ELECTRONICS WORLD

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RADIO & TV NEWS

MAY, 1959

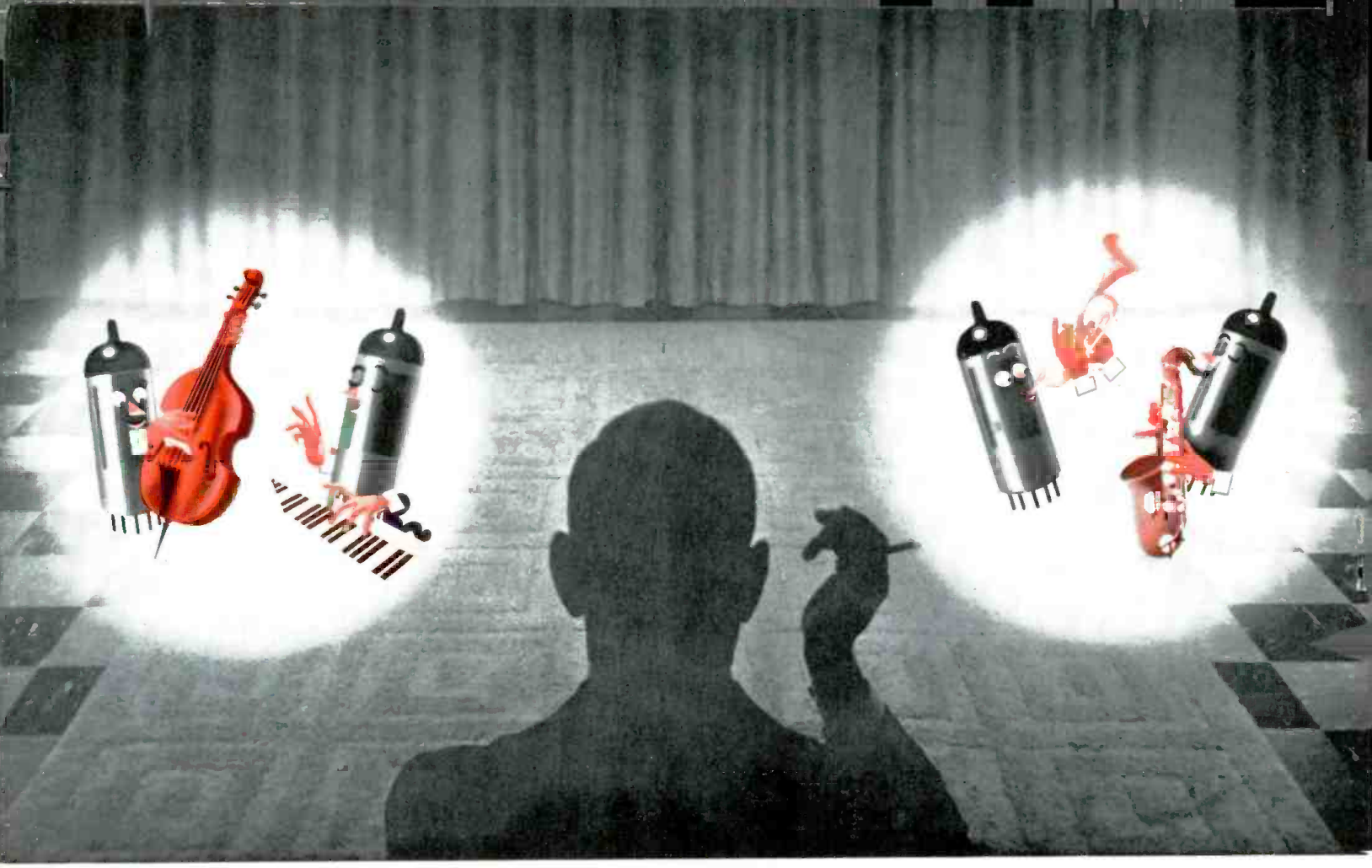
50 CENTS

SPECIAL DESIGN CHART
Hi-Fi Speaker Crossover Networks

- ELECTRICAL SHOCK: Fact & Fiction
- LOUDSPEAKERS FOR STEREO
- LOW-LEVEL CLAMP MODULATOR
- STEREO TEST RECORD—Its Design & Use

HEATING WITH ELECTRONICS
(See Pages 35 & 39)

A ZIFF-DAVIS PUBLICATION



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AMPEREX 'preferred' tube types have proven themselves in the world's finest *monophonic* amplifiers. Now AMPEREX is paving the way with tubes for the world's finest *Stereophonic systems*. Developed in the research laboratories of Philips of the Netherlands, and applications-engineered by Amperex for the American electronics industry, these ultra-advanced tubes have proven their reliability and unique design advantages in late model amplifiers and tuners of the world's leading high fidelity manufacturers. Sold by franchised dealers everywhere . . . available for off-the-shelf deliveries in any quantity.

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6CA7/EL34—Exceptionally linear, high-power output pentode with low-voltage drive requirements. Up to 100 watts in push-pull.

EL84/6BQ5—Unique AF power pentode combining high gain and linearity with 9-pin miniature construction. Up to 17 watts in push-pull.

EL86/6CW5—Low voltage, high current version of the type EL84/6BQ5. Up to 20 watts in push-pull.

ECL82/6BM8—Triode-pentode. Up to 8 watts in push-pull.

UCL82/50BM8—Series string (100 ma. 50v) version of ECL82/6BM8.

PCL82/16A8—Series string (300 ma. 16v) version of ECL82/6BM8.

VOLTAGE AMPLIFIER TYPES

EF86/6267—High-gain pentode with exceptionally low hum, noise and microphonics.* Particularly suitable for pre-amplifier and input stages. Similar to the Z739 and the 5879.

ECC81/12AT7—Medium-gain dual triode with low hum, noise and microphonics. Replaces the 12AT7 without circuit changes.

ECC82/12AU7—Low-gain dual triode with low hum, noise and microphonics. Replaces the 12AU7 without circuit changes.

ECC83/12AX7—High-gain dual triode with low hum, noise and microphonics. Replaces the 12AX7 without circuit changes.

ECF80/6BL8—High-gain triode-pentode with low hum, noise and microphonics.

RF AMPLIFIER TYPES

6DJ8/ECC88—Frame grid, sharp cut-off twin triode. Particularly suitable for cascode circuits, RF & IF amplifiers, mixer & phase inverter stages. Features high transconductance and low noise.

***6ES8**—Similar to 6DJ8/ECC88. Has remote cut-off characteristics.

***6ER5**—Frame grid shielded triode with remote cut-off characteristics. Suitable for RF amplifiers in TV & FM tuners. Features high transconductance and low noise.

†**ECC85/6AQ8**—High gain dual triode for FM tuners with shield between sections for reducing oscillator radiation.

EBF89/6DC8—Duo diode-pentode with remote cut-off characteristics. Suitable for RF & IF amplifiers.

ECF80/6BL8—High gain triode-pentode for RF amplifiers.

RECTIFIER TYPES

EZ80/6V4—Indirectly heated, full-wave rectifier with 6.3 v, 0.6 amp. heater, 90 ma. output capacity and 9-pin miniature construction.

EZ81/6AC4—Indirectly heated, full-wave rectifier with 6.3 v, 1 amp heater, 150 ma. output capacity and 9-pin miniature construction.

GZ34/5AR4—Indirectly heated, full-wave rectifier with 5 v, 1.9 amp heater and 250 ma. output capacity. Octal base. Replaces the 5U4G without circuit changes with the advantage of lower tube voltage drop because of the unipotential cathode.

Also Available: **INDICATOR TUBE TYPES**

EM84/6FG6—Indicating pattern is a varying length bar. For use in broadcast receivers and tape recorders.

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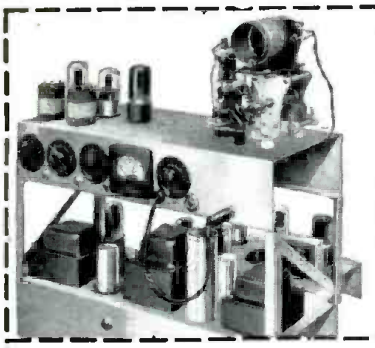
GERMANIUM DIODES

1N542—Matched pair. Replaces 6AL5 in FM detector circuits.

1N87A—High RF rectification efficiency diode. Suitable for AM detector circuits.

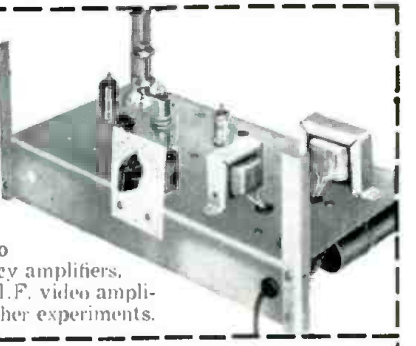
**300, 450 & 600 ma series string versions available.*
†300, 150 & 100 ma series string versions available.



YOU BUILD Broadcasting Transmitter

As part of N.R.I. Communications Course you build this low power Transmitter; use it to learn methods required of commercial broadcasting operators, train for FCC license.

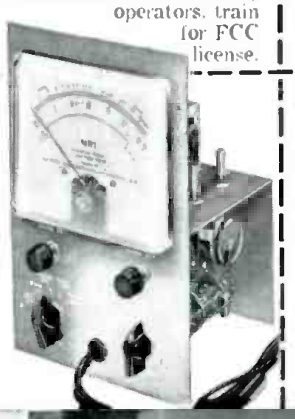
YOU BUILD Signal Generator



N.R.I. sends kits of parts to build this Signal Generator. You get practical experience, conduct tests to compensate Radio frequency amplifiers, practice aligning a typical I.F. video amplifier in TV circuit, many other experiments.

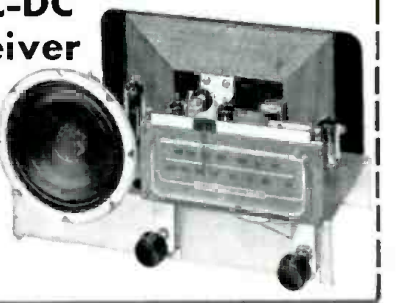
YOU BUILD Vacuum Tube Voltmeter

Use it to get practical experience, earn extra cash fixing neighbors' sets in spare time, gain knowledge to help you work in Radio, Television, Color TV. With N.R.I. training you work on circuits common to both Radio and TV. Equipment you build "brings to life" things you learn in N.R.I.'s easy-to-understand lessons. 64 page Catalog FREE, shows all equipment you get.



YOU BUILD AC-DC Superhet Receiver

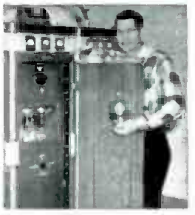
N.R.I. servicing training supplies all parts, everything is yours to keep. Nothing takes the place of practical experience. You get actual servicing experience by practicing with this modern receiver; you learn-by-doing.



Learn RADIO TELEVISION by Practicing at Home

WHAT GRADUATES DO AND SAY

Chief Engineer



"I am Chief Engineer of Station KGCU in Mandan, N. D. I also have my own spare time business servicing high frequency two-way communications systems." R. BARNETT, Bismarck, North Dakota.

Paid for Instruments

"I am doing very well in spare time TV and Radio. Sometimes have three TV jobs waiting and also fix car Radios for garages. I paid for instruments out of earnings." G. F. SEAMAN, New York, N. Y.

Has Own TV Business

"We have an appliance store with our Radio and TV servicing, and get TV repairs. During my Army service, NRI training helped get me a top rated job." W. M. WEIDNER, Fairfax, South Dakota.

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First in radio-television-audio-electronics

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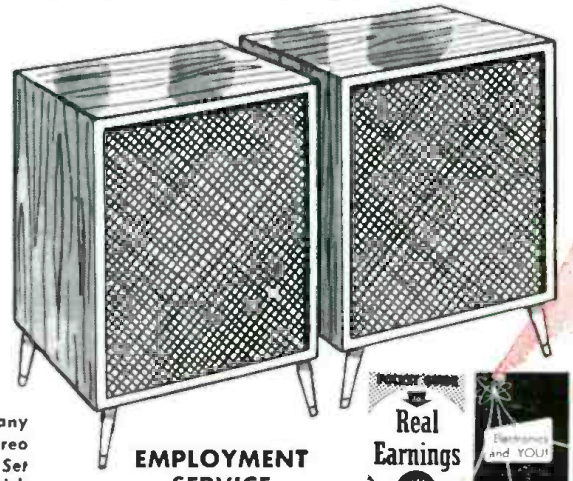

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the revolutionary new receiving tube cathode that means better service profits

FEWER CALL-BACKS due to intermittents and shorts . . . reduced noise and less arcing . . . these are some of the benefits available to you *now* with this "can't be copied" Sylvania development.

The Sarong cathode is a completely new development that transforms conventional sprayed cathode coating into a thin uniform film, precision-wrapped and securely bonded, around each cathode sleeve.

Now in use in nearly 1 million receiving tubes, Sylvania Sarong is a field-proven development setting new standards of efficiency and quality in electron tube performance.

First tubes to incorporate Sarong are tv tuner types 6BZ7, 6BQ7A, 6BC8 and 6BS8. Eventually Sarong cathodes will be utilized in the full line of Sylvania receiving tubes.

Here are some of the reasons why it will pay you to replace with Sylvania Sarong cathode tubes:

- Reduced noise . . . uniformity in spacing has resulted in improved noise level up to 0.6 db for TV frequencies.

