECENT addition to the *Electro-Voice* line of microphones is the highly directional dynamic Model 644. A member of the family of *line*-type microphones, the 644 features sufficient sensitivity so that its working distance is extended over 2½ times that of a non-directional microphone. The directivity will be useful in the TV-broadcast field since it will permit mike booms to be farther away from the performer and there will be less room reverberation effects. The microphone is also useful in high-quality public-address work where acoustical feedback is a problem. With this microphone, individual instruments or voices may be segregated out of a large group of performers without actually getting right on top of the performer.

The unit combines the basic cardioid design with distributed front openings in a foot-long sound pickup tube, or line. As a result of this construction, the microphone responds far better to sound that is on the axis of the line than it does to off-axis sounds. For example, at the upper voice frequency of 3000 cps, the sound pickup is down 10 db along a line 45 degrees off-axis. Pickup from the sides and rear is down 20 to 25 db so that these sources are effectively minimized. As the sound frequency is reduced, the pickup broadens somewhat so that the pattern becomes a cardioid at 700 cps and below (see Fig. 1).

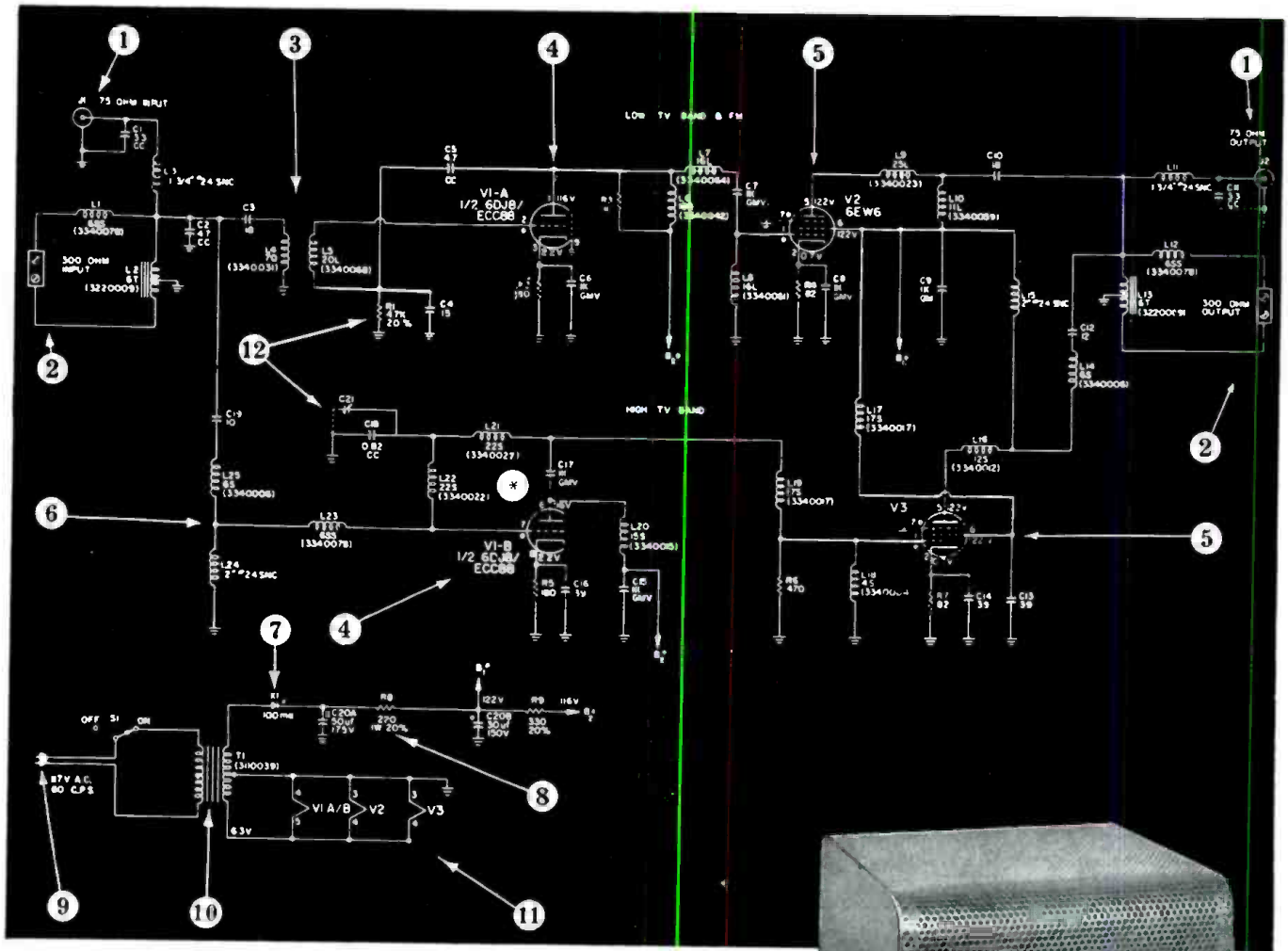
The model checked seemed to have a smooth frequency response extending from about 40 cps up to about 12,000 cps, at which point it drops off sharply. The output level is −53 db with respect to 1 volt/dyne/cm.² when wired for high-impedance output. The microphone nets for $66.

EMPIRE 98 TONE ARM

THE prime purpose of any pickup arm is to hold the cartridge in place as its stylus follows the record groove. The arm must in no way detract from the performance of the pickup. The arm must be light enough to allow tracking even warped records without damaging groove walls and this must be done with minimum friction and despite extraneous vibrations. All tone arms do this to some degree. The differences among various arms is in what degree the necessary functions are accomplished. A good arm takes precision engineering, along with craftsman-like processes in manufacturing.

The *Empire* "Stereo/Balance" professional pickup arm, manufactured by

the secret's in the circuit!



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BLONDER-TONGUE

all-channel tv-fm amplifier

model HAB only $69.50 List

1. Solderless radiation-proof 75 ohm coaxial fittings
2. Exclusive B-T 300 ohm "NO STRIP" terminals. Patents pending.
3. Low-pass coupling – 54 to 108 mc.
4. Premium frame-grid circuitry for minimum noise and maximum gain – 23 db (15 times.)
5. Operated at less than 50% of maximum plate dissipation for maximum tube life.
6. High-pass signal takeoff – 174 to 216 mc.
7. Solid state rectifier for longer life.
8. Dual filtering network for stable, hum-free operation.
9. Low cost operation, draws only 0.24 amps.
10. Power transformer isolates unit completely from power line.
11. Parallel heaters for simplified servicing.
12. Separate high and low bands of amplification consistent with maximum gain and wide band response.

*U. S. Patent 2,761,023—triode neutralization circuit

Available at parts distributors, for further information write Dept. EW-3

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Audio Empire, a division of *Dyna Empire, Inc.*, is one of the most recent tone arms to be made available to the audiophile. Since it is so new, the design engineers have had an opportunity to combine into the arm many major features. It has been designed to have a maximum tracking error of ± .75 degree, with an arm offset angle of 23.8 degrees. The over-all arm length is 12⅞ inches. Its resonance is approximately +2 db at 12 cps when used with most cartridges.

One of its major features is the incorporation of a balance mechanism that provides almost perfect balance in all planes. It is so well balanced and counterweighted that this tone arm could be used to play a record in an upside-down position. Although we didn't try this out, we were able to tip our turntable to almost a perpendicular position and yet have perfect sound reproduction. As a result of this arrangement, the turntable need not be perfectly horizontal when this tone arm is used.

Other features include an instantly removable arm shell that will accept all standard cartridges, a non-resonant counterweight support, an arm rest height adjustment, and a calibrated pressure scale. These additional features simplify all necessary adjustments. The counterweight balance adjustment is used to offset the weight of any particular cartridge used. It can be adjusted for cartridges weighing from 2 to 25 grams. In actual use this counterweight is adjusted for perfect balance while the calibrated pressure scale is in zero position. After balance is obtained, a single control can be adjusted to any desired stylus pressure. Markings are calibrated in one-gram steps.

We made repeated tests in adjusting the counterweight and the stylus pressure control, and after many re-adjustments, there was no noticeable variation in stylus pressure. This was checked against a calibrated scale and results certainly indicated that precision engineering and craftsmanship were employed in producing this tone arm. The retail price is $34.50. Actually, *Audio Empire* has another professional model available at $38.50 that is 15⅞ inches in length and provides even less tracking error and lower arm resonance.

FAIRCHILD STEREO CARTRIDGE

AS we have mentioned recently, almost all phono cartridge manufacturers have virtually eliminated their original designs and are now marketing a second or even a third version. Some have come out with entirely different designs. Each progressive step has resulted in improved stereo sound reproduction.

The most recent new design that has come to our attention is *Fairchild's* SM-1 stereo cartridge. It is an entirely new design employing the rotating magnet principle rather than the moving coil which had been used in previous models. From the results we obtained, the quality of reproduction possible in their latest version is much improved. The cartridge is designed for operation with a 47,000-ohm load and is to be used at a stylus pressure of 3 to 4 grams.

The graph below shows the frequency response of both channels from 30 to 15,000 cps along with the opposite channel response. It is hard to see how the frequency response of one channel with respect to the other could be made more similar. The two curves are within 1 db of each other over the entire range. There is a slight dip of 3.7 db at 5000 cps but the high-frequency re-

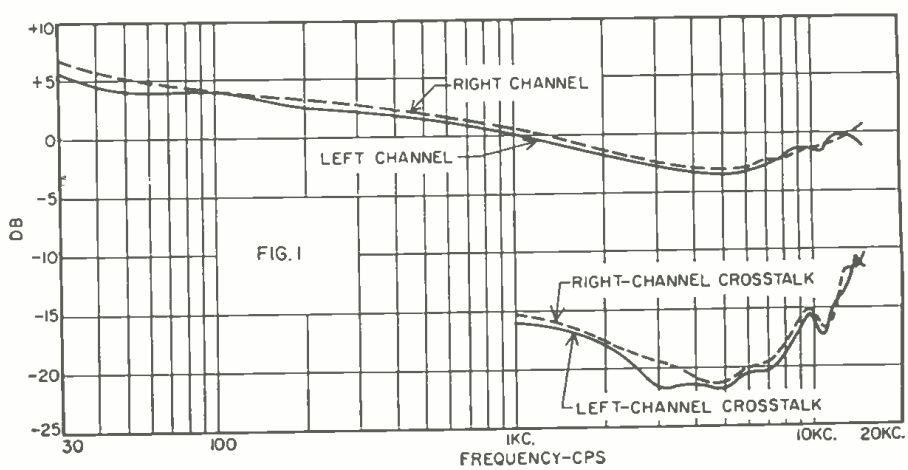


FIG. 1

sponse up to 15,000 cps, the limits of our test, is excellent. The rising characteristic below 1000 cps is the result of the tone arm used in our tests. We have found that all cartridges tested in the past have this same rise so that we can assume that this cartridge is essentially flat below 1000 cps.

Both the left and right channel crosstalk is exceptionally low, especially at the upper mid-frequencies. It is rather unusual to find a cartridge that has as much as 11.5 db separation at 15,000 cps as this cartridge has.

It is rather difficult to check IM and harmonic distortion of cartridges unless specialized lab-type equipment is available. We relied on scope patterns and listening tests, and the results were extremely favorable. We feel that even the most critical ear will find that the quality of reproduction produced by this cartridge is extremely pleasing.

The output voltage per channel is about normal for this type of cartridge, being 5.5 mv. at a recorded velocity of 5 cm. per second. We had no problems with hum pickup. The SM-1 stereo cartridge has a replaceable diamond stylus and retails at $34.95. —30—

CALENDAR of EVENTS

MARCH 21-24

IRE National Convention. Sponsored by the Institute of Radio Engineers. Coliseum and Waldorf-Astoria Hotel, New York City. Information on exhibits from W. C. Copp, IRE Advertising Dept., 72 W. 45th St., New York 36, N. Y. Program data from Gordon K. Teal, Chairman 1960 Technical Program Committee, IRE Headquarters, 1 E. 79th St., New York 21, N. Y.

MARCH 29-31

Twenty-Second Annual American Power Conference. Sponsored by Illinois Institute of Technology in cooperation with Universities of Illinois, Iowa, Iowa State, Michigan, Michigan State, Northwestern, Purdue, Minnesota, Wisconsin, Texas A & M, New York, California Institute of Technology, Georgia Tech, and MIT, plus nine technical societies. Hotel Sherman, Chicago. Inquiries on the conference should be addressed to R. A. Budenholzer, Mechanical Engineering Dept., Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

APRIL 4-8

Sixth Nuclear Congress. Sponsored by PGNS of IRE and EJC. New York Coliseum, New York City. Program information from M. E. Cassidy, USAEC N. Y. Operations Office, 376 Hudson St., New York 14, N. Y.

NOW YOU CAN HAVE YOUR CHOICE OF CENTURY'S UNIQUE Peak-to-Peak VACUUM TUBE VOLT METERS

Model VT-10
LINE OPERATED

WITH LARGE EASY-TO-READ 6" METER
featuring the sensational new
MULTI-PROBE *(Patent Pending)*

Model VT-1
BATTERY OPERATED

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe
❸ Lo-Cap Probe ❹ RF Probe

No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to function as either a DC Probe, AC-Ohms Probe, Lo-Cap Probe or RF Probe.

NEW

LINE OPERATED
Ideal for use on the test bench. Designed to run cool even under continuous operation . . . Line isolated.

BATTERY OPERATED
Completely portable . . . Invaluable wherever line connection is undesirable or unavailable . . . Unique circuitry assures low battery drain.

Model VT-10
$58.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

Model VT-1
$58.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

FUNCTIONS OF VT-1 and VT-10

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

FEATURES OF VT-1 and VT-10

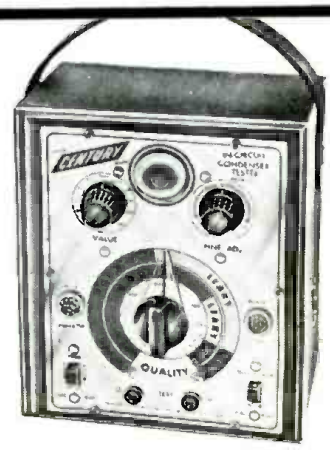
- New advanced pentode amplifier circuit
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.s
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures stability and accuracy
- Amplifier rectifier circuit with frequency compensated attenuator — a feature found only in costly laboratory instruments
- Meter completely isolated
- Hand-crafted circuitry eliminates the headaches of printed circuitry
- 1% resistors used for permanent accuracy
- Rugged gray hammertone steel case provides necessary shielding and eliminates plastic case drawbacks of cracking or melting
- Deep brushed long lasting etched aluminum panel
- Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS OF VT-1 and VT-10

- **DC Volts** — 0 to 1.5/6/30/150/300/600/1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 0 to 3/12/60/300/1200 volts
- **Ohms** — to a billion ohms, 10 ohms center scale — RX1/10/100/1K/10K/100K/1M
- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC volt ranges with zero at mid-scale
- **Decibles** — from —10 Db to +10/22/36/50/62 based on the Dbm unit: ODb-1MW in 600 ohms
- **Impedance** — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model CT-1 IN-CIRCUIT CONDENSER TESTER

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.



in-circuit checks:

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

out-of-circuit checks:

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

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line
- Deep brushed long lasting etched aluminum panel
- Housed in sturdy gray hammertone finish steel case . . . comes complete with test leads

Model CT-1
$34.50 Net

TERMS: $9.50 within 10 days. Balance $5 monthly for 5 months.

10 DAY *FREE* TRIAL ON CENTURY INSTRUMENTS OF YOUR CHOICE

See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation . . . try them for 10 days before you buy . . . only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD

Model CRT-2 **$57.50 Net**

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

Model CRT-2 CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- ***ALL BLACK AND WHITE PICTURE TUBES*** *(including 110° tubes)* . . . from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . and the very latest 7 pin base.
- ***ALL COLOR PICTURE TUBES*** . . . Each of the red, green and blue color guns is handled separately.

CHECK THESE EXCLUSIVE FEATURES

- **THE MULTI-HEAD** (Patent Pending) . . . **A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** —A tremendous advance over the maze of cables and adapters generally found with other testers.
- **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- **CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION** — Stronger than any found in other testers — high enough to really do the job — yet controlled to avoid damage to the picture tube.
- **UNIQUE HIGH VOLTAGE PULSE CIRCUIT**— Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.
- **VISUAL LIFE TEST**— Enables both you and your customer to see the life-expectancy of any picture tube right on the meter . . . helps eliminate resistance to picture tube replacement when necessary.
- **SPECIAL LOW SCREEN VOLTAGE TUBES** — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- **SEPARATE FILAMENT VOLTAGES** — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- **NEW 'SF' PICTURE TUBES** — Accommodates the different base pin connections of this new type picture tube.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST
- For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle.
- For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube.
- For life expectancy.

REPAIR
- Will clear inter-element shorts and leakage.
- Will weld open elements.

REACTIVATE
- The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. The high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- The "BOOST" method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will also improve definition, contrast and focus greatly and add longer life to the picture tube.

Housed in hand-rubbed oak carrying case complete with CRT ADAPTER

Model FC-2 **$69.50 Net**

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

Model FC-2 FAST-CHECK TUBE TESTER

Simply set two controls . . . insert tube . . . and press quality button to test any of over 900 tube types completely, accurately . . . IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK
Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- Checks quality of over 900 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

SPECIFICATIONS

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Technician is checking the amount of distortion present in the output of a 50-watt paging amplifier. He is using audio oscillator for test signal and scope detector.

Simple Audio-Distortion Tester

By C. L. HENRY

Build this low-cost instrument to check per-cent distortion by fundamental suppression. External detector, such as scope or earphone, is required.

HOW often have you wished that you could measure the approximate percentage distortion of an amplifier output? Here is a very simple instrument which can be constructed in just a few hours, costs very little, and will check percentage distortion by the fundamental suppression method.

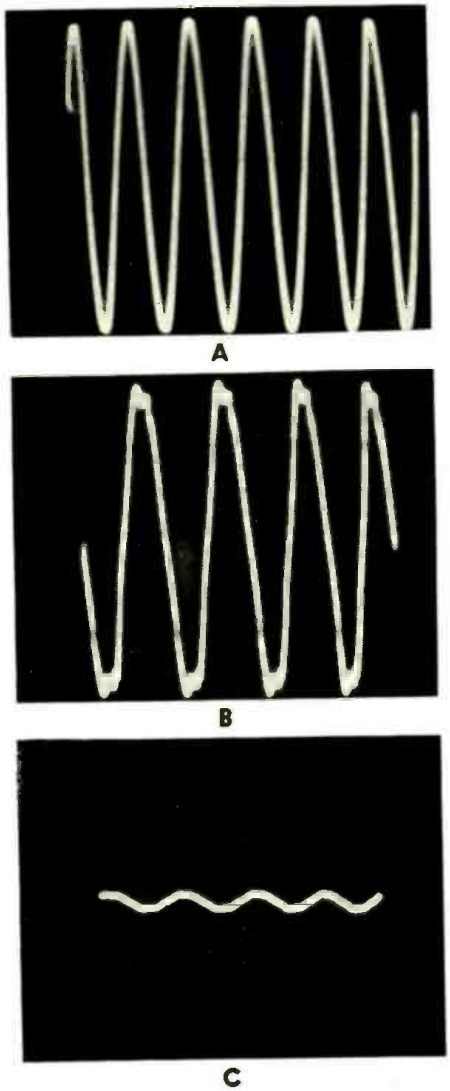
You can use this little instrument to check the distortion of your amplifiers, audio oscillators, or any other type of audio equipment. Instead of a complicated setup—for instance a commercial distortion tester, audio millivoltmeter, oscilloscope, etc.—the only equipment needed with this distortion tester is some sort of external detector. Even a lowly earphone will do!

Circuit Description

Referring to the circuit diagram, you can see that the circuit consists of a Wien-bridge network and a 10,000-ohm potentiometer, which shunts the input. The control in the Wien bridge is "Control A" while the 10,000-ohm pot is "Control B". By varying these two controls, the fundamental of the input signal is cancelled out and only the distortion remains. This may be harmonic distortion, noise, or hum. The Wien-bridge network and the shunting potentiometer form a modified Wheatstone bridge which will null under an extreme variation of sources and loads. When the bridge is in balance the fundamental does not appear across the external detector connectors, J_2 and J_3. Also, any signal that is not the same frequency as that to which the bridge is tuned (by means of the RC networks) will appear at the external detector terminals. The extreme range of input and output load variation is made possible by the 10,000-ohm potentiometer. If the size of this control were reduced and limit resistors installed, the bridge would null properly only under controlled conditions.

The best possible type of external detector is probably an oscilloscope since with a scope you can judge the null point and also tell what type of distortion is present in the output. The toggle switch, S_1, is the range control and is marked "High" and "Low". When the switch is in the "Low" position, the tester will balance well over a range of fundamental frequencies from 20 to 500 cps. A 0.1-μf. capacitor is used in each leg of the bridge for this range. On the "High" position, a 0.01-μf. capacitor is used and the range of

(A) Sine-wave input to amplifier under test. (B) Output of distortion tester before nulling the fundamental. (C) Output of the tester after signal has been properly nulled.

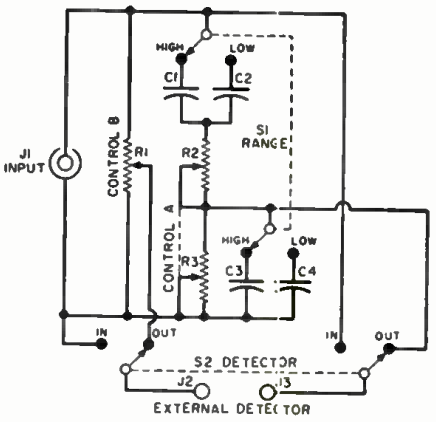


measurable frequencies at which the bridge will balance well is from 400 to 25,000 cps.

Construction

The tester was constructed in an aluminum box which measures 3" x 4" x 5". There is nothing critical about the placement of parts so any arrangement the builder chooses will be suitable. Remember, however, to insulate the input and external detector connectors from the case. If optimum operation is desired, the capacitors in this circuit should be matched, *i.e.*, the units should be checked for capacitance and two .1 and .01-μf. capacitors selected for closest values. The dual potentiometer should be an *Ohmite* AB type or unit of similar quality. This type of potentiometer seems to track very well and gives reliable operation. Control B can be any 2-watt carbon or 4-watt wirewound type. An *Amphenol* type 75-PC-1M connector was used as the input, J_1, and banana jacks were used for the output or external detector terminals, J_3 and J_4. However, any type connector can be used, provided the input is shielded and the input and external detector are not grounded.

One final recommendation on the construction of this tester. Use large



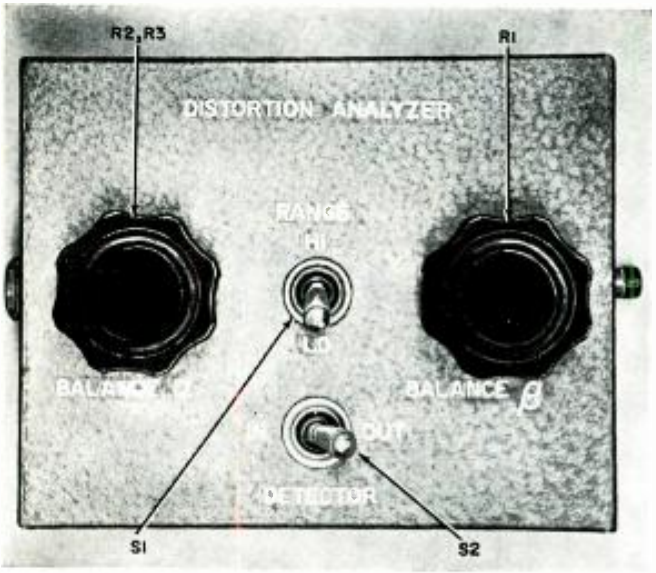
R_1—10,000 ohm, 2 w. carbon pot (Ohmite type AB or equiv. "Control B")
R_2, R_3—100,000 ohm, 2 w. dual-section carbon pot (Ohmite type AB or equiv. "Control A")
C_1, C_2—.01 μf., 400 v. paper capacitor (matched pair, see text)
C_3, C_4—.1 μf., 400 v. paper capacitor (matched pair, see text)
S_1—D.p.d.t. toggle switch ("Range-High-Low")
S_2—D.p.d.t. toggle switch ("Detector-In-Out")
J_1—Mike connector (Amphenol 75-PC-1M, "Input")
J_3, J_4—Banana jack (one red, one black. "External Detector")

Circuit diagram employed for the audio-distortion tester. A Wien-bridge network is utilized in conjunction with an external scope or earphone detector.

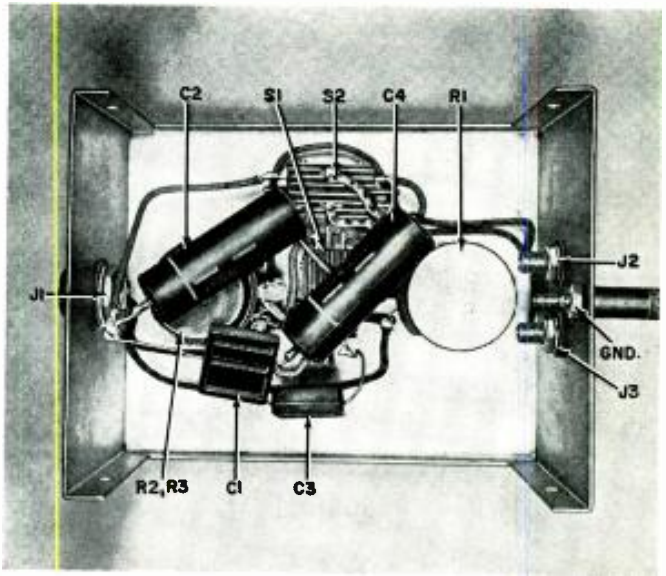
the best null is obtained, the reading on the detector is noted. Divide this value by the reading noted when the detector was on "In", then multiply by 100. This is the percentage distortion of the equipment under test. There are no controls to calibrate or adjust. The tester is ready to use when the construction is completed. Since it only nulls a signal and separates the fundamental signal from the distortion present, there can be little possibility of error.