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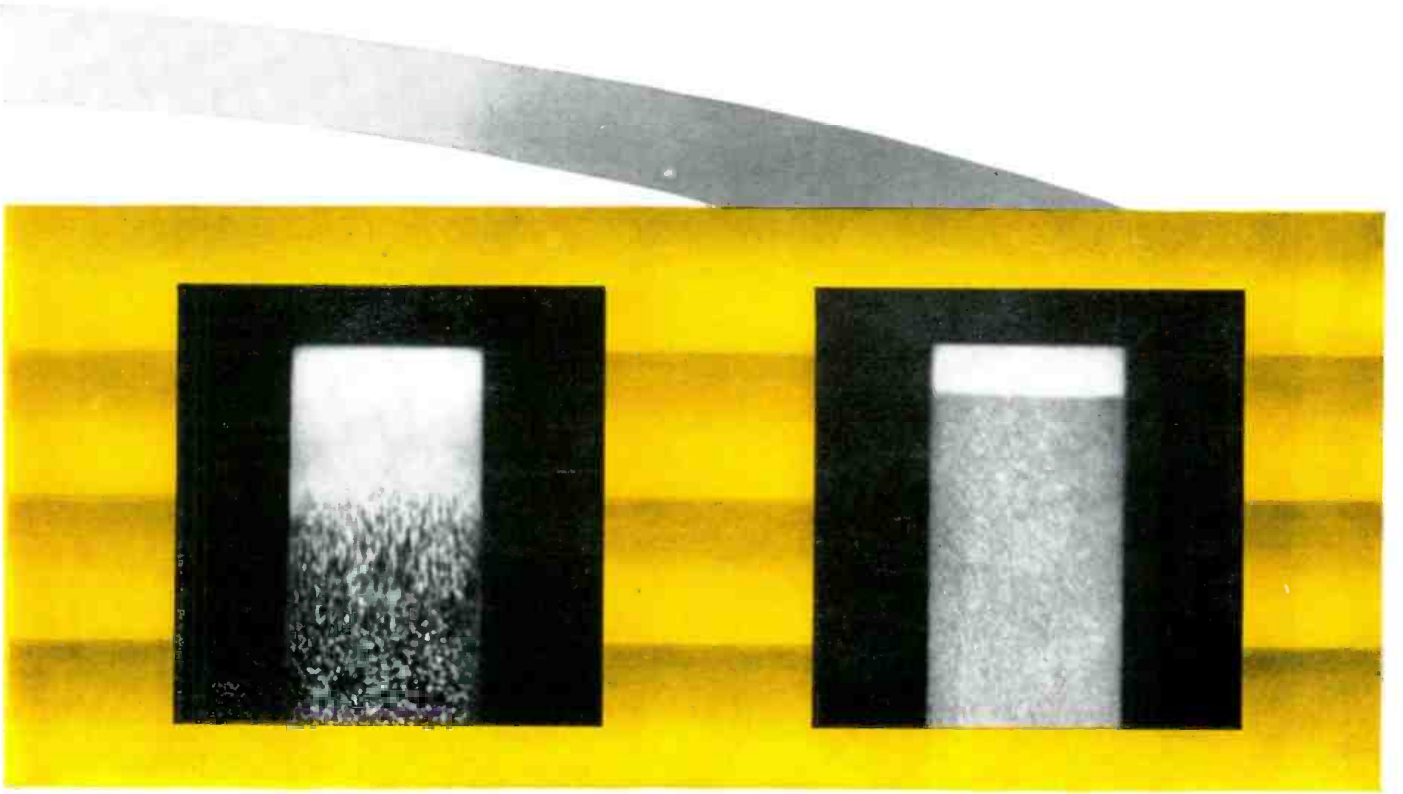
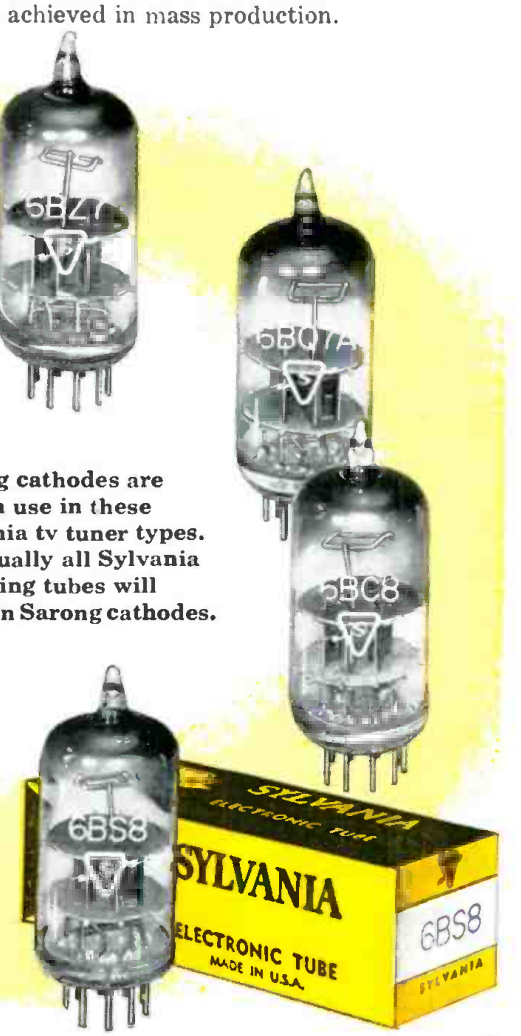
GENERAL SYSTEM



Inherent physical superiority of Sylvania's exclusive Sarong cathode, right, over a conventional cathode, left, is evident in this photomicrograph comparison. The texture, thickness, sharp coating edges and overall uniformity of Sarong represent major improvements in the heart of the electron tube never before achieved in mass production.

- Less heater-cathode leakage . . . Sarong is flake-resistant and smooth textured. No stray coating particles to stick inside cathode.
- Greater tube ruggedness against shock and vibration because of Sarong's superior coating adhesion.
- Reduced cathode-grid shorts intermittent short circuits, and less arcing due to controlled uniformity of Sarong thickness. Sarong cathode coating is held to thickness tolerances five times closer than conventional sprayed cathode coating.

Sylvania Sarong will help you make better profits through reductions in call-backs. See your Sylvania distributor today for the full story on Sarong—available *only* from Sylvania.



Sarong cathodes are now in use in these Sylvania tv tuner types. Eventually all Sylvania receiving tubes will contain Sarong cathodes.

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...for the Record

By **W. STOCKLIN**
Editor

PROSPERITY AND THE TECHNICIAN

THERE is every indication that once the normally slow summer season is over the U. S. economy is in for another period of strong and steady growth. There are many reasons for this optimism—reasons based on facts rather than wishful thinking.

With a projected increase of better than 20 billion dollars in personal income for 1960, people will have almost 13.5 billion "discretionary" dollars to spend on new homes, new cars, and new appliances. During the 1957-58 recession the consumer tightened his belt, cut his indebtedness, and refrained from adding to his installment bill—but now with old debts out of the way and a clean slate, the average citizen is ready, willing, and able to absorb the consumer goods which will be pouring from the production lines.

Although unemployment will continue to plague certain segments of the industry and some sections of the country, a seasonal increase in employment is expected to drop unemployment from the 1958 recession high of 5.4 million to around 3.5 million next year. Even without full employment, there will be money to be spent and customers to spend it. Who will benefit most from this "spending spree?" It is certain that new homes will be built in record numbers and new cars will be snapped up promptly—but of special interest to those of us in the radio and television field is the fact that much of this cash is earmarked for new appliances of various types.

According to estimates made by *RCA*, the electron tube industry which reached a sales volume of about 800 million dollars last year should top 866 million dollars during 1959. Black-and-white television receivers are expected to make a strong comeback this year with color sets gradually gaining a larger share of the TV market. Defense electronics business during 1959 is expected to rise some 14 per-cent over last year's 3.6 billion dollar mark.

Much of the non-military activity in the electronics field will have a direct bearing on the prosperity of the service industry. More TV receivers, radios, auto receivers, and hi-fi gear in the hands of the public means more dollars in the cash registers of the service technician. More cash in the pocket of the consumer means larger sales of "luxury" items and greater outlays for the installation, maintenance, and repair of such equipment.

Of course all this business activity implies a degree of inflation that takes some of the bloom from the boom. The same forces that make possible that extra dollar in the pocket of the customer will operate in increasing *your* costs of doing business. The smart service shop owner will start now to make plans for spreading the margin between income and outgo. It won't be easy—there will be certain items on which it will be impossible to economize—state and city taxes are rising steadily as hard-pressed governments search for new sources of revenue, replacement parts will cost more as the wage-price spiral indulges in a few more round trips, the service truck will cost more to operate as gasoline taxes rise and maintenance goes up—but there *are* places where the belt may be tightened without functioning as a tourniquet as well.

A very careful and thoughtful analysis of your entire business operation would seem to be in order here. Economies which may seem picayune in the singular can add up to a tidy sum if pursued relentlessly and systematically. How much money a day are you losing because of sloppy routing of service calls? Does doubling back, duplicate coverage of the same routes by two of your trucks, unnecessary returns to the shop, etc. increase your gas bill and add to replacement and repair costs? Does careless unpacking and storage of replacement parts send your breakage costs soaring and overtax your trash can? Is bench work performed so hurriedly and so sloppily that expensive meters have to be "hospitalized" for bent pointers and burned out parts? Does the lack of accurate, complete records of expenditures of all kinds prevent your claiming tax exemptions to which you are legitimately entitled? Do obsolete mailing lists raise your advertising costs far above the return for such efforts?

Do you buy carefully and thoughtfully the items you really need and can profitably merchandise *in your particular town or neighborhood* or can any fast-talking salesman "unload" on you just so you can get rid of him? Do you order your replacement parts and tubes in an orderly fashion, placing a sizable order to take advantage of quantity discounts and then pay the bill within the prescribed time to get the discount offered for "cash?"

These may all sound like mere "thumbs in the dike" to hold back the rising costs of doing business, but taken together and followed up religiously not only will you be able to keep faith with your customers by not jacking up your charges but you yourself will be able to avoid being sucked into the vortex of the wage-price spiral and its concomitant inflationary trend. —30—

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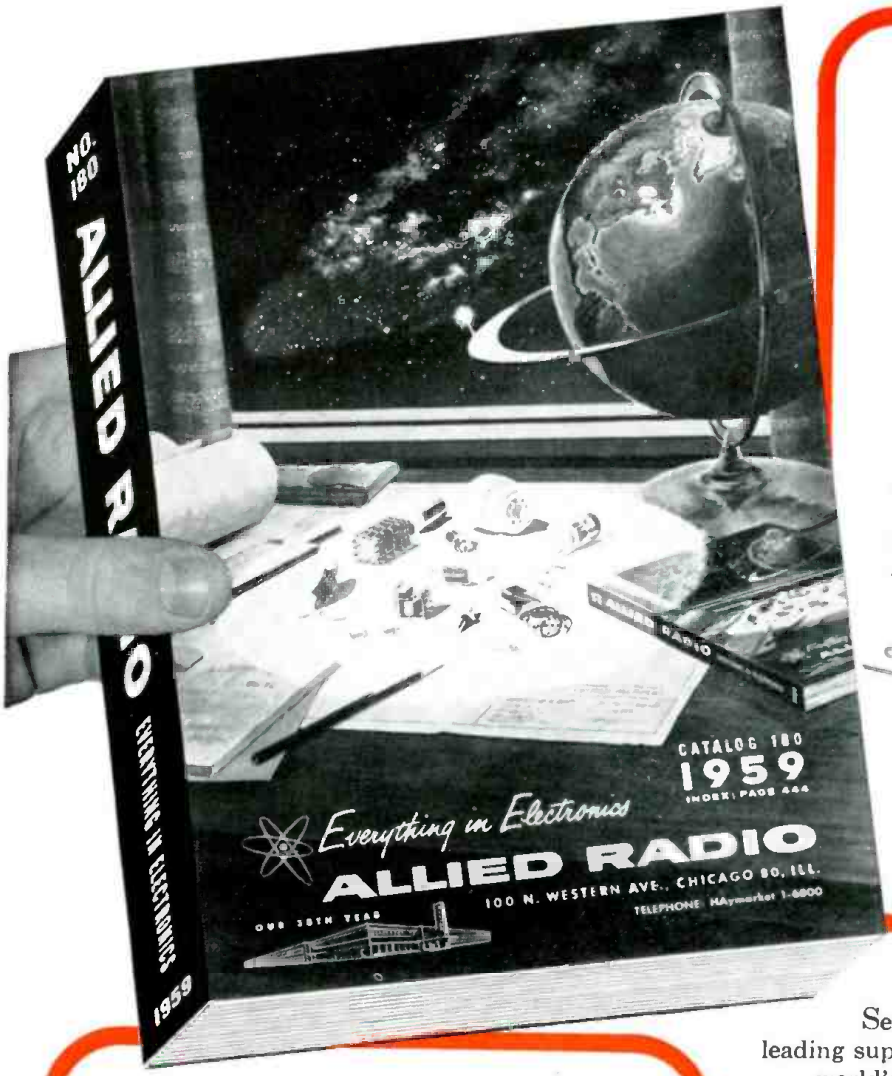

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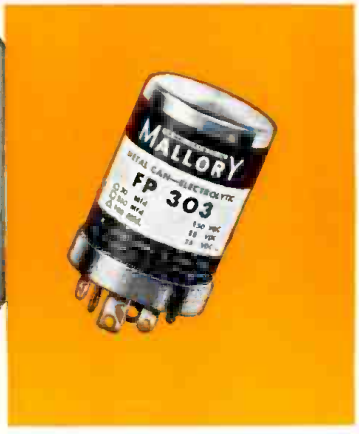

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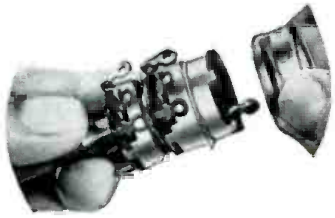
TC Tubular Electrolytics—now in handy new twin pack with the same high quality and performance characteristics.