Applications

Possible applications for this tester are numerous. First of all, it is ideal for checking percentage distortion, hum, and noise in audio amplifiers. If you have a high-fidelity system and wish to be sure that your amplifier is working properly, this is a very good way to test it. You will need an audio signal (60 cps works very well) and an external detector; earphone, oscilloscope, v.t.v.m., or a.c. v.o.m. Check the distortion of the signal source first. Then check your amplifier with the load that you normally have on it—using resistors for this purpose. Figure your percentage distortion and if you are using a scope, determine the type of distortion by direct observation.



Front-panel view of the audio distortion analyzer described. The entire circuit can be readily built into a small chassis.



Internal view shows the placement of the few components that are employed. Parts layout and arrangement are not critical.

knobs on the controls. You will find that under some conditions the nulling process is delicate and the large knobs are easier to use. In addition, a binding post should be installed beneath the external detector jacks and connected to the case. This is necessary since when measuring very low values of distortion it may improve operation to connect the case of the tester to a good ground to prevent spurious indications on the external detector.

Operation

After construction of the tester is completed, make a visual check of the wiring to be sure that it is correct. To use the distortion tester follow this procedure. First, turn both the A and B controls counterclockwise (maximum R). Then, with the input connected to the output of the unit under test and some sort of detector (oscilloscope, earphone, etc.) on the output of the tester, set the detector switch, S_2, to "In" and note the reading. Then set S_2 to "Out" and turn Control A until a slight null is noted. Re-adjust each control for best null and continue this process until the lowest possible signal is observed on the external detector. If an oscilloscope is used as the detector, the type of distortion that is being measured can be determined. When

Distortion in other types of audio equipment can be determined in the same manner. Modulators, audio sections of receivers, audio oscillators, etc. can all be checked and the percentage distortion determined. Amplifier troubles can also be found by looking at the distortion on an oscilloscope and determining what would possibly cause this waveshape.

Although not as accurate as more elaborate distortion measuring equipment, this device has the advantages of being inexpensive, simple to operate, and the indication that it gives is accurate enough for most service jobs that may be encountered. —30—

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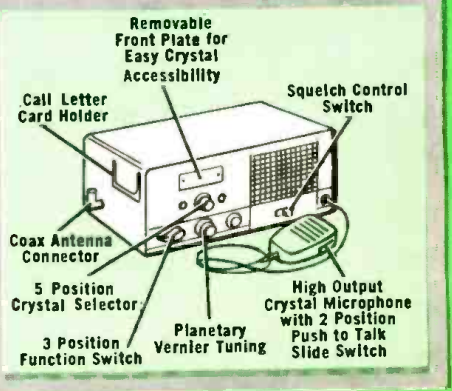

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Controlled-Heat Soldering

(*Continued from page 65*)

triple-throw toggle switch, is used to switch the other half of the 6.3-volt winding (L_2) and a choice of 1-watt resistor, in parallel with L_1.

As the current in L_1 is in the opposite direction through the transformer to that in L_2, the resulting fields will tend to cancel, reducing the effective reactance of L_1. When R_1 is a dead short, the reactance of L_1 is reduced to zero and the full 7-volt supply (less a .2-volt drop across the pure resistance of the windings) is available across the soldering-iron element, giving an output of 7.7 watts. A choice of values for R_1 and R_2 is given in Table 1 showing the output available with each resistor value. Which of these values to use is best determined by trial and error to give the three wattage levels suiting your particular needs.

One advantage of this circuit over current control by resistors only is that practical and readily available resistor values are used. As the resistance of a 6-watt, 6-volt iron is only 6 ohms, any resistors used in a series dropping circuit must be in the region of 0 to 3.3 ohms for effective control! Values of this order are hardly likely to be found in the average service shop. The need for higher power ratings than one watt also complicates the problem.

The 117-volt winding of T_2 serves no useful purpose in heat control. In fact, a "junk" transformer with this winding open can be used. (Care should be taken in this case to ensure that no turns are shorted or the reactor will not "react" correctly!) However, a good 117-volt winding can be used to advantage in providing voltage for a low-heat-indicating pilot light. This is shown in Fig. 1 with a series limiting resistor, R_3.

A small utility box can be used to house the complete heat-control and supply unit if portability is needed. An alternative that makes sure your iron is where it's supposed to be in a fixed installation is to mount the transformer and reactor to the under-side of the bench. The switch and a pair of jacks for connecting the iron can be mounted on a bracket under the front of the bench. A fuse holder can also mount under the bench, to grip the iron when the latter is not in use.

The schematic shows an extra 7-volt output wired to the secondary of T_1. This is for the addition of more reactors with irons, if more are needed. A single transformer has enough capacity to power up to four irons, with their associated circuitry.

In many shops, service on printed boards and other delicate equipment is being managed successfully without special soldering equipment. While this can be done, after a fashion, the use of miniature irons with controlled heat takes away many of the headaches and the risks, while promoting speed and efficiency. —30—

Stereo Microphone Techniques

(Continued from page 67)

center, which we may designate as L+R+C. The side microphone has a single transducing element, which moves forward, say, when the sound is of positive polarity at the left and negative at the right. Hence the electrical signal produced by the side microphone is L–R rather than L+R.

The output transformers, which are part of the SM-2, have special windings that matrix the signals produced by the two microphones, as shown in Fig. 5. The L–R and L+R+C signals are combined in-phase to yield 2L+C. Also, the L–R and L+R+C signals are combined out-of-phase to yield 2R+C. In sum, one output contains primarily L information and the other output primarily R information, but between them they also reproduce the center of the sound source, thus eliminating the hole-in-the-middle effect.

While the SM-2 is priced beyond the budget of the average home recordist, there is the possibility that the mid-side technique may eventually be placed within his reach through a moderate-priced mixer that properly combines the signals of two low-cost microphones with the necessary polar characteristics.

Longitudinal Recording

In experimenting with stereo microphone placement, many things have been tried and one that deserves mention is the "longitudinal" technique, shown in Fig. 6A, where one microphone is placed behind the other. Two effects are achieved by this method. (1) There are differences in arrival time at each microphone. (2) There are differences in the ratio of direct-to-reverberated sound. Both effects create a sense of spaciousness. Moreover, in reproduction, each speaker delivers a different version of the original sound, and these two versions can blend to produce a fuller kind of sound than obtainable from either speaker alone.

It is possible to combine longitudinal recording with other arrangements. Thus one might employ two microphones at the left and right in usual stereo fashion, plus a third considerably farther back and in the center. The signal of the third microphone would then be mixed with the outputs of the left and right microphones.

Multiple Pairs

Sometimes more than one pair of stereo microphones is used, each pair having a different polar pattern in order to pick up sound in the desired manner. This is illustrated in Fig. 6B. Here a pair of cardioid microphones is used up front to pick up a soloist, while omnidirectional microphones are employed farther back to pick up the entire group of musicians and, at the same time, obtain an appreciable amount of reverberated sound.

Best results are apt to be obtained if the microphones are matched in a number of respects. Frequency response is one. The sound may tend to wander haphazardly between left and right in reproduction if the microphones used happen to have different sensitivities at the various frequencies being picked up.

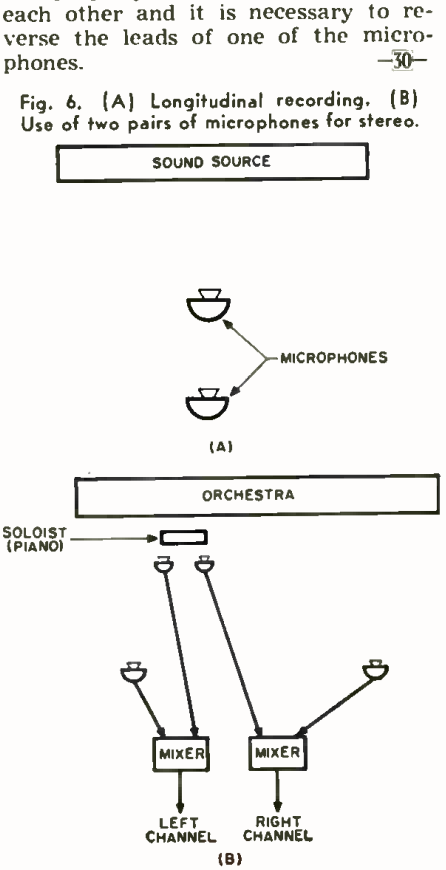
Matching of polar characteristics can be important. Apart from mid-side recording, the use of microphones with unlike coverage patterns may cause the apparent source of the sound to shift, or may result in inadequate reproduction of sounds in the center area.

The microphones should also be matched with respect to over-all sensitivity if serious problems of channel balancing are to be avoided.

Phasing

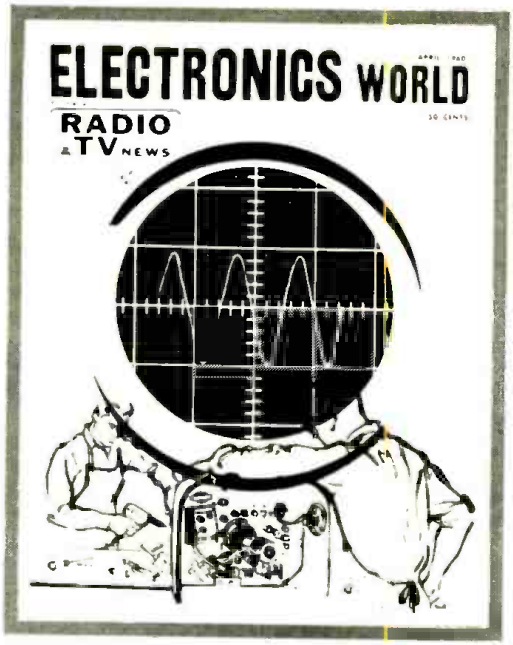
The problem of correct phasing applies to the stereo microphones as much as to the rest of the stereo chain. There is good chance of incorrect phasing if one employs two different types of microphones. To establish whether the microphones are in-phase, one can do the following. Place the microphones next to each other, make a stereo tape recording of a steady sound (*e. g.*, from a test record), and play back the tape through a stereo system where proper phasing has already been established. If the sound appears to come from a point about midway between the two speakers, microphone phasing is correct. If the sound appears to come from an indefinite region, the microphones are not properly phased with respect to each other and it is necessary to reverse the leads of one of the microphones. —30—

Fig. 6. (A) Longitudinal recording. (B) Use of two pairs of microphones for stereo.



COMING IN APRIL..

A SPECIAL REPORT ON ELECTRONIC SERVICING IN INDUSTRY



Last year alone, American *civilian* industry spent over one and a half *billion* dollars on electronic equipment for its own use! This staggering figure—a $170 million increase over the year before—represents only a mere fraction of the enormous total investment that Industry has in electronic equipment.

With money like this at stake, it's no wonder that Industry must evolve its own pattern of in-plant maintenance: establishing, training, and maintaining its own personnel exclusively for the servicing of electronic equipment. April ELECTRONICS WORLD goes into this vast industrial service system—in a comprehensive report on how one large company meets the challenge.

PLUS: special features on service associations, tube inventory, and test equipment.

In addition, April ELECTRONICS WORLD has articles like these:

MULTIPLEXING MUSIC: Home-recording enthusiasts can now convert any tape-recording unit into one capable of multiplexing music -- simply by adding new record-playback and erase heads to the original unit.

ROOM ACOUSTICS FOR STEREO: Part Four in this series tells how to balance furniture in a room to get the most out of a stereo speaker setup.

IS R.F. DANGEROUS? Can there be hidden danger in radio frequency energy? April ELECTRONICS WORLD discusses the answer to this important question.

CITIZENS RADIO TUNE-UP METER PROBE: Construction details on a simple v.t.v.m. probe for transmitter tuning and for monitoring the audio quality of a Citizens Band station.

Whether electronics is your hobby or business—you can't afford to miss the wealth of information that's yours in the important April issue of ELECTRONICS WORLD!

Mac's Service Shop

(*Continued from page 53*)

"You're wrong!" Barney said triumphantly as he picked up a slender blue book from the bench, opened it, and pointed to a table of resistances of metals and alloys. "See; copper has a resistance of 10.37 ohms per circular mil foot as compared with 14.55 ohms for gold. Silver has 9.796 ohms, and it's the only one listed with less resistance than copper."

"What's the name of the book and where did you get it?" Mac asked politely.

"It's called 'Handbook of Electronic Tables and Formulas' published by *Howard W. Sams & Co. Inc.* and compiled by Donald Herrington and Stanley Meacham of the *Sams* Engineering Staff. I picked it up at the distributor's when I was over there after parts. For a long time I've wished someone would come out with a book such as this for folks with feeble memories, like me. No matter how hard I try, I can't keep formulas for reactance, impedance, resonance, frequency-and-wavelength, etc., straight in my head. In fact, there's a whole raft of information involving formulas, wire tables, color codes, miniature lamps, transmission line characteristics, audio and video carrier frequencies of TV channels, and American substitutes for European tubes that I have to keep looking up over and over again; and that has meant going through a half dozen books each time to find what I want. Now, with this handy-dandy little volume right up here on the shelf where I intend to keep it, I can put my finger on what I want 'toot-sweet,' as we French say."

"I just can't get over a penny-pincher like you buying a book," Mac muttered.

"It will save me work, man!" Barney explained. "For example, suppose I want to know how much capacity I need to resonate a one henry choke at 1000 cycles. Do I use a formula to figure out the reactance of one henry at 1000 cycles and then use another formula to determine what value of capacity will have equal reactance at this frequency? I do not! I simply lay a straight-edge across the proper one of these reactance charts in the book, and I immediately see a capacitor of about .025 μf. will do the trick. Neat, huh? You wanta buy part interest in this book?"

"Let me see it, you Shylock," Mac said as he took the book out of Barney's hands. "Hm-m-m, I see it has lots of math stuff in it, too. Here are trig, logarithm, and decibel tables as well as decimal equivalents of fractions, powers of ten, and algebraic operations and geometric formulas. They should help a fellow working with a formula when his math is a little rusty. And here is a whole bunch of stuff that used to be printed on the backs of composition books when I was in school: Measures

and Weights and Metric Equivalents. Boy, does that take me back!"

"Don't overlook that colored foldout showing what services occupy each portion of the spectrum from 10 kc. to 100,000 mc.," Barney suggested; "and there are lots of little goodies tucked away here and there in the book such as the amount of power consumed by various electrical devices used in the home, the proper shunts and resistors to use with d.c. meters to make them indicate desired voltage, current, or resistance, and a complete description of the time and frequency signals put out by WWV and WWVH."

"OK, you've sold me," Mac said as he took out his billfold. "Here's half the price of the book, but let's have one thing clear: it stays right here at the bench where we both can use it during working hours. I don't want you lugging it home and leaving it in your ham shack. OK?

"OK," Barney cheerfully agreed as he put the money in his pocket. "And if I ever get tired of service work I think I'll take up selling. I made a little bet with the boys down at the distributor's that I could make you pay for half of that book!" —30—

SSB DINNER

THE SSB Amateur Radio Association will sponsor its Ninth Annual SSB Dinner and Hamfest on Tuesday, March 22, at the Hotel Statler-Hilton, 33rd St. and 7th Ave., N. Y. C. All amateurs and their friends are invited.

Equipment displays open at 10 a.m. and the dinner starts at 7:30 p.m. Bill Leonard, W2SKE, will be master of ceremonies. Tickets purchased in advance are $8.50 each and $9.50 at the door.

Checks for reservations may be sent to: SSBARA, % Mike Le Vine, 33 Allen Rd., Rockville Centre, N. Y. —30—

FIRST ARMY MARS MARCH SCHEDULES

THE First Army MARS Technical Net has named two new associate net directors and announced its schedule for March.

J. P. Hoffman, Information Officer and Frederic H. Dickson, Chief of the Radio Propagation Agency of the U. S. Army Signal Corps at Ft. Monmouth, have been named associate net directors and will be responsible for lining up speakers from among the electronic scientists and engineers at Ft. Monmouth.

The net can be heard each Wednesday evening at 9 (EST) on 4030 kc. upper sideband. March programs include:

Mar. 2—"Transistorized Test Equipment for the Amateur Radio Station" by Robert W. Gunderson, Editor, Braille Technical Press, New York.

Mar. 9—"Fundamental Requirements for Military SSB Receiver Design" by Dudley Kahn, Instructor, U. S. Army Signal Corps School, Ft. Monmouth.

Mar. 16—"Low Noise Preamplifiers" by Dr. James W. Meyer, MIT Lincoln Laboratory, Cambridge, Mass.

Mar. 23—IRE Convention recess.

Mar. 30—"Fundamentals of Single Sideband and Some Commercial Practice" by S. Edwin Piller, Radio Engineering Laboratories, Inc., N. Y., N. Y. —30—

Scatter Radio Communications

(Continued from page 40)

ous loads, such as pumps and motors, come on and off. To provide really high communications reliability, the prime power source must be arranged so that continuity of power will not be interrupted by failure of an engine or power bus. The newer tropospheric scatter systems use quadruple diversity, with each station employing two transmitters and four receivers for each link. These form two paralleling transmission paths even when a bus or an engine fails. Further reliability is built into the power plants by using several engines in parallel to feed a power bus instead of a single larger machine.

Costs

Tropospheric scatter stations have proven to be very expensive. In a large measure this is true because they are so often remote and must be equipped to be self-contained outposts of civilization, complete with power generating stations, sewage and water supply systems, and immense fuel storage facilities.

A typical remote repeater station might cost as much as $3- or $4-million. Of this, the radio equipment would account for about $½-million and the big antennas about $1-million. Most of the remainder would be spent for construction work of building the site including its access roads and possibly an airstrip.

However, even with these high costs tropospheric scatter is frequently more economical than microwave in remote areas. By spanning obstacles such as mountain ranges, rivers and icy tundra wastes in a single bound, it often costs far less than cable or wire systems which require construction and maintenance along every foot of the route and even microwave systems with relay stations every 20 or 30 miles.

Existing and Planned Systems

In addition to the DEW Line and "White Alice" systems, there are many military networks not as extensive in size. Many new routes are under construction, one of which is the new system being built for NATO, expected to extend all the way from Norway to Turkey.

Several commercial tropospheric scatter systems have also been built. A fairly extensive one was recently completed by the *Bell Telephone Company of Canada* in Quebec and Labrador. Other commercial systems are in the planning stages throughout the world.

The only tropospheric scatter system now capable of transmitting television signals is the single link system between Florida and Cuba built jointly by the *American Telephone & Telegraph Company* and the *International Telephone & Telegraph Company*.

New techniques, together with improved equipment, promise to further extend the usefulness of this new medium. At this time it seems doubtful if the formidable technical obstacles standing in the way of long distance television transmission by tropospheric scatter can be overcome. However, significant increases in bandwidth are being made and the remarkable past history of electronic marvels clearly shows the risk of forecasts which narrowly limit the horizon of the future.

One curious result of today's swift scientific pace is that a breakthrough, once accomplished, is accepted as commonplace almost immediately and the race is on to the next obstacle. Inventions which would have been the marvel of other times create little more than a ripple in the stream of today's public consciousness.

Electronic engineers and scientists are looking forward to revolutionary changes in the art of communications in the next five or ten years.

In much the same way that rocketry and space vehicles have suddenly emerged from the realm of science fiction to become casually accepted realities, communication by such exotic means as underground radio or reflection of signals off space satellites are thought to be much closer to fact than fancy. —30—

Mountain-top terminal station of "White Alice," northwest of Fairbanks, Alaska. Two dish-shaped antennas are pointed toward the next relay station, 75 miles away.

Wide-Stage Stereo

(Continued from page 52)

pedance mismatches have been made in "tolerable" directions and assume speakers of 16-ohm nominal impedance. Output difference up to 6 db may be compensated by choice of output taps in two-amplifier systems. Speakers need not be of equal "efficiency" or output per *volt* input, but may differ as much as 6 db even in two-amplifier systems. Where a pad is indicated, the "L" pad is to be preferred over a "T."

The theoretical level of the center channel has been derived as 3 db down from the flanking channels[2], but experience shows this to be a function of environment. Room geometry has dictated center-channel levels from 0 to −9 db relative to the flanking channels and these values may not include all extremes.

Latest Experiments

Stereo geometry experiments have been conducted comparing three independent channels with two-track-derived three channels.[7] These experiments are still under way but those completed thus far indicate the two-microphone, two-track, three-channel system approaches the three-microphone, three-track, three-channel system in performance and exceeds the two-channel playback in accuracy of geometry.

This author is in agreement with Steinberg and Snow's[1] conclusions, *i.e.*, that the center channel is necessary for the preservation of a reasonable approximation of the original geometry in stereo playback. Addition of the center channel permits wider spacing of flanking speakers, culminating in the natural limiting case of corner placement and the natural angular rotation of flanking units for complete coverage of the wide listening area. Wide-stage stereo means wide listening area as well and the corner-limited arrays permit full advantage to be taken of the improved tonality afforded by corner-placed speakers and, preferably, corner-designed speakers.

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—30—

"PIN POINT TRANSISTOR TROUBLES IN 12 MINUTES" by Louis E. Garner, Jr. Published by *Coyne Electrical School*, Chicago. 465 pages. Price $5.95. Spiral binding.

This is the fourth book in this publisher's "Pin Point" series but covers all types of transistorized equipment rather than just receivers. For this reason the book will be of interest not only to professional service technicians but to radio amateurs, hobbyists and builders of electronic projects, but maintenance men who troubleshoot commercial gear incorporating transistorized circuitry.

The author assumes that the reader has an elementary knowledge of semiconductor theory so there is no space wasted on basic material. The text material is divided into ten sections which deal with the basic test procedures; servicing preamplifiers and hearing aids; servicing audio amplifiers, "hybrid" portables, transistorized portable receivers, "hybrid" auto sets, transistorized auto receivers, transistorized TV sets, and special types of equipment. The final section supplies useful reference data such as semiconductor symbols, testing transistors, transistor types, interchangeability, etc.

The text is elaborately illustrated with photographs of commercial equipment, test procedures and equipment set-ups, schematic diagrams, charts, tables, line drawings, and pictorials. Three quick-reference troubleshooting charts help the user to localize service faults to sections, tables, and pages in the volume. The charts are divided by equipment types and further broken down by specific items of the general class.

The writing is informal and the author has eschewed mathematical treatment in favor of clear, almost non-technical explanatory copy.

* * *

"CIRCUITS FOR AUDIO AMPLIFIERS" prepared by Technical Service Dept., *Mullard Ltd.* Distributed in U. S. by *International Electronics Corp.*, 81 Spring St., N. Y. 12, N. Y. Price $2.50. Soft cover.

Ever since the introduction, in 1954, of *Mullard's* design for the now-famous "Five-Ten," the reputation of the company's circuits has grown. Those who are knowledgeable in the hi-fi art have come to consider that amplifiers built from these circuits are conservatively rated, honestly engineered, and high in performance. We have covered in our own pages some of these circuits, along with "Americanized" and "improved" versions.

This volume begins with some brief introductory chapters on general principles, distortion, and construction techniques. Included in this portion of the book is some excellent material on the operation of EL34 and EL84 power output tubes. The bulk of the book (over 100 pages) is devoted to detailed construction information on circuits, some of which have appeared before but others which have just come out of the laboratory.

Complete details are included on basic amplifiers ranging from 20 watts (this one would probably be rated closer to 35 watts here) down to 2 watts. Preamps, mixers, tape circuits, and stereo preamps and power amplifiers are also covered. Pictorial diagrams and chassis layouts make the construction easier for the audiophile. Although the commercial components listed are mainly of British manufacture, complete specifications are included so that American builders should encounter no difficulties along these lines. The volume is certainly a worthwhile addition to the library of the man who "builds his own."

* * *

"ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES AND THEIR USES" by John F. Rider & Seymour D. Uslan. Published by *John F. Rider Publisher, Inc.*, New York. 1356 pages. Price $21.95. Second Edition.

"Monumental" is the best word to describe this giant-sized volume that covers the oscilloscope completely from Astigmatism Control to Z-axis Input. The original edition of this book (1950) established for itself a much-deserved reputation for usefulness because one could find just about everything one wanted to know about the scope between its covers. But the scope and its uses have not stood still in the past decade. As more and more technicians and engineers learned the true value of this unique and highly valuable test instrument, its application and features have multiplied. This volume has kept pace with this advance.

All of the useful portions of the First Edition, from how the CRT works and what the controls do to almost 85 pages of complex waveform analysis, have been retained and brought up to date. In addition, new circuits have been covered, particularly those having to do with triggered and driven sweeps as used in laboratory-type instruments. A wide variety of industrial, engineering, medical, and scientific applications have been included along with uses in servicing and measurements on AM, FM, and TV receivers and transmitters

and audio equipment. Much useful information on pulse measurement and observation techniques and material on the maintenance of the scope is to be found in this latest edition.