RMC Discaps®—Long the original equipment standard, now available for replacement in the handy "file card" five pack.

Mallory GEMS—five tubular capacitors in easy-to-use dispenser: best bet for outstanding service in buffer, by-pass or coupling applications.



Sta-Loc*—New design enables your distributor to custom-build the exact replacement you need in just 30 seconds, eliminates waiting for out-of-stock controls.

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F.C.C. LICENSE—THE KEY TO BETTER JOBS

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WHICH LICENSE FOR WHICH JOB?

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

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

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The Grantham course covers the required subject matter completely. Even though it is planned primarily to lead directly to a first class FCC license, it does this by TEACHING you electronics. Some of the subjects covered in detail are: Basic Electricity for Beginners, Basic Mathematics, Ohm's and Kirchhoff's Laws, Alternating Current, Frequency and Wavelength, Inductance, Capacitance, Impedance, Resonance, Vacuum Tubes, Transistors, Basic Principles of Amplification, Classes of Amplifiers, Oscillators, Power Supplies, AM Transmitters and Receivers, FM Transmitters and Receivers, Antennas and Transmission Lines, Measuring Instruments, FCC Rules and Regulations, and extensive theory and mathematical calculations associated with all the above subjects explained simply and in detail.

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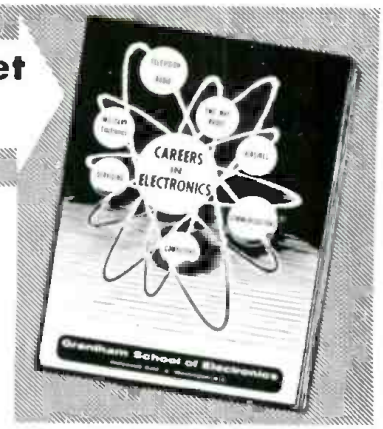

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	License	Weeks
Roy E. Alexander, Pikeville, Kentucky	1st	12
Robert J. Conley, 129 W. 46th St., New York 36, N. Y.	1st	14
W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Howard E. Martz, 301 S. Penn. St., Fairmount, Ind.	1st	24
John W. Dempsey, Box 55, Rising Sun, Md.	1st	12
Donald H. Ford, Hyannis RD, Barnstable, Mass.	1st	12
Richard J. Falk, 2303 Holman St., Bremerton, Wash.	1st	22
Denson D. McNully, 1117 N. Houston St., Amarillo, Texas	1st	9
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12
Odie B. Perry, Jr., Rt. #3, Zebulon, N. C.	1st	12
Milton C. Gee, Rt. #1, Washington, N. J.	1st	11

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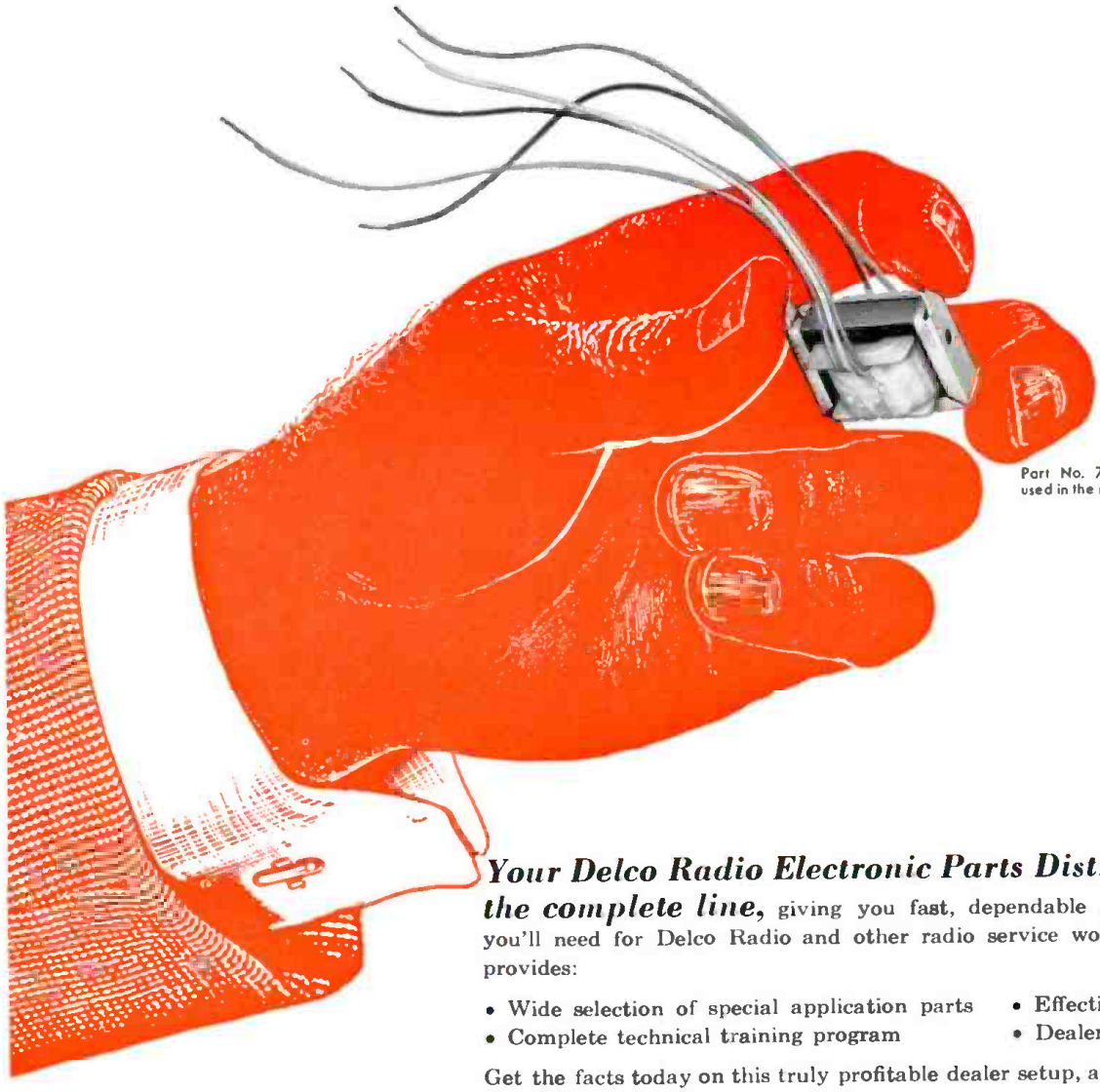

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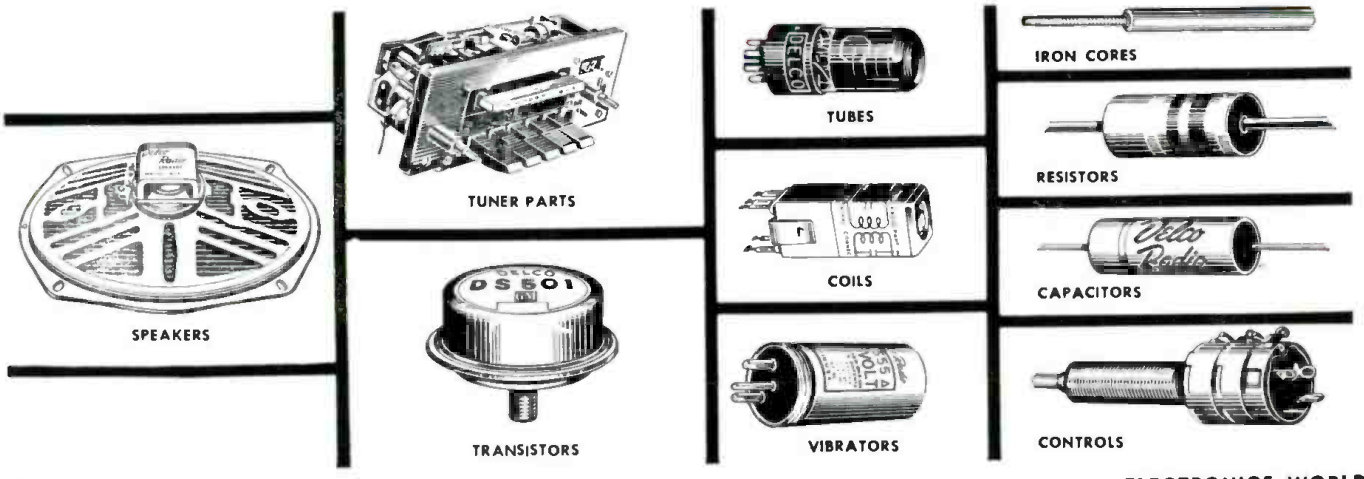

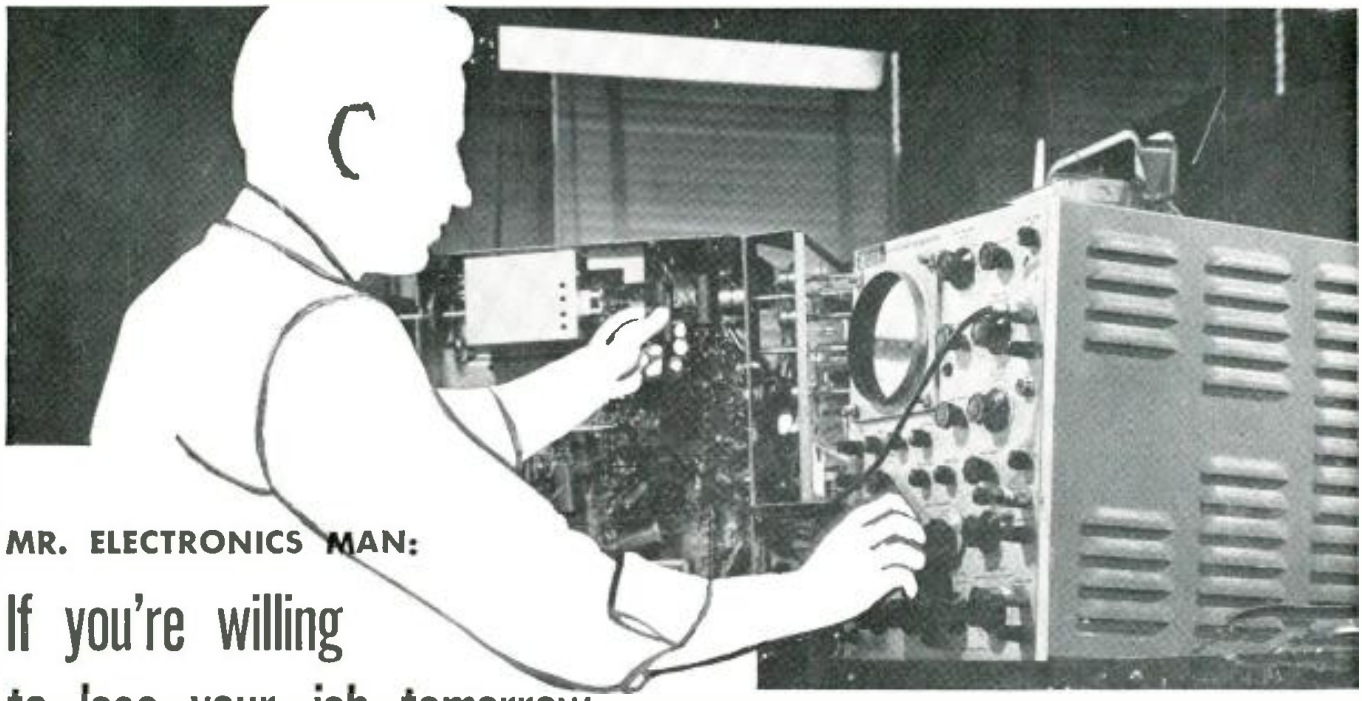

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OUR "SOUND" CHART

To the Editors:

With reference to your February issue, we would like you to send us 50 copies of the "Sound" fold-out page. We are exclusive *RCA* Industrial Sound Contractors, and these would be of tremendous value to our technicians.

ROBERT MARTIN, President
Otto K. Olesen Electronics Inc.
Montebello, California

To the Editors:

We would like to compliment you on the design chart entitled "Sound" in your February issue. This is indeed an excellent presentation and is especially helpful in my occupation.

In fact, I liked this chart so much that I would like to distribute copies to my staff. I would, therefore, be most appreciative if you could provide me with 30 additional copies.

LESLIE C. HEARTZ
Colonel, USAF
Deputy for Communications & Electronics
United States Air Force
Richards-Gebaur Air Force Base, Missouri

To the Editors:

Can you tell me what you would charge for 3000 to 5000 reprints of the "Sound" gatefold?