A most interesting section of almost 60 pages has been included dealing with square-wave testing of *RC*-coupled amplifiers and networks. In this section, four standard square waveforms are applied to a circuit whose frequency response is changed in a controlled, predetermined manner and the effects on the waveforms are illustrated. There are over 225 pages of specifications and schematics of commercial oscilloscopes ranging from the simple general-purpose unit to the complex, highly specialized laboratory instrument.

Any present or prospective user of the oscilloscope, be he beginning experimenter, advanced hobbyist, service technician, industrial technician, or engineer, would do well to keep a reference copy of this volume on the shelf right next to his scope.

* * *

"R-L-C COMPONENTS HANDBOOK" by David Marks. Published by *John F. Rider Publisher, Inc.*, New York. 144 pages. Price $3.50. Soft binding.

This is an extremely specialized text but, as the author points out, too little time and space is spent on the subject of resistors, capacitors, and inductors in ordinary engineering and radio texts with the result that the properties of these important components are not as fully understood as they should be.

The text material is divided into six chapters with two each devoted to characteristics of resistance and commercial resistors; capacitance and capacitors; and inductors and transformers. Since the wide range of operating frequencies currently involved in electronics calls for innumerable sizes and shapes of components, this text covers them all.

The information provided in this book is suitable for the technical student, the technician, or the beginner.

* * *

"TUBE REPLACEMENT GUIDE" compiled by H. G. Cisin. Published by *Harry G. Cisin*, Amagansett, N. Y. 49 pages. Price $1.00. Paper bound.

This is an expanded edition of the author's earlier volume and covers over 2700 substitutes for more than 1500 tubes. Substitutes are listed for radio and television receiving tubes, TV picture tubes, tubes used in hi-fi and stereo equipment, as well as for foreign tubes widely used in the U. S.

The guide is divided into five sections covering replacements for radio, TV, hi-fi and other electronic receiving equipment; newer model TV picture tubes, picture tubes for older TV sets, U. S. substitutes for foreign tubes, and transistor replacement. The material is presented in tabular form with complete instructions for using. —30—

Sound on Tape

By BERT WHYTE

AT year's end there are always some critics who sum up the developments of the year in records, tapes, etc. for some newspaper. Frequently, these pundits are way off base. This year was no exception as several experts set out to tell their readers how bad things were in the tape world. "The two-channel is dead and 4-channel has not had the reception the backers expected" . . . "the public is confused and doesn't know whether it wants cartridges or reels" . . . "and anyway, who wants to play tape when a stereo disc is so good and so convenient."

Now I am not going to say that there isn't some truth in some of the things they say, for example, the four-track has not caught on as expected. But . . . and it's a big but . . . tape is far from dead and even in the critical areas there are good reasons for the problems. As far as two-channel is concerned, most companies who are still making them can't supply the demand and their duplicators are running constantly. The reason 4-channel is not a bigger factor is there are not enough of them on the market to create sufficient excitement and this is caused by the comparative lack of 4-channel duplication equipment. Despite this, there are plenty of 4-trackers being sold and as the duplication situation clears up, this will improve rapidly.

The tape cartridge has been produced in such small quantities there is hardly any sense in trying to evaluate it. Most tape bugs who have either 2- or 4-track 7½ ips equipment, indicate that present tape cartridge quality is not for them. So actually the cartridge is a separate market entity for an entirely different type of music lover.

It is probably true that there are also a good many people who would like to get into tape but are confused and are waiting to see the results of the reel *versus* cartridge battle. Fuel is added to this fire when they hear announcements of new cartridge developments lik the *3M* ⅛-inch type. In the over-all picture, tape is certainly far better off at the end of this year than last year. And there is every reason for continued optimism. As an example, in this column I will review a tape by *Decca*. They are entirely new to tape production but evidently feel that it will be worthwhile. And wonder of wonders, *London Records*, which was practically the only major company not in tape during the heyday of a few years ago, are now going in for the 4-track reel tapes! *UST*, the *Ampex* tape subsidiary, will distribute them and it is expected that most of the great *London* operas as well as selected orchestral works will be available. Could there be a bigger shot in the arm than that? Does this sound like tape is dead?

SUNRISE SERENADE

The Ray Charles Singers with orchestra conducted by Ray Charles. Decca 4-track Stereo. ST72-8838. Price $7.95.

One of the first tapes from *Decca* and a darn good one. The Charles Singers are a melodious group which benefits from the expert arrangements by boss Ray Charles. With a beautifully balanced ensemble they sing such as "Good Morning," "Daybreak," "Oh, What a Beautiful Morning," "Hey, Mister Sun," "Sunrise Serenade," and others of similar persuasion. In the colorful arrangements, the control exhibited by this group is outstanding and bespeaks of much practice together.

The stereo is quite good, with fine directionality, good center fill, and reasonably good depth. The individual timbres of the voices and instruments are easily discerned. All is quite clean and wide in frequency response. Tape hiss was present but not to an objectionable degree. All in all a good start in tape for *Decca*.

LEROY ANDERSON (VOL. 2)

Eastman Rochester Pops Orchestra conducted by Frederick Fennell. Mercury 4-track Stereo STB90043. Price $7.95.

The first volume of the ingratiating LeRoy Anderson music by Fred Fennell was an immediate and well deserved hit. Now the 2nd volume, with perhaps not the excitement of the tunes on the first issue, but LeRoy Anderson nonetheless and very welcome. Here we have such items as the "Typewriter," "The Syncopated Clock," "Waltzing Cat," "Fiddle Faddle," "Horse and Buggy," "Blue Tango," and others.

As in the first volume, they are played to a fare-thee-well by Fennell, whose unit exhibits tremendous drive and zest. The sound is the thing, of course, and this is as outstanding as the original. The stereo is very spacious yet with well controlled directionality, the depth perspective is wonderful and the instrumental separation is great. With total absence of distortion and the great frequency and dynamic range, this is a worthy successor to the first volume. —30—

Now available at electronics parts stores, hi-fi salons, and record shops!

Stereo-Monophonic
Test Record

Specially packaged
at only **$1.59**
($1.98 In Canada)

As a man who is seriously interested in hi-fi, you will certainly want to take advantage of this new and important test record, now on sale at electronics parts stores, hi-fi salons, and record shops. It will enable you to know your system inside-out. As a result, your listening enjoyment will be even greater than ever before.

This Stereo-Monophonic Test Record is the *most complete test record* of its kind—containing the widest range of essential check-points ever incorporated into *one* test disc! And, best of all, you need no expensive test equipment when you use this record! Just listen and get the thorough results you want—*all checks can be made by ear!*

Here are some of the questions this record will answer for you!

- ✔ *How good is my stylus? Is it worn? Will it damage my records?*
- ✔ *What about my stereo cartridge? Does it have enough vertical compliance so that it won't ruin my expensive stereo records?*
- ✔ *Is my turntable running at the right speed? Is it free of rumble, wow, and flutter?*
- ✔ *What sort of standing waves do I get in my listening room?*
- ✔ *Are my speakers hooked up correctly? Are they phased properly, and is the correct speaker connected to the right stereo channel?*
- ✔ *How perfectly is my system equalized?*
- ✔ *What about separation? Is it adequate?*

This special test record brings you an extraordinary 2-way value. First, it guides you in evaluating the quality of reproduction your equipment now produces. Second, it specifies the adjustments necessary to get the best recorded sound you have ever heard! This is easily the best value of the year for everyone who owns a hi-fi system—either monophonic or stereo!

NOW ON SALE EXCLUSIVELY AT ELECTRONICS PARTS STORES, HI-FI SALONS AND RECORD SHOPS!

You can be sure this Stereo-Monophonic test record comes as close to perfection as is humanly possible, because the editors of ELECTRONICS WORLD — leading technical magazine in the field of electronics—have poured their accumulated know-how into this record. Purchase your record today! (If you find your dealer does not yet have a supply available, ask him to order them for you.)

SPECIAL NOTE TO DEALERS: for information on ordering your supply of records, contact Ziff-Davis Publishing Company, Direct Sales Division, One Park Avenue, New York 16, N. Y.

Manufacturers' Literature

TRANSISTOR TESTING

CBS Electronics, 100 Endicott Street, Danvers, Mass., has published a new bulletin entitled, "How To Test Transistors." It is available through the firm's distributors or directly from the company's Information Services.

The new bulletin, PA-219, contains simple resistance checks which provide a fast evaluation of probable ability of transistors to function properly. Tests for gain (both *alpha* and large-signal current gain) are described, with test circuits included.

A separate section describes how to make distortion measurements using a calibrated oscilloscope.

ARGOS PRODUCT CATALOGUE

Argos Products Company, Genoa, Ill. has issued a new and complete catalogue, C-59, covering its entire line of tube caddies, wall and corner baffles, and high-fidelity enclosures.

The 8-page, 2-color booklet introduces the company's new tuning tube for matching its hi-fi cabinets to any speaker; two new hi-fi cabinets; and a new line of p.a. speakers in combination with wall and corner baffles.

Copies of this publication are available without charge on request.

SEMICONDUCTOR DIODES

Microwave Associates, Inc., Burlington, Massachusetts, has made available a new 17-page booklet which discusses applications of new and recently developed semiconductor diodes. It is obtainable upon request from the company.

"Applications of New and Recently Developed Diodes" was written by Dr. Arthur Uhlir, Jr. It covers such topics as varactor characteristics and measurements, varactor computers, silicon *MESA* computer diodes, etc.

The booklet was prepared as a supplement to the company's brochure, "Varactors," with particular emphasis on the use of varactors as modulators and harmonic generators.

TUNGAR BULB DATA

The Electronic Components Division of *General Electric Company*, Owensboro, Ky. has announced publication of a revised edition of its "Tungar Bulb Data Manual" which is currently available through authorized distributors.

Carrying typical circuits and operating data the 8-page brochure also features descriptive and theoretical data on the use of Tungar bulbs in rectifier circuits to provide noise-free power supplies with low voltage drop and high over-all efficiency.

Power-handling capability of the ten types of bulbs now available range from 20 amperes at 25 volts to 6 amperes at 250 volts.

The manual (ETR-2091) can be obtained through franchised distributors or from the Distributor Sales Operation of the company.

SELENIUM "FLATS"

The Selenium Division of *Radio Receptor Company, Inc.*, 240 Wythe Ave., Brooklyn 11, N. Y. is offering an 8-page brochure covering its new line of selenium rectifier "flats" which are currently available in production quantities.

Bulletin No. 295 provides basic rectifier information, product description, and methods of selecting the right rectifier for the circuit. Prices are also included in the bulletin. Designed primarily for applications in the electronic, entertainment, and special product fields, the new units are available in all circuit types from 15 to 600 volts and can be operated into a resistive or capacitive load.

MICROWAVE DIODES

Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., has announced a new technical booklet on microwave diodes. Copies may be obtained direct from the company.

The 12-page booklet contains complete electrical and mechanical data on all microwave diodes manufactured by the company as well as a replacement guide to nearly 200 widely used diodes.

The new brochure also contains technical information on the firm's recently announced "Micro-Min" line.

WIRING AND CONNECTIONS

Methode Manufacturing Corp., 7447 W. Wilson Avenue, Chicago 31, Illinois, is offering a new booklet entitled, "The Systems Approach to Electronic Wiring and Connections." The booklet may be obtained directly from the firm by writing to them on your company letterhead.

The booklet, which is not a catalogue, attempts to show many possibilities for wiring device advancement by illustration of efforts already made in wiring device integration and advanced applications in use of standard and flexible printed wiring, flat conductor cable, and associated components.

The 28-page book is divided into three parts. First is a section on "Case Histories" on printed circuit and wiring device applications. Second are check lists to assist in specifying, designing, and integrating multiple wir-

ing device components, etc. The third section covers the company's design, tooling, manufacturing, and inspection facilities. The brochure also offers engineering analysis designed to assist in packaging and interconnecting high density electronic assemblies.

TV DISTRIBUTION HANDBOOK

Jerrold Electronics Corporation, The Jerrold Building, Philadelphia 32, Pa. has just published a "TV Distribution System Handbook" which has been written especially for TV technicians.

The new booklet provides 150 typical charts covering most of the situations a technician might encounter in planning such systems. Split-page arrangements of typical TV system layouts make it easy for the technician to match typical "head ends" to various "distribution systems" for a great variety of coaxial cable and twin-lead installations.

One section of the 6" x 9" booklet suggests cures for common troubles in operating systems and makes recommendations for system servicing. The publication may be obtained from the company's distributors or by writing the company direct. The price is $1.00 per copy.

ALLIED'S CONNECTOR DATA

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. has issued an "*Allied* Connector Directory" which contains comprehensive listings of the most widely used electronic connectors.

The 16-page directory is offered as a convenient buyer's guide for manufacturers, research labs, engineers, designers, etc. Alphabetically arranged by manufacturer, *Amphenol, Cannon, Cinch-Jones, Harvey-Hubbell*, and *Hart & Hegeman* connectors are listed in numerical order for easy reference.

Issue No. 1 of the new "Connector Directory" will be supplied without charge upon request.

RELAY DATA

Artisan Electronics Corporation, 171 Ridgedale Ave., Morristown, N. J. is currently offering a copy of its two-color, single-page data sheet covering its line of general purpose relays.

The data sheet provides complete information on the coils, contacts, insulation material, terminals, finish, etc. on both plate-circuit and general-purpose versions of the components.

Copies of Bulletin No. 99 will be supplied without charge on request.

INDIVIDUAL SCHEMATICS

As a service to the experimenter, electronic engineer, or technician, *Supreme Publications*, 1760 Balsam Road, Highland Park, Illinois is offering individual diagrams and service data on popular sets of all periods.

Schematics for radio receivers are priced at 40 cents each while TV data is available for 75 cents. All material supplied is from the firm's servicing manuals. A 54-page "Master Index," which lists all the material available, can be obtained for 25 cents. —30—

The "Stereo Classic"

(Continued from page 68)

distortion is concerned, refer to Figs. 1 and 2.

Fig. 1 shows the 1 and 2% harmonic distortion curves in relation to the available power output for each channel. According to the Institute of High Fidelity Mfg.'s power-bandwidth standard in rating amplifiers, *G-E* could have rated this unit at 24.7 watts from 20 cps to approximately 25,000 cps at 2% harmonic distortion. Or, it could have been rated as a 23.5-watt amplifier from just above 20 cps to approximately 19,000 cps for 1% harmonic distortion. Note that the manufacturer actually rates the amplifier at 20 watts per channel at 1% harmonic distortion. We have always felt that 2% harmonic distortion is the maximum for top quality high-fidelity performance. As can be noted, this amplifier surpasses this requirement over the entire range of audio frequencies.

Fig. 2 shows the IM distortion curve in relation to power output. All our tests were made using 60 and 6000 cps at a four-to-one ratio. As can be seen from the curve, the IM distortion is 1.32% at the rated output of 20 watts. Our own standard, as pointed out in the past, is to have a maximum of 1% IM distortion and, as can be noted, this unit does not quite meet this requirement by a slight amount.

The balance of the tests were not too unusual.

Frequency Response: with both bass and treble tone controls adjusted to the electrical center (bass, 11:30 o'clock position; treble, 12:30 o'clock position) was ±.5 db from 30 to 15 kc., the limits of our test.

Low Filter (Rumble filter): down 8.2 db at 30 cps.

High Filter: down 23.2 db at 15 kc. The filter tests were in reference to 1000 cps and the limits of our tests were 30 cps to 15 kc.

Bass Control: −18.2 db and +10 at 30 cps.

Treble Control:—13.5 db and +12 db at 15 kc.

Sensitivity: for 20 watts output—tape, 4.0 mv., tuner and auxiliary, .174 volt; magnetic phono input (mono and stereo), 4.6 mv.

Tape Output: 2.23 volts is available for 1 volt input applied to the high gain circuits.

Channel Separation: at 1000 cps, and with tuner input. With 1 volt into left channel, right channel output is −53 db. With input to right channel, left channel output is −32.8 db. Although these figures are somewhat unusual in that greater separation is obtained in one direction than the other, both provide more than enough separation for stereo operation. Actually these tests were made with the input circuits of the opposite channel open-circuited. Under normal operation, with both inputs connected, the separation in either direction becomes more similar.

This amplifier should provide no problem as far as instability is concerned. We found no tendency towards oscillation with either the output transformer shorted with a .1-μf. capacitor or when the secondary winding was completely open-circuited.

Obviously from the tests made this is one of the best integrated amplifiers that we have checked in a long time and there is no doubt that it will provide true high-fidelity performance.

—30—

Letters from Our Readers

(Continued from page 12)

microns equal .0035 inch, 120 microns equal .0047 inch—sizable gaps! A micron is 39.37 times as large as a micro-inch.

I can't emphasize too strongly that the use of the word "micron" in any other meaning than a millionth of a meter is incontrovertibly and incontestably incorrect and should not be tolerated under any circumstances. All scientific work and measurements are based upon the metric system of which the micron is a part. Think what confusion can be wrought by the unthinking introduction of a new meaning for the word micron!

PHILIP N. BRIDGES
Rockville, Maryland

There are not too many manufacturers guilty of the above, but at least the distinction should be kept in mind. —Editors

* * *

IRRADIATION OF FOOD

To the Editors:

I am pleased to say that I have found the article "Preserving & Cooking Food with Electronics" by Walter Buchsbaum in your November issue quite informative and instructive. However, there seems to be some doubt as to possible harmful side effects created by irradiation.

Could you, therefore, attempt to further clarify this matter as I am extremely interested in its possibilities with regard to the ready-to-eat meats industry.

C. COORSH
Secretary-Treasurer
S. Coorsh & Sons Ltd.
Montreal, Canada

The U. S. Army Quartermaster has decided to postpone construction of the large radiation center in California. This is, at least in part, an economic move. It appears true that on some of the laboratory animals food deficiencies due to vitamin or other unbalance were found. It was not definitely established whether this was caused by the irradiated food or by a generally poor diet. Additional research will be needed with a closer control on all aspects before this method of food preservation can be released to industry. No harmful effects of any kind were ever observed on the human volunteers.— Editors.

—30—

"Line-Cord" Antennas

(Continued from page 41)

C_1 is generally a few hundred micro-microfarads, and C_2 is larger, but small enough to impede 60 cycles—say about .05 μf. Conscious of the need for electrical safety, most manufacturers have used units rated at 1000 volts or more for C_1 and C_2. Since there is connection to only one side of the a.c. line, there is no complete circuit path even in the unlikely event of a short.

Another type of unit (Fig. 2) is one that clamps to the line cord of the TV or FM set, rather than connecting to a wall outlet. In this variation, the line cord is run parallel to a metal plate that connects to one side of the antenna lead, but a thickness of plastic provides spacing between the two. This arrangement, although it looks less impressive than that in Fig. 1, generally performed better. Shock hazard with this well-insulated device is even less than with the type first described, being virtually non-existent.

Either type of unit will definitely couple whatever signal is actually intercepted by house wiring, with reasonable efficiency, into the attached transmission line while being relatively insensitive to undesired phenomena on the a.c. line that are lower in frequency. An important question remains: How much signal *is* there in house wiring? It is *not* true, as some have stated, that its effectiveness is insignificant because it is shielded and grounded. Once we move a few feet from the physical ground point of the house-wiring system, we lose our low-impedance path in the v.h.f. band. Signals this high in frequency that reach cable shielding will be coupled quite well to the wiring inside the shielding.

The capture area of an antenna is some indication of its sensitivity. To this concept we owe the practice of counting the number of elements in an unknown array for an estimate of its probable performance. From this, a considerable maze of house wiring would appear to be most promising. Unfortunately, a good antenna system has quite a few other requirements, and power-line cabling falls short on these.

A good antenna is seldom an accident. The size, shape, orientation, and spacing of its various elements are carefully worked out. It is designed to match a specified impedance. It is faced in a given direction for optimum performance. Except by an occasional lucky accident, your wiring is likely to rate low in these important respects, although not zero.

Thus, in general, the line-cord couplers will not give you performance that even approaches that of a moderately effective outdoor unit. Performance is roughly comparable to that of an indoor rabbit-ear dipole, although there is appreciable variation depending on the unknown quantity to which you are coupling. To a considerable ex-

tent, then, you are taking pot luck.

More specifically, you are not likely to do well with one of these units unless signal availability in your area is good, and ghosts due to reflected signals are not a problem. If you fall into this category, of course, more conventional indoor and outdoor antennas will also work. However, you may be able to avoid the periodic repair-and-replacement requirements of the latter and the obvious appearance of the former.

If you live in an apartment house or other building with a metal superstructure, this metal is much more likely to screen out the desired signal than will any shielding or grounding associated with the power-line system. In fact, it was only in test situations in such locations that coupling to the a.c. line provided little improvement over reception obtained by simply running a few feet of transmission line, connected to the antenna input, along the floor.

The couplers performed most reliably on the lower v.h.f. TV band and the lower portion of the FM band. At the top of the FM band and on high TV channels (7 and above), performance was much more critical; that is, slight changes in the position of the connecting transmission line produced noticeable changes in reception. With a sensitive FM tuner in a good location, the couplers are likely to give their best showing. In fact, many manufacturers of FM receivers have been using similar built-in line-cord antennas in their models for several years. Thus the principle of operation is scarcely "new and revolutionary."

If good reception is obtained with one of these units on some desired transmissions but not all, some manipulation is possible. With the plug-in type, trying another wall outlet or plugging other appliances into the outlet it uses (adding "elements," in other words) can help. With the clamp-on type, moving it to different positions along the line cord provided an unexpected flexibility of adjustment.

Since there is no reliable way of predicting whether a line-cord coupler will give satisfaction in any individual case, you should never buy one without a clear-cut money-back guarantee if you are not satisfied. Fortunately, the adapters are widely available on that basis.

Another objection to the couplers is their cost, if one is to judge by the list prices (up to $6.00). However, these prices have been plunging rapidly and, since mark-ups appear rather high, large discounts are available. You can make up one of the units shown in Fig. 1 for about a dollar, if you are so inclined. If you don't want to bother, be your own judge of how much more than that you are willing to spend, with a suitable guarantee, for trying one out with no risk. If it gives satisfactory reception, you have yourself a bargain to the extent that you have saved the additional expense of a conventional indoor or outdoor antenna. —30—

Signal-Powered Compressor

(Continued from page 56)

The maximum audio input voltage, E_i (max.), is found next. The d.c. voltage across C is equal to the maximum current through CR_2 times R, but the audio voltage applied to a half-wave rectifier is approximately 1.41 times the d.c. output of the rectifier, therefore:

$E_i\ (max.) = 1.41IR = 1.41 \times .0001 \times 41{,}000 = 5.8$ volts.

E_a, which we have set graphically at 6 mv., along with the maximum audio input, and the diode impedance at that input, determines the value of the series resistor, R_s:

$R_s = Z_R E_i\ (max.)/E_a = (454 \times 5.8) .006 = 440{,}000$ ohms.

The value of C is based on the lowest audio frequency (F) to be used (assuming a rapid attack time is desired). For speech work F will be about 200 cps:

$C = 20/FR = 20/(200 \times 41{,}000) = 2.44$ μf.

R_1 serves to limit the current through the rectifier, CR_1 and also reduces the attack time. If we wish to limit the current through CR_1 to 5000 μa.:

$R_1 = E_i\ (max.)/I_{CR1} = 5.8 .005 = 1160$ ohms.

The attack time is simply R_1C and release time RC, so the attack time is 2.82 milliseconds and the release time is 1/10 second. The attack time is somewhat longer at low input, because of the higher resistance of CR_1.

Maximum loss, when R_s is at least $10Z_R$, is the ratio of R_s to Z_R, therefore:

Maximum loss $= R_s/Z_R = 970$ or 59.8 db.

The calculated values of the components are still somewhat arbitrary, because they are based on a perfect reciprocal impedance-to-current curve for the compressor diode. However, they provide good approximations. The curve of Fig. 3 is the output-input characteristics of the circuit of Fig. 2, with the following values: $R_s = 470{,}000$ ohms; $R_1 = 1200$ ohms; $R = 47{,}000$ ohms, and $C = 2$ μf. These are stock values approximating the calculated values. The circuit's frequency response is shown in Fig. 4.

Applications

There would seem to be many applications for this circuit because it is entirely powered by applied audio and, as a direct result, can be made very compact. Where it is desired to incorporate this compressor into a transmitter or other piece of equipment, the loss sustained by it can be recovered by a pair of triodes or transistors. One particular application is in the recording of communications broadcasts where the compressor can be driven from a 500-ohm receiver output transformer. The compressor output is about right, then, for a high-impedance microphone input on a magnetic tape recorder.

The primary considerations in applying this circuit are the input and output impedances. The input should be from a source of less than 15,000 ohms, and the output should work into something in excess of 50,000 ohms. This is easily done when the compressor is followed by a tube, but is a little more difficult with a transistor. However, a resistor of at least 47,000 ohms between the compressor output and the following stage will permit transistor operation. —30—

ONE-TRANSISTOR BROADCAST RECEIVER

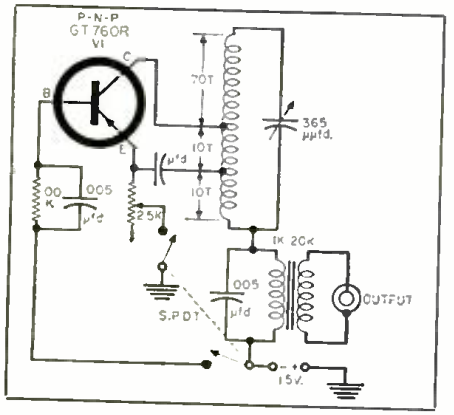
By HERB COHEN
General Transistor Corp.