HAROLD GLICKMAN
Harold Glickman Advertising
Boston, Massachusetts

We were certainly pleased with the excellent response that this gatefold produced. Single copies of the chart are available at a price of $.15 each while a lower cost is available on quantity orders. Address your inquiry to the Editorial Department of ELECTRONICS WORLD, *One Park Avenue, New York 16, New York.—Editors.*

* * *

"SPRA-KOAT CIRCUIT COOLER"

To the Editors:

In Mac's Service Shop in your January issue, mention is made of *General Cement's* "Spra-Koat Circuit Cooler." I would like to express deep concern about the use of this "Freon" gas. My trade is refrigeration and I have a strong basic knowledge of the various refrigerants that are used. The manufacturers of "Freon" give many wonderful characteristics of this gas as compared to others used for refrigeration. However, they fail to mention that when exposed to open flame or high heat, "Freon" may break down into toxic gases of chlorine and phosgene. Spraying a cloud of gas onto a hot tube may wreck the envelope and, if the serviceman is in a small area, the toxic gases produced may be very dangerous.

Also, if the technician is smoking, this may be disastrous, especially if one man tries to demonstrate the effect of a cold north wind on the back of another man's neck at the same time.

Finally, if the container is inverted, there is a chance of squirting a stream of liquid "Freon" which will burn the skin.

HENRY BOYCE
San Leandro, California

Although Mac's Service Shop did point out quite a few of the precautions mentioned by Reader Boyce, we forwarded his letter to General Cement. *They in turn sent it along to* Du Pont's Freon Products Division. *A small portion of their reply is as follows.—Editors.*

Dear Mr. Boyce:

Your experiences with "Freon" refrigerant and the anticipated experience of someone using "Freon" from the "Spra-Koat Circuit Cooler" package are quite different. It is true that, although the "Freon" compounds are nonflammable, practically odorless, and are virtually nontoxic, they do decompose when heated to sufficiently high temperature. In the case of "Freon-12," the temperature of decomposition is just slightly over 1000°F, as shown in the *Underwriters' Laboratory* report attached. It is true that the portion of "Freon-12" which is exposed to this temperature or higher will decompose into halogen gases, including hydrogen fluoride, hydrogen chloride, and slight traces of phosgene. These gases give ample warning of their presence because of their extreme pungent odor. The circumstances in refrigeration service work which are most responsible for producing these halogen products are the conditions where a halide torch is used for refrigerant leak detection or when service lines containing refrigerant gas are being soldered or welded. In this latter condition, I might also point out that the decomposition products of certain soldering fluxes, lubricant, and miscellaneous materials also produce unpleasant and sometimes dangerous-to-inhalation gases. For this reason, it should be a part of every refrigeration serviceman's training that whenever leak testing or soldering operations are to be carried out on refrigeration equipment, adequate ventilation must be supplied.

The situation is quite different when using the "Spra-Koat Circuit Cooler." First of all, the temperature of hot parts in radio and television equipment

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will not be sufficient to decompose the "Freon" during the test procedure. This is quite different from the instance of the halide torch where the refrigerant gas is actually passed through the torch flame. In radio and TV service operations, the hottest condition in the area would probably be the hot tip on a soldering iron. In my opinion, the normal precautions taken during any soldering operation, where ventilation is available is adequate to take care of any conceivable use of "Spra-Koat Circuit Cooler" in the electronic servicing area.

You have raised the question of smoking in the presence of "Freon." This is certainly not advisable, but I would not associate the intermittent spray of "Freon" on a TV part for spot cooling as a condition which should prohibit smoking in the area. As a matter of fact, here again if concentration of "Freon" is such that smoking causes decomposition, the smoker experiences a very strong, unpleasant taste sensation which, long before it becomes harmful, will make him stop smoking. You mention horseplay in your letter. Of course, any horseplay is dangerous and unwise. Liquid "Freon" sprayed on the skin over a period of seconds could result in frostbite.

A. H. LAWRENCE, JR., Manager
Aerosol Propellent Sales
E. I. Du Pont de Nemours & Co., Inc.
Wilmington, Delaware

* * *

TRANSISTORIZED TACHOMETER

To the Editors:

I have constructed the "Transistorized Tachometer" described in your January issue exactly as suggested, except that I used a 1N1508 *International* MZ 4.7 zener diode in place of the one suggested.

After placing the unit in service, however, I observed the meter deflection varied up to about 40 per-cent as the temperature increased from about 20°F to 75°F. I would appreciate any suggestions you might have on eliminating the temperature effect.

SIDNEY ARNOW
Brooklyn, New York

Some of our readers have had difficulty in obtaining a source of supply for the zener diode mentioned in the article. Although the diode originally specified is listed in Allied Radio's *latest semiconductor directory of in-stock items, we have learned that there is some lag in the delivery of these units from the manufacturer. We hope this situation is temporary and that the diode will be more readily available soon. Meantime, substitutions such as the one suggested above might be tried. Regarding Reader Arnow's temperature problems, here is what the author says.—Editors.*

Dear Mr. Arnow:

The original experimental work on the tachometer was done in New England in late winter. Therefore, the temperature problems were not en-

countered. With the advent of summer, we also ran into some temperature difficulties. Since the pulse counter output is very stable, any change in meter reading must be caused by a change in transistor gain or collector leakage. This latter will cause the meter to vary, but only if the current is large in the first place.

Several types of recent transistors are rated at only 1 or 2 μa. leakage. One of these transistors would probably help greatly.

If leakage current at high temperatures is still noticeable, especially if you are using a sensitive meter, it will help to reduce the meter sensitivity with a shunting resistor and increase the setting of the calibration control to restore proper calibration. Start by turning the calibration control all the way up. Then find a value of resistance that will reduce the meter sensitivity so that the tachometer indicates about 10 to 20 per-cent high. Install this resistor and then reduce the calibration control to give proper indication.

Should you find this modification necessary, I would suggest that you reduce resistor R_5 from 8200 ohms to 3900 ohms before performing the above adjustments. This will increase the drive to V_2 and allow the meter to be shunted even more. At the same time, you should reduce resistor R_7 to 200 ohms to prevent saturation of V_2 at the higher current level.

RICHARD H. SMALL
Altadena, California

—30—

IMPORTANT NOTES ON OUR CITIZENS BAND TRANSCEIVER

THE article "Build This Citizens Band Transceiver" by Don Stoner in our March, 1959 issue attracted considerable interest. The following two points should have been made in the article.

First, when testing or adjusting the transmitter with its dummy load lamp, no license is required since useful radiation will not occur. Such adjustments may not be made with the transmitter radiating into its antenna unless they are under the supervision of a licensed commercial radio operator.

Second is the matter of the crystal to be used in order to meet the required .005% frequency tolerance. We have just learned that International Crystal is not certifying its FA-type crystals at .005% but instead is offering a "packaged" unit, FO-27, which is completely wired with a 6AU6 tube and crystal. This unit, which may be used as the r.f. section of the transceiver is available from the company at 18 North Lee Ave., Oklahoma City, Okla. for $11.95.

Suitable crystals are also available from other sources. In such cases be sure to specify a frequency tolerance of .005% and inform the manufacturer of the circuit in which the crystal is to be used. This is important since the precise operating frequency will depend on the circuit capacity which appears across the crystal.

It is interesting to note that the FCC would like to see the Citizens Band put into use "with a minimum of restricting regulation." Hope to see you on the Citizens Band soon. —30—

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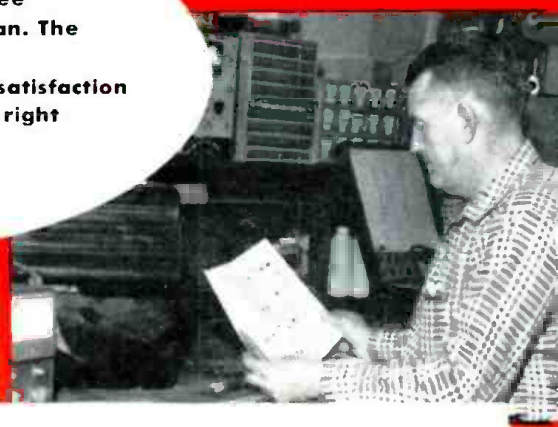
Gadsden, Alabama



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—Jerry Beccia, *Waterbury, Conn.*

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—Ray Myers, *Austin, Minn.*

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WE'RE LEARNING WHY TWO EARS ARE BETTER THAN ONE

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In listening to stereophonic music, how is it that our ears and brain construct a picture of the entire orchestra with but two samples (the sounds from two speakers) to work with?

How is it that our ears and brain are able to pinpoint *one* voice in a roomful of talkers—to listen to it alone and ignore the rest?

What makes *two* ears better than one?

Bell Telephone Laboratories scientists are searching for the answers. For in finding them, better telephone instruments and better ways of transmitting sound will surely result.

Our hearing performs feats that no electronic system can yet duplicate. How? Laboratories scientists believe the secret lies in the way our two ears function in partnership and in the way our neural network connects them with our brain. *The problem:* to discover what functions the network performs and to see whether electronic duplication might enhance understanding.

The work is under way. Electronic circuits that simulate the operation of nerve cells have already been created—and conceptual models of the neural network are being constructed.

Alexander Graham Bell's interest in deafness and hearing led to the invention of the telephone. Bell Laboratories' current explorations in binaural sound may well lead to important new advances in the transmission of speech and music.

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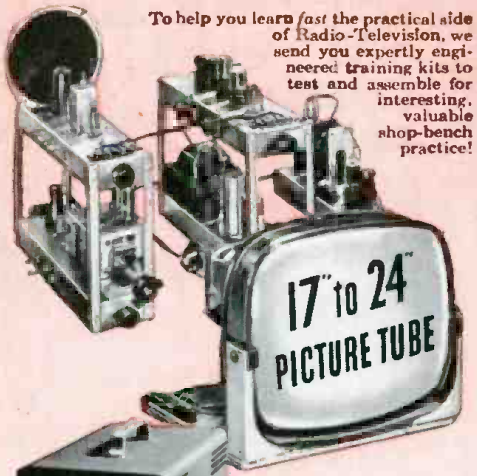

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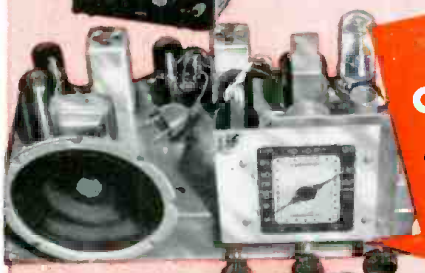

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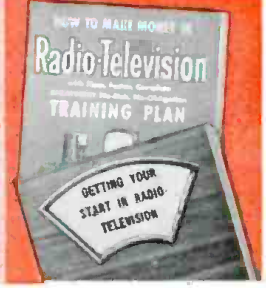

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Within the Industry

RAY C. COMPTON has been named assistant sales manager of *Weller Electric Corporation*. He will cover, primarily, the hardware and automotive markets.

Prior to joining the organization, Mr. Compton was with the consumer products division of *Monsanto Chemical Co.* and most recently with *Kaiser Aluminum and Chemical Company*.

A native of Washington, D. C., Mr. Compton was formerly with the Federal Bureau of Investigation. He was an agent from 1941 to 1949.

* * *

RICHARD DEUTSCH and **ROBERT CORTES** are now eastern and western sales supervisors, respectively, of *Channel Master Corp.* . . . **HERBERT A. FRANK** has been named director of sales, *Granco Products, Inc.* . . . **DR. W. CRAWFORD DUNLAP** is now director of semiconductor research for the research division of *Raytheon Manufacturing Company* . . . *Erie Resistor Corporation* has named **GEORGE P. FRYLING, II** vice-president, manufacturing, and **GEORGE F. KEMPF** vice-president and general manager of *Erie Resistor of Canada, Ltd.*, a subsidiary of the organization . . . **GEORGE F. HARTMAN,** Colonel, U.S.A.F. Ret., has been appointed vice-president in charge of sales for *Trad Electronics Corp.*

* * *

NEIL W. TURNER has been promoted to the position of director of product planning for the *Heath Company*, Benton Harbor, Michigan. Prior to this he was the firm's merchandising manager.

In his new capacity, Mr. Turner will administer the company's new products development program and its market research activities. He has been with the organization since 1950.

In addition, Robert K. Swander was advanced from purchasing agent to director of purchasing. Ellis Grear is now the new purchasing agent.

* * *

P. R. MALLORY & CO. INC. has formed a new subsidiary company **P. R. MALLORY INTERNATIONAL INC.,** for the purpose of managing foreign activities and interests . . . An agreement on terms for the acquisition of **ALTEC COMPANIES, INC.** stock by **LING ELECTRONICS, INC.** has been announced . . . **AMPHENOL-BORG ELECTRONICS CORPORATION** has formed a separate division to be known as **AMPHENOL DISTRIBUTOR DIVISION** . . . **TELECHROME MANUFACTURING CORP.** has merged with **ENCAPSOR PRODUCTS INC.** The latter will operate as a wholly owned subsidiary.

* * *

ELECTRONIC REPRESENTATIVES ASSOCIATION (ERA) will operate the message and directory service at the 1959 Electronic Parts Distributors Show.

Up-to-date methods will assure swift, effective communication among the more than 12,000 industry members expected. Closed-circuit, fixed-focus TV will be employed to page visitors in the exhibition hall, display rooms, lobbies, meeting rooms, and similar locations throughout the hotel. Visitors will leave and pick up messages at an information center at the show.

* * *

R. H. ROGERS has been appointed to the post of advertising and sales promotion manager of *National Company*.

He comes to the company from *Laboratory for Electronics* where he was public relations director and advertising manager. He is also a former associate editor of "Power Engineering Magazine."

Prior to that, Mr. Rogers spent ten years with *General Electric Company* as an engineer, editor, and technical consultant to the advertising and sales promotion divisions.

* * *

EARL F. BROIHIER has assumed his new duties as assistant advertising manager for *Heath Company* . . . *Concertapes, Inc.* has appointed **PAUL FLYNN** to the newly created position of promotion manager . . . The appointment of **ELMER J. PERRY** to the newly created post of manufacturing manager of the semiconductor division of *Sylvania Electric Products Inc.* has been announced . . . **LEON ROBBIN** has been elected to the board of directors of *P. R. Mallory & Co. Inc.* . . . *Acoustica Associates, Inc.* has announced the following appointments: **GERALD M. HENRIKSEN** is now executive vice-president; **RALPH REYNOLDS** is general manager of the eastern division and continues as vice-president and director of the company; **FRANK P. DeLUCA** is general manager of the western division and a director of company, as well as continuing as a vice-president; and **STANLEY R. RICH** is vice-president of the firm and continues as president

FREE

tells how

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.

EFFECTIVE JOB FINDING SERVICE HELPS CIRE TRAINEES GET BETTER JOBS

"License and $25 raise due to Cleveland Institute training"

"I sat for and passed the FCC exam for my second class license. This meant a promotion to Senior Radio Technician with the Wyoming Highway Department, a $25 a month raise and a District of my own for all maintenance on the State's two-way communication system. I wish to sincerely thank you and the school for the wonderful radio knowledge you have passed on to me. I highly recommend the school to all acquaintances who might possibly be interested in radio. I am truly convinced I could never have passed the FCC exam without your wonderful help and consideration for anyone wishing to help themselves."

CHARLES C. ROBERSON
Cheyenne, Wyoming

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS WITH OUR COACHING

Name and Address	License	Time
John H. Johnson, Boise City, Okla.	1st	20 weeks
Prentice Harrison, Lewes, Delaware	1st	27 weeks
Herbert W. Clay, Phoenix, Arizona	2nd	22 weeks
Thomas J. Bingham, Finley, North Dakota	2nd	9 weeks
William F. Masterson, Key West, Fla.	2nd	24 weeks

EMPLOYERS MAKE JOB OFFERS LIKE THESE TO OUR GRADUATES EVERY MONTH

Employers Make Job Offers Like These To Our Graduates Every Month

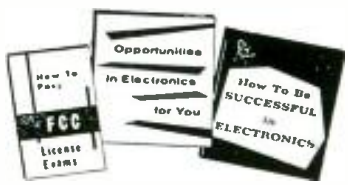
Broadcast Station in Illinois: "We are in need of an engineer with a first class phone license, preferably a student of Cleveland Institute of Radio Electronics; 40 hour week plus 8 hours overtime."

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."

Your FCC Ticket is recognized by employers as proof of your technical ability.

Accredited by National Home Study Council

Cleveland Institute of Radio Electronics
Desk RN-29, 4900 Euclid Bldg., Cleveland 3, Ohio



Act Now!

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

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

In what kind of work are you now engaged? .....

In what branch of Electronics are you interested? .....

Name ..... Age ..... Address .....

City ..... Zone ..... State .....

RN-29

of *General Ultrasonics Company*, a subsidiary.

* * *

E. W. KINGSBERY, JR. is now general sales manager and a member of the executive board of *Clarostat Mfg. Co., Inc.*

Mr. Kingsbery has been associated with firms supplying technical components to the electronic, missile, and aircraft industries, among them *Bendix Aviation, Vectron* (now *Itek*), *CGS Laboratories*, and *Electrol Hydraulics*. More recently he was in charge of a sales firm supplying components for such missiles as the "Atlas," "Redstone," and "Polaris."

* * *

RAYTHEON MANUFACTURING COMPANY has a new office at the Solar Building, 1000 Sixteenth Street, N.W., Washington, D. C. . . . **HOWARD W. SAMS & CO., INC.** has established its first branch office in New York City. The office will occupy space at the new *Corning Glass Building*, 56th and Fifth Avenue, now being completed.

* * *

CHARLES W. MARTEL has been named advertising and sales promotion manager for the semiconductor division of *Raytheon Manufacturing Company*. His duties will include direction of national advertising and sales promotion for the firm's transistors and semiconductor diodes and its power rectifiers.

Mr. Martel has been with the company since 1936, serving in various sales engineering, technical sales promotion, and technical information capacities. Most recently he was manager, technical information service. In this post he handled advertising and the dissemination of technical information on the firm's semiconductors and industrial tubes.

* * *

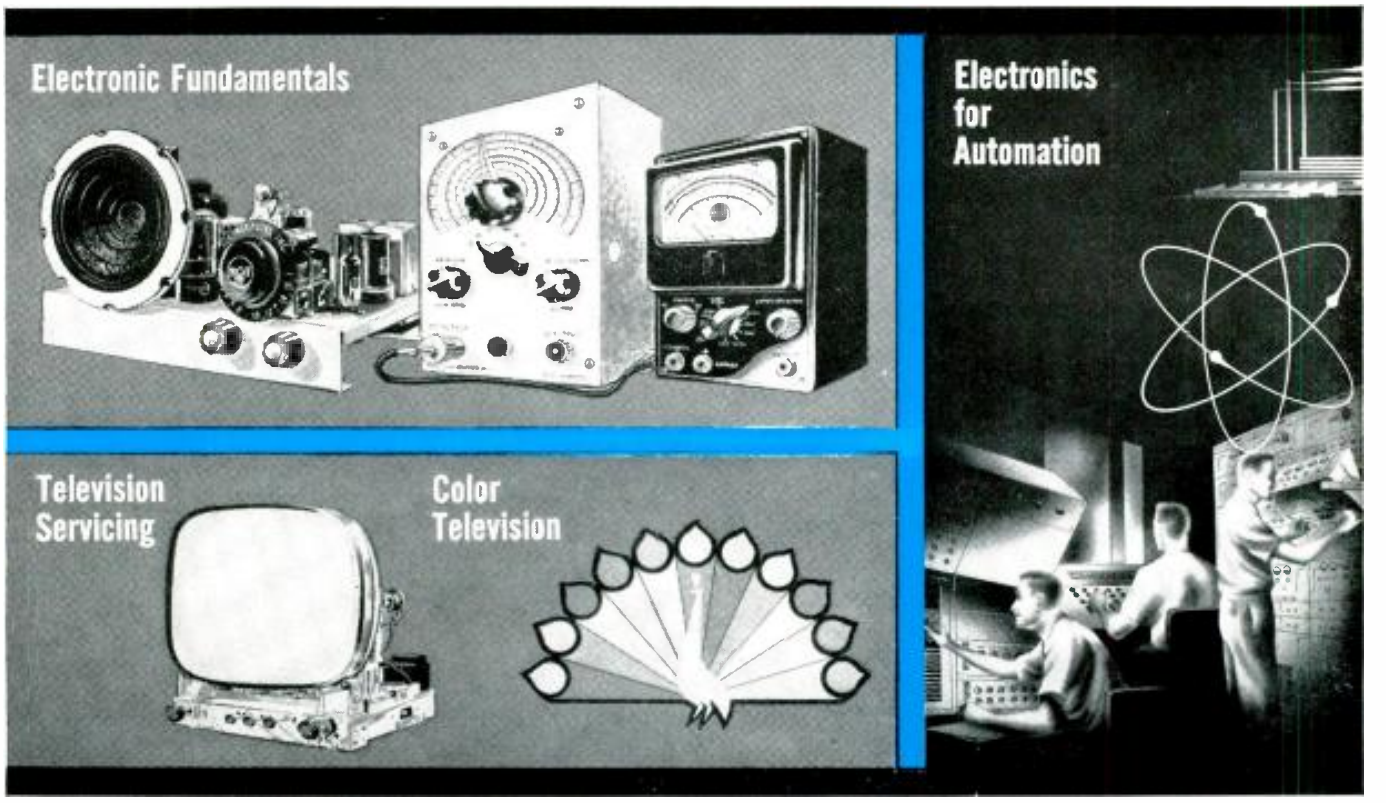
THE NATIONAL STEREOPHONIC RADIO COMMITTEE, formed by EIA, has announced the following appointments: Donald G. Fink, *Philco Corp.*, chairman of Co-ordination Committee; Charles J. Hirsch, executive vice-president of *Hazeltine Research Corp.*, chairman of Panel 1—System Specifications; Axel Jensen, retired director of audio and visual engineering, *Bell Telephone Labs.*, chairman of Panel 2—Interconnecting Facilities; Ralph N. Harmon, director and vice-president engineering, *Westinghouse Broadcasting Co.*, chairman of Panel 3—Broadcast Transmitters; J. N. Benjamin, president of *David Bogen Co.*, chairman of Panel 4—Broadcast Receivers; A. Prose Walker, manager, engineering dept., NAB, chairman of Panel 5—Field Testing; and Dr. A. N. Goldsmith, chairman of Panel 6—Subjective Aspect. —30—

LET RCA TRAIN YOU IN ELECTRONICS

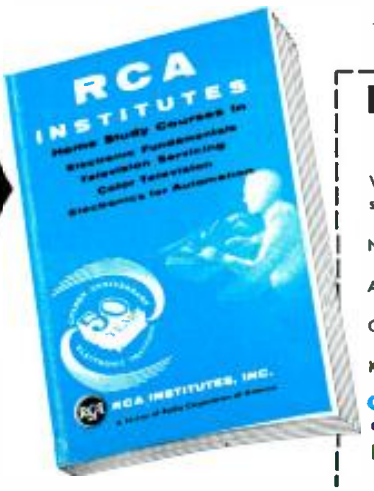
RCA Institutes celebrates Fifty Years of Electronic Training by introducing its newest Home Study Course . . .

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.



Send for our 64 page Home Study Catalog **FREE!**



FOR RESIDENT SCHOOL COURSES SEE AD ON OPPOSITE PAGE

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

RCA INSTITUTES, Inc. Home Study School, Dept. RN-59
A Service of Radio Corporation of America
350 West Fourth Street, New York 14, N. Y.

Without obligation, send me the FREE catalog of Home Study Courses. No salesman will call.

Name ..... Please print

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Korean Vets! Enter Discharge Date .....

CANADIANS — Take advantage of these same RCA courses at no additional cost. No postage, no customs, no delay. Send coupon to: RCA Victor Company, Ltd., 5001 Cote de Liesse Rd., Montreal 9, Quebec

To save time, paste coupon on postcard.

The Dream Amplifier

IS NOW A REALITY!

Hum and Noise: Only 1/1000th of 1% of full rated output!

IM Distortion: Less than 0.08% (European CCIR standards.)

THE FISHER *SA-300*

Laboratory Standard Stereophonic

60-Watt Amplifier

Hum and noise content less than 0.00001 part of full rated output (1/1000th of 1%!)

Distortion-free audio power at ALL listening levels. Less than 0.1% harmonic distortion at *full rated output.*

Optimum fidelity with ALL existing speakers, BOTH low-efficiency and high! Uniform response from 20 to 20,000 cps, within +0 and −0.5 db.

Only FISHER could have produced so unique an instrument, and at such moderate cost. The SA-300 will match *any* existing speaker, *and* supply the distortion-free power all speakers require for optimum results. When using low-efficiency, high-compliance systems, the SA-300 is an absolute *prerequisite* for professional sound reproduction! With this amazing instrument, even your choice of enclosures is less critical. The SA-300 actually permits you to obtain the damping factor your system requires! Complementing this FISHER exclusive is still another – TWO inputs for each channel (one for standard response, and one with controlled frequency response to improve high frequency reproduction!) The dream amplifier has, indeed, become a reality. This is it! **$169.50**

Slightly Higher in the Far West

WRITE TODAY FOR COMPLETE SPECIFICATIONS

FISHER RADIO CORPORATION • 21-38 44th DRIVE • LONG ISLAND CITY 1, N. Y.

Export: Morhan Exporting Corp., 458 Broadway, New York 13, N. Y.

Latest Information on the Electronic Industry

Spot News

By ELECTRONICS WORLD'S WASHINGTON EDITOR

EARTHQUAKES NOW BEING REPORTED BY AUTOMATIC RADIO TO OBSERVATORY--An automatic radio system featuring an FM transmitter to record earthquakes has been devised by Richard R. Ross, an electronic scientist for the Coast and Geodetic Survey, U.S. Department of Commerce. Tests are now being conducted at an Arizona mountainside where movements are being transmitted to an observatory fifteen miles away; quake information appears on tape of a seismograph. The operation, technically a telemetering process, involves the use of a pickup unit, housed in a small insulated building that is topped by a directive antenna, with a seismometer (sensing part of a seismograph), amplifiers, converters, and the FM transmitter. Power is supplied by a butane motor. The unit is untended and requires only one visit a week for servicing. At the observatory end, there is also a directive antenna, an FM receiver, detecting unit, and seismograph recorder. Washington expects to adapt the radio link for installations in Honolulu and Fairbanks, Alaska. The improved station, system experts say, will also provide increased capacity to monitor future atomic explosions here or the Pacific area.

ELECTRONIC PROXIMITY SCORER INVENTED--An estimated savings of $2.5-million yearly to the U.S. Air Force is expected to result from a recent invention of an electronic proximity scorer by Captain W. F. Kirlin and Homer F. Roland, engineer-scientists with the Air Research and Development Command Air Proving Ground Center, Eglin Air Force Base, Florida. The device electronically tells the pilot just how close his missiles are coming to a target. In these days of high-priced missiles and targets, missiles are programmed to miss the target by a slight distance in practice so that the target is not destroyed each time a missile is fired. However, a pilot must know just how much this "miss distance" is, to determine if the missile functions properly.This is the part played by the proximity scorer. Mounted in either towed or free-flying targets, the scoring unit, weighing 8 pounds, surrounds the target with electro-magnetic radiations. When the missile passes near the target, these radiations are reflected, triggering the relay that transmits the missile's miss-distance to the "attacking" pilot's plane, the target aircraft, or to observers on the ground.