THIS simple, sensitive AM broadcast receiver has several unique features. The sensitivity of the basic superregenerative circuit is greatly enhanced by the construction of the coil which allows us to do away with an external antenna. The feedback loop is from a tap on the tuning coil to the emitter through the .1 μf. capacitor. This gives us our basic oscillator circuit. The quench frequency is produced by the .1 μf. capacitor and the internal lumped resistance of the emitter circuit. The 2500-ohm pot is used to control the sensitivity by varying the quench frequency as well as the feedback current. The base current is limited by a 100,000-ohm resistor and is shunted by a .005 μf. capacitor which insures that the base is grounded for a.c.

The construction of the coil is interesting in that we tap well down for both the emitter and the collector. This allows us to have a very high impedance without loading. In addition, the coil is loaded on a ½" diameter plastic form and a ½" x 4" ferrite rod is inside the coil form. This insures that the coil itself is not wound directly on the ferrite rod. This drastically reduces the shunt capacity of the coil and provides an enormous "Q" coupled with a tapping down of the collector which makes it unnecessary to use an external antenna in the city.

The battery is a 1.5-volt penlite cell and the unit draws about ½ ma. The earphone is either a high-impedance magnetic or a 1000-to-20,000 ohm matching transformer into an inexpensive crystal phone. The transistor itself is a GT760R with an alpha cut-off of 3 mc. It is priced at approximately $1.50. —30—

Circuit diagram for the one-transistor b.c. receiver. Note that the 90-turn coil should be tapped at the 10th turn from the bottom for emitter and 20th turn for collector.



What's New in Radio

NEW CB TRANSCEIVER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has just introduced a new superheterodyne CB transceiver, the HE-15.

Completely wired and tested, the new transceiver meets all FCC rquirements

and features five crystal-controlled transmitting channels operating at a maximum legal plate power input of 5 watts.

The superheterodyne receiver is tunable over the 22-channel band with 3 watts audio output. Controls include a three-position function switch (transmit, receive, and transmit with spring return), planetary vernier tuning, and squelch noise limiter control. All coils are ferrite tuned.

The output impedance matches 52- and 72-ohm antennas and has an *Amphenol*-type coaxial connector for operating into a dipole, ground plane, or rod antenna. Also provided is an input jack for crystal or ceramic microphone plus power receptacle in the rear for a.c. line or 6- or 12-volt external power supply for mobile operation.

The HE-15 comes complete with one transmitting crystal and high-output crystal microphone with push-to-talk two-position slide switch. Additional crystals are available. The chip-proof cabinet measures 10¼" x 5½" x 6⅜".

POWER SUPPLY

Power Sources, Inc., Burlington, Mass. is now marketing a fully transistorized power supply which is intended for general purpose applications.

Designed to provide a stable, regulated source of 125-150 volts d.c., the Model PS-1018 has a load current range of 0-1.5 amp., operating from a nominal input of 105-125 volts a.c. Output varies less than ± 0.2 volt for line changes of ± 10 volts, with load held constant. In addition, the supply is regulated so that there is less than 0.2 volt change in the output for load changes from zero to full rated current.

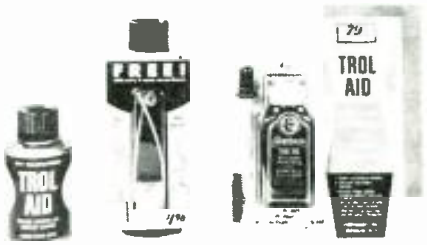
A monitoring meter is provided on the front panel which reads the voltage drop across one regulator transistor. A selector switch provides for readings of output voltage and current as well. The ripple and noise figure for the unit is less than 2 mv. r.m.s. Efficiency of the supply is 65 per-cent at full-rated load.

Detailed information and specifications may be obtained from the manufacturer.

THREE "TROL AID" PACKAGES

Chemtronics Inc., 122 Montgomery, Brooklyn, N. Y. is now offering its "Trol Aid" in three different packages. The product is a non-toxic volume control and contact cleaner used in servicing radio and TV receivers as well as other electronic equipment.

For bench use by service technicians, the product is packaged in an eight-



ounce aerosol can. With this size container the company provides a free wall mount and spray aid. A three-ounce can, known as the "caddy size," is also available in aerosol form.

For those who prefer a compact container, the cleaner-lubricant is also being packaged in a two-ounce bottle with an unbreakable applicator.

TV RECEIVING TUBES

Sylvania Electronic Tubes, Emporium, Pa. has announced five new tubes for use in television receivers.

The Type 10DR7 is a T6½ double triode with high-mu section for vertical deflection oscillator application and a low-mu section for use as a vertical deflection amplifier. It is a 9.7 volt, 600 ma. version of the 6DR7.

The 10EG7 is a T9 double triode for series-string television with a medium-mu section designed for vertical deflection oscillator use and a low-mu section for vertical deflection amplification.

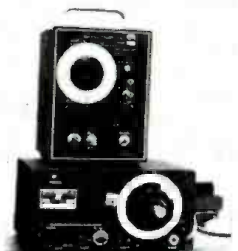
Types 6GN8 and 8GN8 both incorporate a high-mu triode and a sharp

cut-off pentode in one T6½ envelope. The triode section is designed for voltage amplifier or sync separator service. The pentode section, designed for video amplifier service, features a controlled knee characteristics.

The Type 12BZ6 is a T5½ semi-remote cut-off pentode for use as an automatic-gain-controlled amplifier. It is a 12.6 volt, 150 ma. version of the 6BZ6.

FREQUENCY CHECKER

Lampkin Laboratories, Inc., Bradenton, Florida is now marketing a low-cost system for measuring the frequencies of mobile transmitters to the FCC split-channel tolerance of .0005% (above 50 mc.).



The new system is called the "PPM Package" and consists of the company's micrometer frequency meter and a modified *Measurements Corporation* Model 111 crystal calibrator. When used in conjunction with a WWV receiver, transmitter frequency checks can be made to an accuracy of better than one part per million (.0001%).

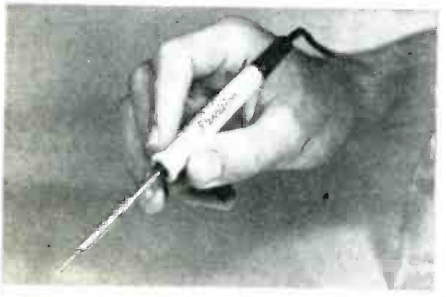
The crystal calibrator has been modified by *Lampkin* to include a 3½" dial which tunes the crystal and is calibrated in parts-per-million with a range from +25 ppm to −25 ppm. The crystal calibrator produces harmonics spaced 250 kc. apart up to 500 mc. and beyond. The output frequency of the meter mixes with the 250-kc. harmonics and creates a new side frequency which can be located on any transmitter channel.

The unit is available either as a "package" or the individual instruments may be purchased separately. Write the company for full details and a data sheet.

LOW-WATTAGE IRON

M. M. Newman Corporation, 79 Clifton Ave., Marblehead, Mass. is now offering its "Precision" miniature soldering iron for applications requiring low wattage and light weight.

The new iron measures just 6½ inches long and operates on 110-115



volts without a transformer. The unit weighs 1 ounce. Complete with new safety handle that stays cool and withstands contact with other hot soldering irons without melting or charring, the

iron has a 50-megohm insulation between element and tip, making it suitable for use around semiconductors.

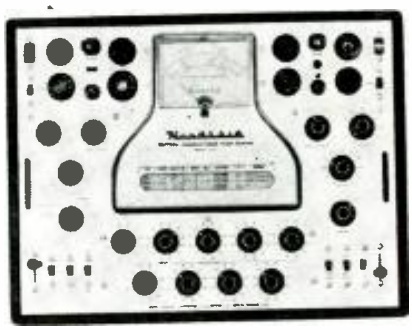
Heat-up time is about 45 seconds and the sealed element maintains constant temperature at approximately 626 degrees. Both operator and component are protected by an ultra-flexible, three-wire cord that allows for grounding the instrument.

For complete information, a data sheet, and price write Department IR-26 of the company.

HEATHKIT TUBE TESTER

Heath Company, Benton Harbor, Michigan has added a low-cost mutual conductance tube tester to its line of service equipment in kit form.

The Model TT-1 provides quick and accurate testing of transconductance



and grid current in multi-element tubes and will also check diodes and rectifiers, voltage regulators, low-power thyratrons, and electron-eye tubes. Mutual conductance values are read on an illuminated dial from 0 to 24,000 μmhos. The meter will indicate down to as low as ¼ μa. on grid current tests. A built-in variable d.c. power supply provides direct-reading voltage indications on voltage regulator tube tests.

Other features of the new unit include an illuminated meter, a "constant tension" illuminated dial chart with thumbwheel drive at each side, removable line cords, 110-volt a.c. outlet, and blank socket on the panel for future tube types.

"TRANSIST-O-CHECK"

The Components Division of *Transistor Specialties, Inc.*, Terminal Drive, Plainview, New York is now offering a

low-cost, portable battery-powered transistor tester as the Model 902 "Transist-O-Check."

Designed to meet laboratory, production, incoming inspection, and shop requirements for the simple and rapid testing of low- and medium-power transistors, the instrument checks the most significant transistor characteristics: d.c. *beta*, I_{cbo}, and I_{ceo}, as well as the existence of collector-to-base and collector-to-emitter shorts.

Completely self-contained, the unit operates from an internal, easily replaced six-volt battery and incorporates a wide-view 50 microampere meter for direct reading of current values. All functions are controlled by only two switches.

The unit measures 7¼" x 4⅜" x 4⅛" and weighs less than 2 pounds. Bulletin 101 carrying complete specifications on this unit is obtainable from the manufacturer on request.

TV SERVICE TABLES

Easy-Up, Inc., 1006 State Street, Racine, Wisconsin is offering a new line of portable tables which are designed specifically for TV servicing applications.

The units are priced so that each set can remain on its own table until the service job has been completed. In addition, the table can function as an order-filling cart for assembling service parts or customers' orders. The basic unit is 30" high with a 24" x 24" x ⅝" top. Other sizes and shapes are available on special order.

A data sheet on these new tables is available on request.

CERAMIC CATHODE SUPPORT

Sylvania Electronic Tubes, Seneca Falls, N. Y. has announced the development of a new design in TV picture tube construction which is said to provide brighter and sharper pictures with minimum warm-up time.

Known as the "*Sylvania* Cloverleaf," the new design features a unique ceramic cathode support which doubles the responsiveness of picture tubes while reducing the number of tube failures due to loss in heat conduction, according to the company.

The new design, by reducing the cathode support area, improves the over-all efficiency and life of the tube. It contacts the cathode in an area only half as large as conventional supports and permits the cathode to reach operating temperatures in a minimum period of time.

TRANSISTORIZED CONVERTERS

Cornell-Dubilier Electric Corporation, South Plainfield, N. J. is now offering two new "Transipower" transistorized converters for use in portable and mobile transmitters, receivers, and transmitter/receivers.

The Model 12TP12 is a transmitter power supply which converts 10.5 to 14.5 volts d.c. (12.6 volts d.c. nominal input) to 500 volts d.c. at 240 ma. (120 watts) output, or 500 volts d.c. at 150 ma. and 250 volts d.c. at 100 ma. Ratings are based on 50% duty cycle. The unit measures 5¼" x 4¼" x 3" and weighs 1¾ pounds, with space provided for the internal mounting of a control relay.

The Model 12TP3 is a receiver power supply which converts 10.5 to 14.5 volts d.c. to 300 volts d.c. at 100 ma. or 300 volts d.c. at 70 ma. and 150 volts d.c. at 60 ma. Ratings are based on continuous duty. This unit measures 5⅞" x 3¾" x 1½" and weighs ¾ pound. Both units are circuit-protected against transients and overloads.

TWO-SET TV COUPLER

Channel Master Corp. of Ellenville, N. Y. is now marketing a new version of its "Matchmaker" two-set TV coupler featuring a completely re-designed plastic case and a unique concept in coupler packaging.

The Model No. 0036 is housed in a compact Dylene case. The coupler features new insulation-piercing terminals which eliminate wire stripping, wire winding, and terminal lugs. The circuit features interlocked coil forms which assure permanent installation as the coil forms cannot shift, slide, or loosen.

According to the company, the unit meets all five requirements of an efficient coupler: minimum insertion loss, absolute signal isolation, perfect impedance matching, perfect impedance isolation, and equal division of the signal. The unit comes complete with installation hardware. —30—

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An Odd "Tube" Problem

(Continued from page 64)

handle tubes. During a busy day, one technician can handle fifty tubes, or even more. If he fails to charge for only three of them, because of the reasons we've already covered, in the course of a week—and that's only about 1 per-cent—then 150-odd tubes have jumped the fence in a year.