RADAR SPACE OBSERVATORY PROPOSED--A radar space observatory for electronically feeling out the surface of the moon has been blueprinted by researchers at the University of Michigan. Vehicle, the scientists say, would be about 150-feet long, 6-feet in diameter, weigh less than 2 tons, orbit about 100 miles above the moon, and carry a nuclear power source to supply 3 or 4 kw. of electrical power. Radar transmitter would send simultaneously to moon, ten signals of varying frequencies for an electronic picture of composition and depth of moon's top layer, information on firmness of second or underlying layer, and data on heights and contours of mountains, as well as the depths of craters.

HAM RULE AMENDMENT UNDER STUDY--The FCC has invited comments on a proposed rule-making which would amend amateur rules (Part 12) to permit Technician Class amateur operation in the 144-148 mc. band.

LONG-DISTANCE REMOTE-CONTROL ELECTRONIC DRONE MAKES SUCCESSFUL DEBUT--A remote-controlled drone, the SD-3, packed with electronic and advanced sensory devices, built for the U.S. Army Signal Corps by Republic Aviation, has been flown successfully at the Army's test center facility in Yuma, Arizona. Weighing less than half a ton and only 15-feet long, with a wingspan of 11 feet, the drone features interchangeable nose units which enable rapid switches from one surveillance technique to another.

COMPATIBLE STEREO SYSTEMS DEMONSTRATED TO NATIONAL EIA COMMITTEE--Members of the National Stereophonic Radio Committee, announced by EIA in Washington, to study methods of broadcasting stereophonic sound, recently attended a special demonstration of a compatible stereo circuit, developed by F.K. Becker of Bell Labs, which depends on a psycho-acoustic phenomenon known as "precedence effect" for its operation. Also systems developed by Philco, RCA, and Westinghouse have been demonstrated to the press and elsewhere. See "Compatible Stereo Broadcasts" and "Compatible Stereo for AM Stations" in this issue.

-30-

HOW FAR CAN YOU GO IN ELECTRONICS WITHOUT A DEGREE?

LESS THAN TWO YEARS AGO, 20-YEAR-OLD TIM WICKHAM HAD ASKED HIMSELF THIS QUESTION.

Today, firmly established as a Computer Units Field Engineer with IBM, Tim knows some of the answers. His story of how he assumed important engineering responsibilities on one of our country's biggest electronics projects makes encouraging reading for every technician who feels himself handicapped by lack of a formal degree.

"I always wanted to be an electronics engineer," Tim says, "ever since I first tinkered with hi-fi in my high school days. But my formal education ended when I entered the Marines in 1953. In spite of the excellent radar training I received in the Service, I still had doubts as to how far I could go in my chosen field without a degree."

HEARS ABOUT IBM—AND SAGE

A few months prior to his discharge, Tim began to look into the opportunities for a civilian career. He heard about IBM, learned that IBM was willing to invest thousands of dollars training the right men to assume engineering responsibilities in the Project SAGE program. "Would I qualify?" Tim asked himself. To be brief, Tim did qualify, and upon discharge, reported to Kingston, N. Y., to begin training as an IBM Computer Units Field Engineer.

SAGE—PROJECT OF NATIONAL SIGNIFICANCE

SAGE—for which Tim was trained—means Semi-Automatic Ground Environment. It is part of America's radar warning system—a chain of defense that will ultimately ring our country's perimeter. At the heart of this system are giant electronic computers, built for the project by IBM. These computers receive data from Texas towers, picket ships, reconnaissance planes, radar stations—analyze the data for action by the Air Defense Command and other defense units. "These computers are the largest in the world," Tim points out. "Each contains *50,000 vacuum tubes plus 170,000 diodes.*"

BECOMES FIELD ENGINEER

"My twenty weeks' training at Kingston were a revelation," Tim remembers. "Here were top-notch courses in advanced electronics, taught by instructors who really knew their business—and had a personal interest in our progress. We had classroom lectures in which we learned about basic computers, logic, programming, general machine operation—how everything worked together. Instead of a lab, we worked in actual test areas, along with the regular test area personnel. Incidentally, IBM went out of its way to make our stay at Kingston pleasant. They helped us with housing accommodations and we received a living allowance over and above salary during our training period."

INSTALLS WORLD'S LARGEST COMPUTER

His training completed, Tim was assigned to the Project SAGE site at Newburgh, N. Y. "The giant computer was ready for installation," Tim recalls, "but before it could be moved into its new building, 919 miles of external wiring and signal cables had to be checked out. Then we made interconnections and brought in the power. Next came the testing phase—a long procedure, as you may imagine, for

a computer of this size. Then we set up the auxiliary equipment. Finally, when everything was ready, the Air Force ran its acceptance tests—a stiff trial with no if's, and's or but's permitted. I'm happy to say we got an unqualified OK.

"My present work," continues Tim, "is in the Tape Section of the computer. I'm responsible for the maintenance of the Central Computer Tape System which includes eight tape drives (a means of storing information) and two tape adapter frames which adapt information for admittance into the Central Computer. A Computer Units Field Engineer like myself works in several areas of the computer, thus learning something about the whole system."

A NEW ENGINEERING DIMENSION

"IBM has proved to me," Tim says, "that a degree is not the only measure of a man's ability, or the only indication of what he can do when given the opportunity. Around me at the site I see a lot of men who were once considered 'just technicians'—men who have had a new engineering dimension added to their careers—all because IBM will spend time and money to train technicians for engineering responsibilities. I know this better than ever, now that I'm on the job. I'm on the Education Committee at the Newburgh site and I see what IBM will do to train men. My job on the committee is to find out what the men want. Then, IBM supplies courses, instructors, classrooms—everything that's needed."

YOUR CAREER OPPORTUNITY WITH IBM

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

If you have a minimum of 3 years' technical schooling or equivalent experience—you may be eligible for advanced training for 20 weeks as a Computer Units Field Engineer. While training, you receive full pay plus living allowance before assignment to a permanent location. You are paid a salary, not hourly wages, plus overtime.

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

WRITE TODAY TO:

Mr. N. H. Heyer
Room 650E
Military Products Division
IBM Corp., Kingston, N. Y.

You will receive a prompt reply. Personal interviews arranged in all areas of the United States.

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

Checking panel wiring of Simplex console

Trouble-shooting a computer frame

Discussing a problem in computer magnetic tapes

Working on SAGE magnetic input drums

Classroom lecture in computer logic

RCA pre-sells for you ...with these hard hitting ads!

How to make sure you get what you pay for in TV Picture Tubes!

If the time ever comes to replace the picture tube in your TV set, you should know these important facts:

All Tubes Are Not New!

One out of every two replacement picture tubes sold are made of used or reconditioned parts. In fact, many *rebuilt* picture tubes are sold as *new*. Until now, you and even many TV Technicians could not tell the difference.

RCA Takes the Guess-Work Out of It!

With RCA, you know what you're getting...and you get what you pay for. For all RCA ... Tubes are now clearly labeled ALL-NEW or RE-BUILT—rig...

How can you be sure you're getting a brand new picture tube?

Do you know that many TV picture tubes are made with reconditioned materials? Can you tell the difference between a new and a rebuilt picture tube? How can you be sure you are getting what you ask and pay for?

The answer is simple! RCA now manufactures two lines of picture tubes—*all-new* Silverama and *factory-rebuilt* Monogram. Each is clearly labelled as either new or rebuilt. Each is warranted for one full year. Each is priced accordingly. And *both* fit virtually every make and model TV set.

All guess work is eliminated. You're sure you're getting an all-new factory-fresh TV picture tube when you ask for RCA Silverama—or the finest rebuilt picture tube made when you ask for RCA Monogram.

All-New, Premium
RCA Silverama®
Finest picture tube made!
Completely new, glass and all parts. For the brightest, sharpest, clearest picture your TV set can deliver! $49.00*

Factory-Rebuilt
RCA Monogram
Finest rebuilt picture tube made!
A picture tube for the budget-minded. Reprocessed and tested in the same factory as RCA's premium picture tubes. $36.00*

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

*Optional list prices for a popular 21" tube. Monogram prices slightly higher far West.

These ads are typical of the big advertising program for RCA SILVERAMA and RCA MONOGRAM Picture Tubes. You'll see these messages in TV GUIDE, LIFE, and the SATURDAY EVENING POST... on such leading TV shows as Steve Allen, Dave Garroway's Today, and Jack Paar.

Cash in! Make sure you're identified with this program. Your authorized RCA Distributor will tell you how. Contact him today!

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

STEREO
STEREO AND MONAURAL

the experts say... in HI-FI the best buys are

EICO®

World-famous EICO advantages guarantee your complete satisfaction:

- Advanced engineering • Finest quality components
- "Beginner-Tested," easy step-by-step instructions
- LIFETIME service & calibration guarantee
- IN STOCK — Compare, then take home any EICO equipment—right "off the shelf"—from 1900 neighborhood EICO dealers.

Over 1 MILLION EICO instruments in use throughout the world.

NEW STEREOPHONIC EQUIPMENT

HF85: Stereo Dual Preamplifier is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source—tape, discs, broadcasts. Superb variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any high-quality stereo power amplifier such as EICO HF86, or any 2 high-quality mono power amplifiers such as EICO HF14, HF22, HF30, HF35, HF50, HF60. **"Extreme flexibility . . . a bargain"** — HI-FI REVIEW. Kit **$39.95**. Wired **$64.95**. Includes cover.

HF86: Stereo Dual Power Amplifier for use with HF85 above or any good self-powered stereo preamp. Identical Williamson-type push-pull EL84 power amplifiers, conservatively rated at 14W, may be operated in parallel to deliver 28W for non-stereo use. Either input can be made common for both amplifiers by Service Selector switch. Voltage amplifier & split-load phase inverter circuitry feature EICO-developed 12DW7 audio tube for significantly better performance. Kit **$43.95**. Wired **$74.95**.

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

MONO PREAMPLIFIERS (stack 2 for Stereo) HF-65: superb new design. Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95**. Wired **$44.95**. **HF65** (with power supply) Kit **$33.95**. Wired **$49.95**.

MONO POWER AMPLIFIERS (use 2 for STEREO)

HF60 (60W), HF50 (50W), HF35 (35W), HF30 (30W), HF22 (22W), HF14 (14W): from Kit **$23.50**. Wired **$41.50**.

MONO INTEGRATED AMPLIFIERS (use 2 for STEREO)

HF52 (50W), HF32 (30W), HF20 (20W), HF12 (12W): from Kit **$34.95**. Wired **$57.95**.

SPEAKER SYSTEMS (use 2 for STEREO)

HFS2: Natural bass 30-200 cps via slot-loaded 12-ft. split conical bass horn. Middles & lower highs: front radiation from 8½" edge-damped cone. Distortionless spike-shaped super-tweeter radiates omni-directionally. Flat 45-20,000 cps, useful 30-40,000 cps. 16 ohms. HWD 36", 15¼", 11½". **"Eminently musical"**—Holt, HIGH FIDELITY. **"Fine for stereo"**—MODERN HI-FI. Completely factory-built: Mahogany or Walnut. **$139.95**; Blonde, **$144.95**.

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

FM TUNER HFT90: For the first time, makes practical even for the novice the building of an FM tuner kit equal to really good factory-wired units. No instruments needed. Pre-wired, pre-aligned temperature-compensated "front end" is **drift free**—eliminates need for AFC. Precision "eye-tronic" DM-70 traveling tuning indicator, supplied pre-wired, contracts at exact center of each FM channel. Pre-aligned IF coils. Sensitivity 6X that of other kit tuners: 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. Frequency response uniform 20-20,000 cps ±1 db. Has 2 output jacks: cathode follower output to amplifier, plus Multiplex output for FM Multiplex Stereo adapter: thus prevents obsolescence. Flywheel tuning, AGC, stabilized low limiting threshold for excellent performance from weaker signals, broadband ratio detector for improved capture ratio & easier tuning, full-wave rectifier & heavy filtering, very low distortion. **"One of the best buys you can get 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. Built-in ferrite loop, prealigned RF & IF coils. Sensitivity 3 uv @ 30% mod. for 1.0 V out. 20 db S/N. Very low noise & distortion. High-Q 10 kc whistle filter. Kit **$39.95**. Wired **$69.95**, incl. Cover & F.E.T.

BEFORE YOU BUY, COMPARE:

You may examine the complete EICO line at any of 1900 neighborhood EICO distributors coast to coast. Compare critically with equipment several times the EICO cost—then you judge. You'll see why the experts recommend EICO, kit or wired, as your best buy.

EICO, 33-00 NORTHERN BLVD., L. I. 1, N. Y.
Fill out coupon on other side for FREE CATALOG

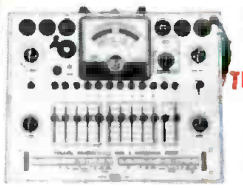
the specs prove it . . your BEST BUY is EICO®

for COLOR & Monochrome TV servicing

FREE CATALOG

shows you HOW TO SAVE 50% on 50 models of top quality professional test equipment.

MAIL COUPON NOW!



NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

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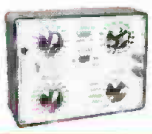

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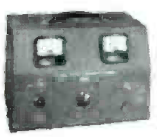

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1000 Ohms/Volt V-O-M #536
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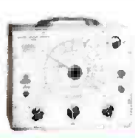

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INDUCTION HEATING

By G. W. McCOOK
Induction Heating Corp.
and
WALTER H. BUCHSBAUM

The story of how electronics is used to produce controlled heating in many branches of industry.

THE operator holding a gold ring into a fixture for a second then wiping it quickly is actually brazing the ring. Her hands do not get burned, there is no flame, yet each ring she brazes comes out perfect, without discoloration and without having to be cooled. The secret—electronics does the heating!

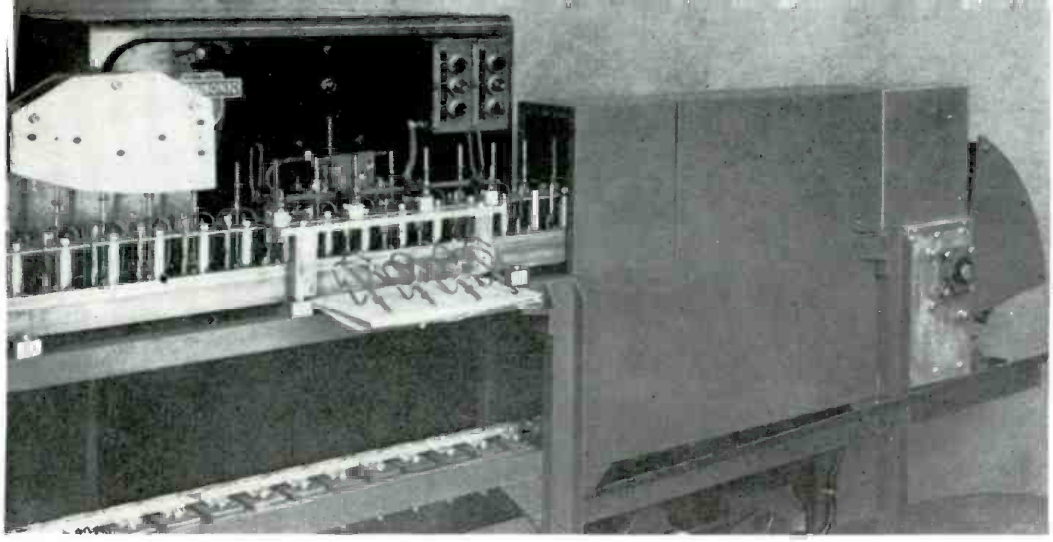
In the manufacture of transistors and diodes, silicon is grown into large single crystals at a heat of 1400° centigrade. This is done in a vacuum or in a controlled atmosphere and the temperature must be maintained within ±.25°. Again electronic heating does the job. In many other applications such as hardening, tempering, soldering, etc., the heat is generated without fire, without sparks, without heating up the air or the surrounding tools. Only the point where the heat is needed gets hot, quickly and at a controlled temperature.

As many of our readers know, induction heating is employed widely in research and production in the electronics industry. This is especially true in the component manufacturing field where tubes, transistors, diodes, capacitors, and transformers are often brazed, welded, or soldered into their containers. In addition to the electronics industry, induction heating has found wide application in all branches of metal working and allied industries.

It would be impossible to describe, or even mention, all of the possible applications of induction heating. Mentioned below are a few of the more common applications where electronic heating takes the place of the torch or the smithy.

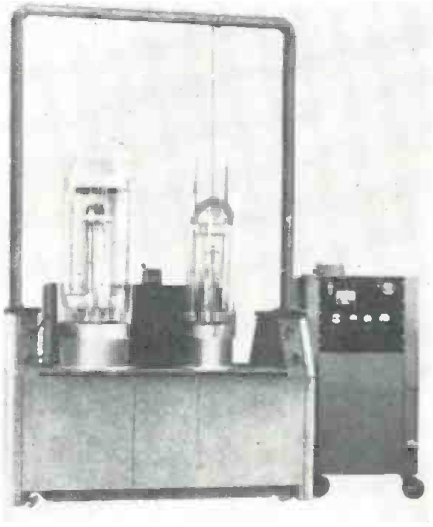
An example of one application of v.h.f. energy is the apparatus shown in Fig. 2 which is used for zone-refining of ultra-pure silicon, ferrite materials, etc. This machine operates at 120 mc. and at this frequency it is possible to keep a zone-refining process going in yttrium iron garnet, a material used in the recently publicized solid-state microwave amplifiers. The double glass bells surrounding the work piece serve as vacuum chambers and safety shields respectively. At the control panel (shown at right) the various critical parameters are adjusted while the main r.f. generator is located behind the glass bells.

One application of induction heating that may be of particular interest to our readers is soldering. Whether it is the sealing of a transformer in its shield can, joining a feedthrough terminal to a glass bead, or the assembly of microwave cavities, induction heating allows us to solder quickly and with such concentrated heat that other delicate parts in the assembly do not get



◀ Fig. 1. A conveyor carries beaters for home mixing machines through this induction heating unit which brazes the beater blades to the main stems automatically.

Fig. 2. The v.h.f. energy is used here for zone-refining silicon. Double glass bells are used as vacuum chambers and shields. ▼



warm. Here are some other uses.

As an example of a typical automatic installation Fig. 1 shows an induction heating machine of the vacuum-tube type, coupled with an automatic conveyor and handling system for the mass production of beaters used in home mixing machines. Here the brazing of the beater blades to the main stem is done automatically. The total heating time is only 3 seconds, not long enough to discolor the stem or in any way damage the temper of the blade. Other products whose manufacture involves brazing by induction heating include ice skates, spark plugs, curtain rings, and many other consumer items as well as all types of industrial equipment.

Low-frequency induction heating is usually employed to heat the entire work piece and not just a part of the surface. Low-frequency power is delivered to the work coil by one of three methods. In a few cases the work coil can be designed to connect directly to the 60-cycle power line, but more often a transformer is used to match the work coil impedance to the line. Where higher powers are used, a rotating motor-generator set delivers the heating power, usually at a frequency higher than the 60-cycle line. Typical are 960, 3000, and 10,000 cps.

One novel application of low-frequency induction heating is as a metal melting furnace. Operating at 960, 3000, and 9600 cycles, *Allis-Chalmers* makes such furnaces with output ratings up to 1250 kw. Because the application of heat is quite fast and only the metal to be melted is heated, there is less oxidation, forming of scale, and other wasteful side effects which are inevitable with conventional furnaces. An unusual device is the "Frequency Transformer," made by *Induction Heating Corp.*, which generates 180-cycle power from a 3-phase, 60-cycle line without any rotating machinery. A transformer-like device, capacitors and resistors form an *RLC* network which efficiently generates the third harmonic of the power-line frequency. This equipment, in addition to metal melting, is used for heating relatively large metal pieces such as bearings or housings for shrink fitting.

In the metal working industries induction heating finds wide application in the hardening and tempering of bearing portions of moving machinery. The gear tooth-hardening process in Fig. 3 is typical. Here the rack gear teeth of a business machine are hardened at the rate of one-inch-per-second. At the right, out of the picture, is a magazine containing a sizable stack of racks, which are fed into the rollers one after the other. The rack passes through the specially shaped work coil for heating. While still hot, the rack is fed into a circular quenching chamber at the left and finally the rack emerges hardened along the teeth and back edge leaving a tough area between. Other typical hardening applications include the bearing area of turbine shafts, cutting edge of blades, tool bits, drills, and practically every piece of metal which is subject to wear.

Hot forming processes such as forging, bending, etc. can all be done more efficiently by using induction heating. In bending, for example, only the area of the bend itself need be heated and since induction heating does this so quickly, the rest of the work piece will remain rigid and retain its shape. Fig. 4 shows a moving coil fixture in which an aluminum door handle is heated to 900° F and bent at right angles in 3 seconds, the entire operation being completely automatic, accurately controlled, and without forming scales, discoloring, or distorting.

Shrink fitting of bearings is another typical use of induction heating equipment. A work coil which fits inside the hole heats up the metal sufficiently to expand the hole diameter and then the shaft or other part is quickly inserted in the hole. As the metal cools it grips the insert firmly and produces a reliable, tight fit.

Fig. 3. Automatic hardening of typewriter ratchet gear teeth.

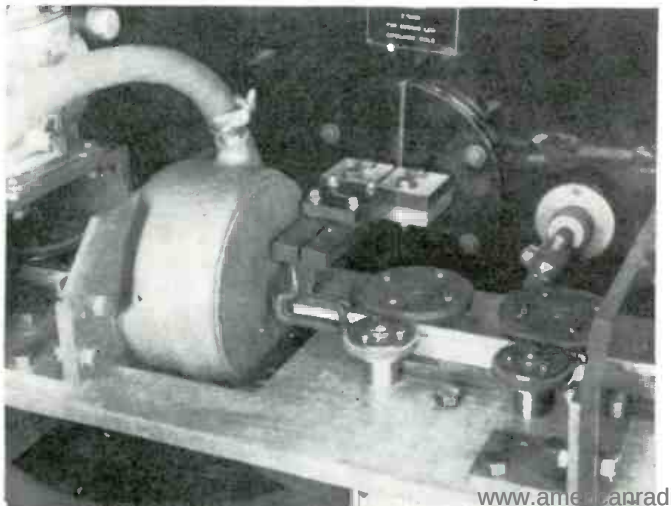
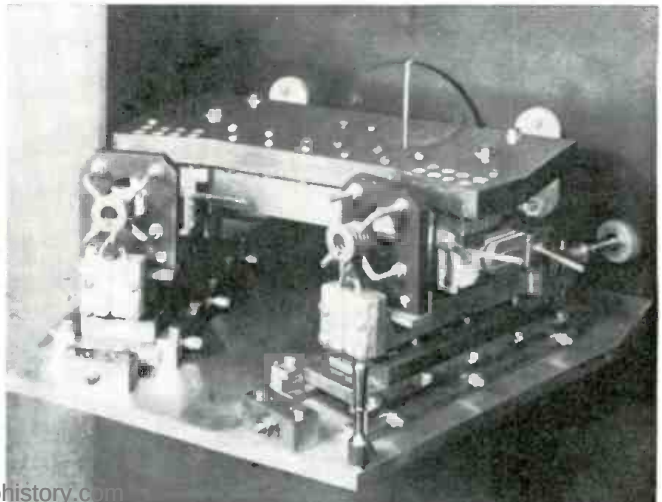


Fig. 4. Moving coil fixtures for heating, bending door handles.



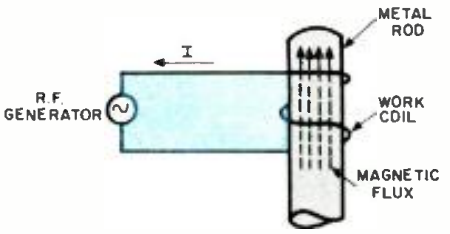


Fig. 5. Basic relation between r.f. generator, coil, and the rod to be heated.

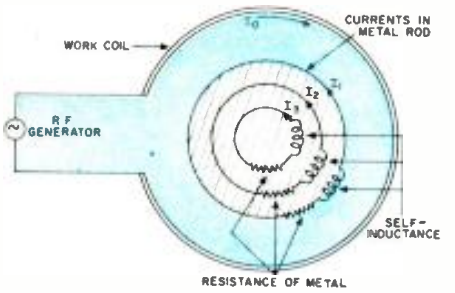


Fig. 6. Cross-section of currents in rod.

In addition to the few examples outlined here, there are a host of special purpose applications where induction heating is often the only method which permits the efficient production of a particular metal part. Whenever metal must be heated, induction heating offers a rapid, efficient, and easily controllable source of heat. The basic reason for this lies in the principle of induction heating—the heat is generated electronically, directly in the work piece itself.

How It Works

The device that generates the power for the induction heating process is very similar to a radio transmitter. It takes low-frequency power from the power line and converts it into a high-frequency signal. In an ordinary radio transmitter the signal is sent out over the antenna and radiates through the air. In addition to the power that is radiated, a certain amount of power is lost because none of the components is "ideal." Thus we know that in a power transformer there are losses due to hysteresis and eddy currents. To keep the latter to a minimum, laminated rather than solid steel cores are used. In addition there are losses in capacitors and coils as well as in the purely resistive circuit elements. In a radio transmitter the ratio of input from the power line and the antenna output is an indication of its efficiency. In induction heating equipment, the amount of radiated energy is kept to a minimum and the losses, concentrated on the work piece, are a measure of its efficiency. Here the eddy current and hysteresis losses are utilized to heat up the work piece. The r.f. energy is concentrated in the metal by means of a work coil which is designed to fit the particular piece to be heated.

Fig. 5 shows the basic relationship between the r.f. generator, the work coil, and a steel rod which is to be heated. The generator puts a current through the work coil and this current sets up a magnetic flux. The alternating magnetic flux, in turn, sets up a voltage—to be precise, a counter-electromotive force—which causes a current to flow in the metal. This is the eddy current and, depending on the type of metal and the frequency used, more eddy current tends to flow on the outside of the metal than in the inner core. This characteristic, called "skin effect," is used to regulate the depth of heating by proper frequency choice and is especially useful in such applications as surface hardening. In magnetic materials there is a secondary heating effect due to hysteresis losses but these are relatively small and are not usually considered in calculations of heating efficiency.