"Remember, this is for one man only. Also remember that we haven't covered all the ways in which tubes can vanish. Sometimes, in the customer's home, a tube is accidentally burned out on a tester, for example. Filament voltage may be set for 50 volts and the 6SN7 being checked flares like a flash bulb. The technician feels it isn't fair to charge the customer for such a mistake. And then there's petty theft. I'm not saying it happens here, but a small percentage of tubes in many shops find themselves emitting electrons in the sets of the technician's friends or neighbors. Am I getting home?" Mr. Tish smiled.

"On all channels," Ray murmured thoughtfully. "But, according to the way you figure, we should be short at least seven hundred tubes."

"Wow! We've got a surplus!" Super-Sonic exclaimed with a grin.

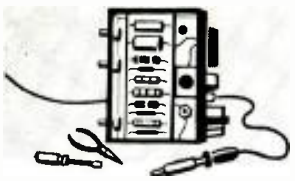
"As for remedying the situation," Ray queried, obviously relieved at this convincing accounting that avoided unpleasantness, "Do you have an answer?"

Mr. Tish took a small pencil out of his shirt pocket, jotted a few tube numbers on the back of an old repair tag, and then said: "This answer is so simple I feel funny about being the one to mention it. However, every time a technician takes a tube from the shelf regardless of how he intends to use it on the job—he should mark it down on the back of the repair ticket. When the job is finished and ready for billing, he should check the reverse side of the tag and charge accordingly for tubes replaced. This procedure will make sure that none are overlooked. It will also remind him to take out temporary substitutions that might otherwise be left in the set without charge. Complicated? No. Yet it takes care of the single factor that accounts for most of the tubes that show up missing on an inventory. As for the other losses, like burn-outs and breakage, figure a normal overhead charge of about three per-cent and allow that much leeway on inventory loss. That should be enough."

"I always allow for some loss," Ray replied cheerfully.

Mr. Tish gave him a knowing nod. "One important rule to remember, then," he concluded, raising the red tip of his pencil in front of Super-Sonic's wondering gaze. "Always write the tube numbers down with a red pencil. It's a 'tip' that might just keep you from getting a colored reputation."

—30—



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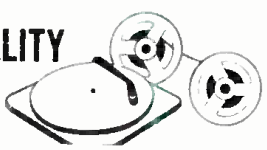

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INDEX OF Advertisers

MARCH 1960

ADVERTISER	PAGE NO.
Advance Electronics	126
Airex Radio Corporation	104
Allied Radio Corp.	9, 93, 110, 111, 112, 113
Argos Products Company	107
Ashe Radio Co., Walter	125
Aubanel Publishers	100
Audax—Division of Rek-O-Kut Co., Inc.	75
Audio Empire	10
Audion	146
Audiotex Mfg. Co.	87
B & K Manufacturing Co.	73, 131
Baltimore Technical Institute	108
Barry Electronics Corp.	146
Bell Telephone Laboratories	34
Blonder-Tongue Laboratories, Inc.	115
Burstein-Applebee Co.	137
CBS Electronics	31
C & H Sales Co.	146
Canadian Institute of Science & Technology Limited	142
Candee Co., J. J.	130
Candler System Co.	146
Capitol Radio Engineering Institute	18, 19, 20, 21
Carston Studios	125
Centralab, Electronics Division of Globe-Union Inc.	12
Century Electronics Co., Inc.	118, 119
Champion DeArment Tool Company	92
Channel Master Corp.	11
Chicakasha Electronics, Inc.	142
Cleveland Institute of Electronics	23
Columbia Electronics	138
Coyne Electrical School	109, 116, 133
Crosby Electronics, Inc.	76
Crystal Electronics Company	145
DeVry Technical Institute	5
Dressner	125
Dynaco, Inc.	85
EICO	35, 36, 84
Electro-Voice, Inc.	28
Electronic Chemical Corp.	143
Electronic Experimenter's Handbook	128
Electronics World	127
Electronics World Book Service	108, 141
Electronics World Stereo Disc	135
Electronics World Subscriptions	148
Essco C-B Hqts.	125
Esse Radio Company	145
Fair Radio Sales	133
G & G Radio Supply Co.	101
General Electric	16, 17, 26
Glaser-Steers Corporation	74
Goodheart Co., R. E.	132
Grantham School of Electronics	7
Greenlee Tool Co.	140
Hallicrafters	144
Harmon-Kardon, Inc.	32
Heath Company	89, 90, 91
Henshaw Radio Supply	145
Hi-Fidelity Center	137
Hi-Mu Electronics	134
Homewood Industries, Inc.	134
Hy-gain Antenna Products	128
Indiana Technical College	146
International Business Machine Corporation	78, 79
International Radio & Electronics Corp.	86
International Resistance Company	129
Jensen Industries, Inc.	144
Johnson Company, E. F.	109
Key Electronics Co.	140
Kuhn Electronics	145
Lafayette Radio	122, 123, 124
Lampkin Laboratories, Inc.	139
Lektron	106
Micro Electron Tube Co.	117
Milwaukee School of Engineering	82
Moss Electronic, Inc.	94, 95
National Radio Institute	3
National Schools	25
North American Philips Co., Inc.	2nd Cover
Olson Radio Corporation	139
Pacific International College of Arts & Science	140
Paco Electronics Co., Inc.	83
Peak Electronics Company	114
Pickering & Co., Inc.	86
Picture Tube Outlet	108
Platt Electronics Corp.	108
RCA Institutes, Inc.	29
R W Electronics	130
Rad-Tel Tube Co.	99
Radio Corporation of America	4th Cover, 13, 14, 15, 24
Radio Shack Corp.	117
Rinehart & Co., Inc.	129
Roebuck Corporation	140
Sams & Co., Inc., Howard W.	102, 103
Seco Manufacturing	22
Sonotone Corp.	8
Sprague Products Company	33
Sprayberry Academy of Radio-Television	27
Standard Surplus	139
Sylvania	6
"TAB"	136
Teltron Electric Co.	143
Terado Company	104
Texas Crystals	98
Thorens	77
Tri-State College	137
Triplett Electrical Instrument Company	3rd Cover
Tru-Vac Electric Company	105
Valparaiso Technical Institute	131
Van Nostrand Company, Inc., D.	145
Windsor Electronics	131
World Radio Laboratories	107
Xcelite, Incorporated	104

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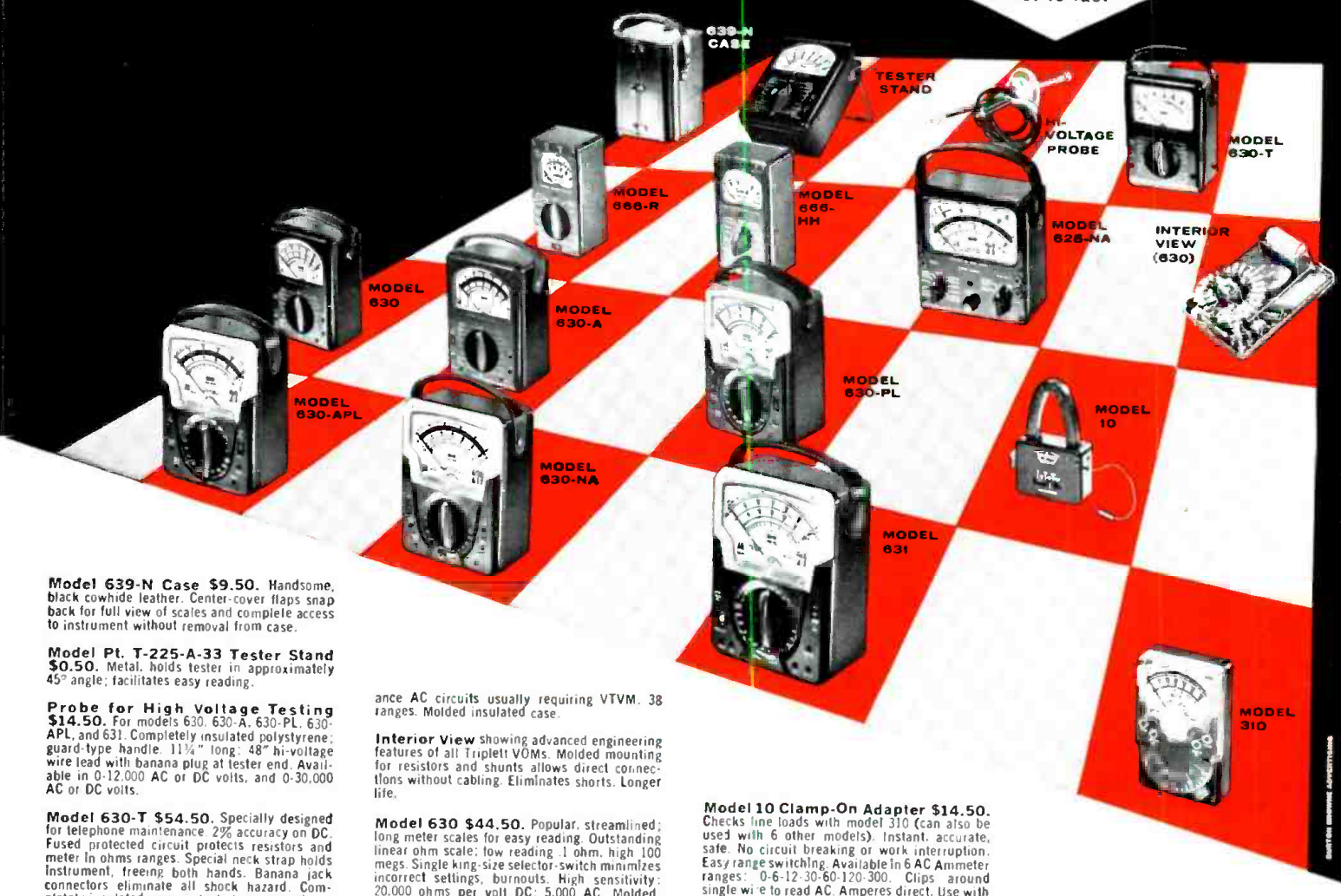

Model 639-N Case $9.50. Handsome, black cowhide leather. Center-cover flaps snap back for full view of scales and complete access to instrument without removal from case.

Model Pt. T-225-A-33 Tester Stand $0.50. Metal, holds tester in approximately 45° angle; facilitates easy reading.

Probe for High Voltage Testing $14.50. For models 630, 630-A, 630-PL, 630-APL, and 631. Completely insulated polystyrene; guard-type handle. 11¼" long; 48" hi-voltage wire lead with banana plug at tester end. Available in 0-12,000 AC or DC volts, and 0-30,000 AC or DC volts.

Model 630-T $54.50. Specially designed for telephone maintenance. 2% accuracy on DC. Fused protected circuit protects resistors and meter in ohms ranges. Special neck strap holds instrument, freeing both hands. Banana jack connectors eliminate all shock hazard. Completely insulated case protects from ground.

Model 666-R Pocket VOM $29.50. Hand size, ideal for electrical maintenance. With recessed range knob it fits easily into case. AC rectifier pre-calibrated unit for easy replacement. Banana jacks at panel top prevent leads falling over meter dial. Single king-size selector switch minimizes incorrect settings, burnouts. 20 ranges. Molded case streamlined, fully insulated.

Model 666-HH Pocket VOM $27.50. Compact, hand-size; 3" meter integral with panel, adjusted to 400 microamperes at 250 millivolts. Only 3 jacks necessary for all ranges. 19 ranges.

Model 625-NA $54.50. Dual sensitivity for extra ranges; large mirror scale for super readability. 3-color meter scale 5" long, 6" instrument. 0-50 microamp. AC volts at 10,000 O/V for checking many audio and high impedance AC circuits usually requiring VTVM. 38 ranges. Molded insulated case.

Interior View showing advanced engineering features of all Triplett VOMs. Molded mounting for resistors and shunts allows direct connections without cabling. Eliminates shorts. Longer life.

Model 630 $44.50. Popular, streamlined; long meter scales for easy reading. Outstanding linear ohm scale; low reading .1 ohm, high 100 megs. Single king-size selector-switch minimizes incorrect settings, burnouts. High sensitivity: 20,000 ohms per volt DC; 5,000 AC. Molded, fully insulated case.

Model 630-A $54.50. Laboratory type; ½% resistors for greater accuracy. Long mirrored scale eliminates parallax. Banana jacks, low resistance connections; high flux magnet increases ruggedness. Single king-size selector switch minimizes incorrect settings, burnouts. Molded fully insulated case.

Model 630-PL $44.50. Instant-vision, wider spread scales; streamlined case; handsome modern design. Unbreakable window. Outstanding linear ohm scale; low reading .1 ohm; high to 100 megs. Single king-size selector switch minimizes incorrect settings, burnouts. 5 to 500,000 cps frequency response in AC measurements. DC Polarity Reversing switch. High sensitivity; 5,000 ohms per volt AC; 20,000 ohms per volt DC.

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