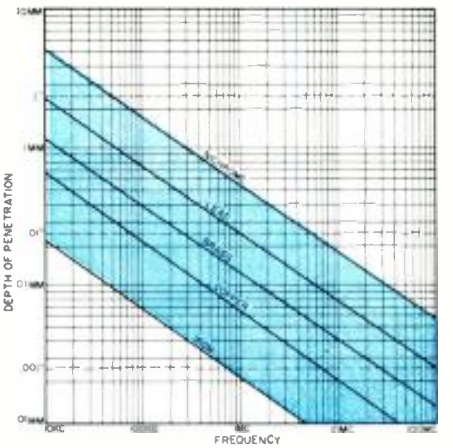


Fig. 7. Depth of penetration for metals.

Fig. 8. Photo above shows the front panel of a 7.5-kw. induction heating generator. Note simplicity of the controls required.

To show how the skin effect works for the smooth rod used as an example in Fig. 5, a simplified electrical presentation of the currents in the metal is shown in the cross-section drawing of Fig. 6. This shows that the current flowing in each circular path sets up a flux opposing the work coil flux, thereby acting as an electromagnetic shield for the material inside it. For this reason the flux in the inner concentric

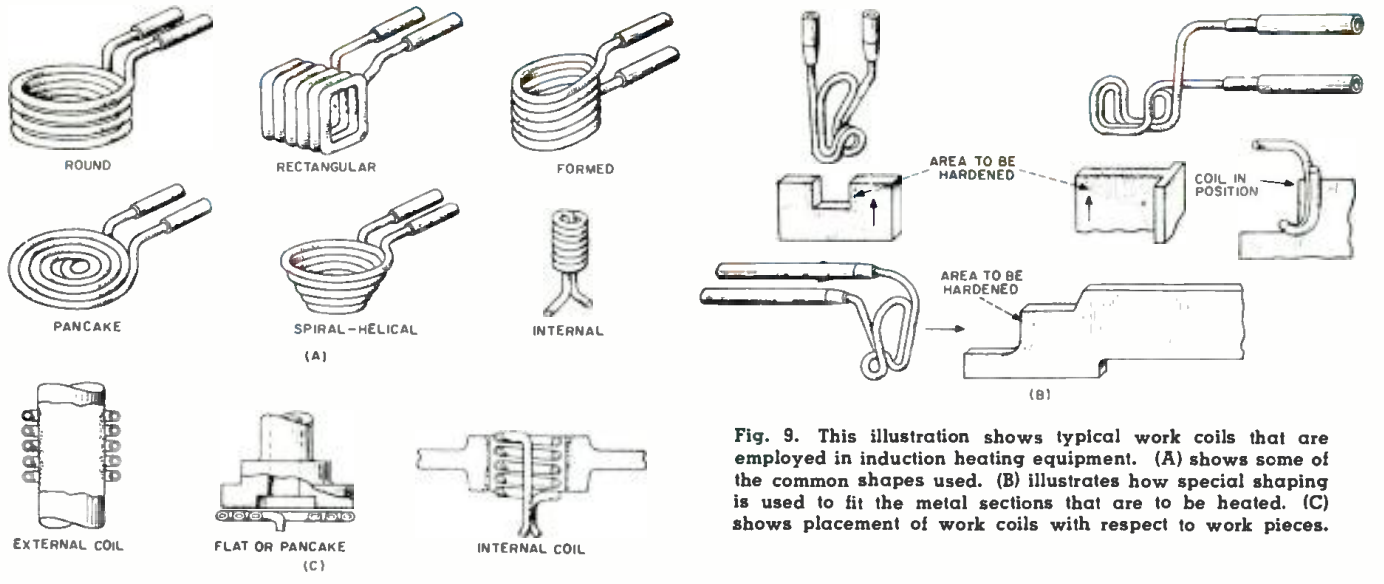


Fig. 9. This illustration shows typical work coils that are employed in induction heating equipment. (A) shows some of the common shapes used. (B) illustrates how special shaping is used to fit the metal sections that are to be heated. (C) shows placement of work coils with respect to work pieces.

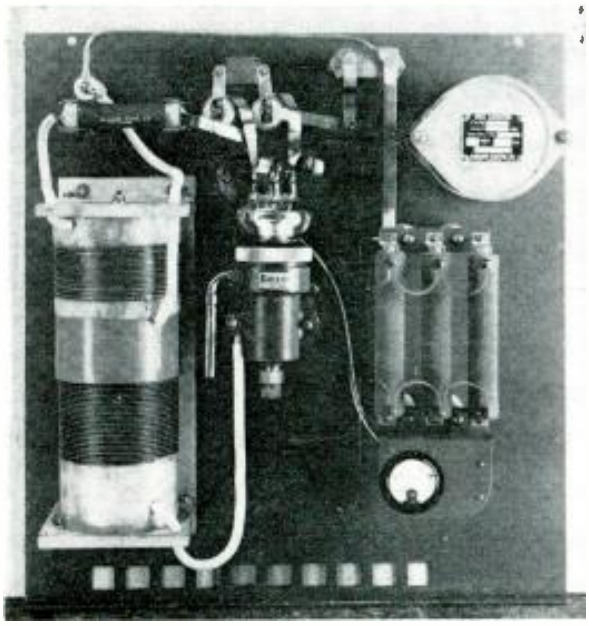


Fig. 10. Interior view of generator of Fig. 8, showing the r.f. oscillator.

paths is reduced exponentially, which demonstrates why flux, eddy current, and the consequent heating is greatest on the surface of the work piece. The "depth of penetration" is the point at which the current density is about 37% of its value at the outside surface of the work piece. The actual values of "depth of penetration" for various metals at frequencies ranging from 10,000 cps to 100 mc. are shown in the graph of Fig. 7. By proper selection of frequency it is possible to determine accurately the depth to which the metal should be heated as well as the actual skin temperatures.

The Frequency Problem

The choice of frequency determines the depth of penetration as indicated in Fig. 7. In practice, frequencies ranging from those used for power transmission to high radio frequencies are employed. In addition to the effect on the work piece, selection of the right frequency must be considered along with efficiency, complexity, and cost when designing the generating equipment. Every radio ham knows that it usually costs more to put the same power on the air in the 2-meter band than in the 80-meter band. At the higher frequencies tubes become less efficient, losses inside the generating equipment rise, and the amount of spuriously radiated power increases. This latter type of loss is costly in two ways. First, any r.f. power that is radiated into the surrounding atmosphere is lost to the work coil; second and of more importance, radiating energy interferes with other services such as communication or radar. In most machines the exact frequency is not controlled by a crystal oscillator but depends on the tuning of the power oscillator and stable, known frequencies are difficult to maintain. This is particularly true where frequencies are adjusted for a certain work piece during one production run but must be changed during the next run. Radiation at frequencies which can interfere with aircraft beacons, communications, and similar services is possible. In addition, the harmonics generated by high-power induction heating machines may reach into the TV, FM, v.h.f., and other frequency bands.

To avoid interference with other services, the FCC has issued strict limits on permissible radiation from industrial and medical equipment. For operation at any frequency except 27.55 mc., the maximum radiated field permitted is 10 microvolts-per-meter at a distance of one mile. The 27.55 mc. band is set aside as an experimental and industrial frequency allocation within which these limits need not be observed. The radiation limits apply not merely to the fundamental but also to all harmonic and subharmonic signals which might be due to induction heating machines. To insure compliance with FCC regulations each induction heating machine must be tested, signal strength readings must be taken, and a certificate of approval obtained from the engineering firm doing the testing. In many installations, especially at the lower frequencies, radiation does not present a problem, but where higher frequencies are used shielded work booths and similar devices must occasionally be employed to avoid interference.

How serious the interference problem can be is shown in a recent case history of persistent interference with an aircraft localizer beacon. The interference was finally traced, by an FCC mobile unit, to an insufficiently shielded induction heating installation. Makers of induction heating machines are now aware of the radiation problem and usually have every new model checked for radiation before leaving their plants.

Some of our readers who have experience in building transmitters may ask why crystal-controlled induction heating machines are not in wide use. Actually most manufacturers make at least one type of crystal-controlled unit, operating at 27.55 mc., which does not require extensive external shielding. For a general-purpose induction heating machine, such as the 7.5 kw. unit shown in Fig. 8, the nominal frequency is 450 kc. As the work coils are changed, as more or less power is demanded, the oscillator frequency will normally change somewhat.

There is little point in keeping the frequency absolutely fixed by means of a low power crystal oscillator and a chain of power amplifiers, each of which merely wastes d.c. power. Instead, the tank circuit can be adjusted for maximum power output for each individual work piece. To minimize the external shielding required, the entire generator is housed in a grounded, electrically bonded cabinet.

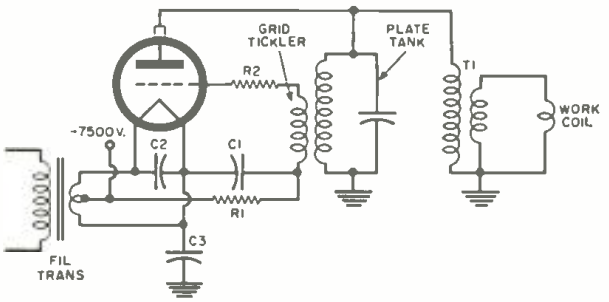


Fig. 11. Here is the basic circuit that is employed in the 7.5-kw. induction heating unit described in text.

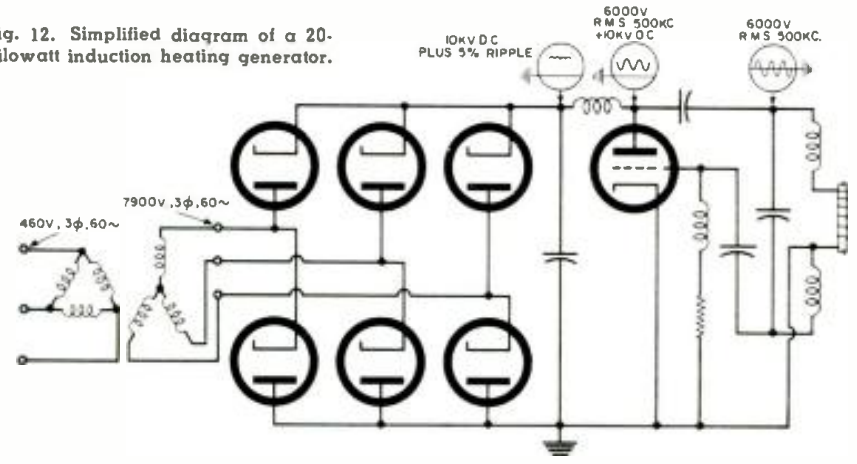


Fig. 12. Simplified diagram of a 20-kilowatt induction heating generator.

The Basic Circuit

The 7.5 kw. induction heating generator just mentioned is probably typical of the medium-sized machines and its circuit, shown in Fig. 11, will be of interest to our technically minded readers. One unusual feature of this oscillator is the fact that the plate is grounded while the grid and cathode receive a high negative voltage. Part of the r.f. signal developed across the plate tank circuit is fed back to the

grid through the tickler coil. R_1 and C_1 make up the grid-leak network. R_2 limits grid current during the positive portion of the cycle. The working r.f. energy is coupled by transformer T_1 to the work coil and its load. If the plate were at a high d.c. voltage, a coupling capacitor would be required or the transformer would have to have high-voltage d.c. insulation. The simplicity of the basic circuit of Fig. 11 is shown by the physical appearance of the r.f. power panel of the *Thermonic* model 750 generator, Fig. 8. Fig. 12 is a simplified diagram of a 20 kw. *G-E* induction heating generator. Here a coupling capacitor isolates the work coil from the d.c. power and the work coil forms a part of the oscillator tank circuit. In addition to the r.f. oscillator circuit there is a d.c. supply to furnish the necessary power.

The control circuits to regulate the "on" time and to protect the equipment in case of failure of the cooling system, are quite a plant in themselves. The 7.5 kw. generator shown in Fig. 8 requires 300 cubic feet of forced-air cooling per minute and 8 gallons of water at a pressure of 40-45 psi. The water is used to cool the transmitting tube and the various power coils and then the heated water gives off its heat to the cooling air. This means that an internal pump circulates water to the hot points in the system and then, just like in an automobile, the water is cooled down again by passing through a radiator while a fan blows cool air through it. This cooling system removes the d.c. and filament power which is not turned into working r.f. power.

The Work Coil

Once an induction heating generator is installed, the design of a suitable work coil for the particular application is the most important problem. Since the magnetic field generated by the work coil decreases rapidly with distance, the coil is placed as close as possible to the area to be heated. Therefore, work coils are designed to fit each application. Many work coils are cooled by the main water cooling system and are made of copper tubing or hollow copper fixtures. Some typical shapes for various jobs of hardening, brazing, and soldering are shown in Fig. 9. Note how the shape of the coil determines the shape of the area which is heated. It is possible to heat inside surfaces as long as the work coil can be made small enough to fit into the opening.

In industrial practice, once the basic work coil for a particular generator has been designed, special variations are often built by plant technicians who are familiar with induction heating methods. Larger automatic and semi-automatic installations serving continuous production runs usually employ carefully designed and tested work coils, especially if an additional operation such as quenching or bending is part of the heating set-up. Typical of this is an area hardening process where a certain spot is rapidly heated and then sprayed with a cooling fluid or else dropped into a coolant bath. Here the hardening cycle would be automatically controlled by a timer and at the end of the hardening cycle the spray would be turned on for a short period.

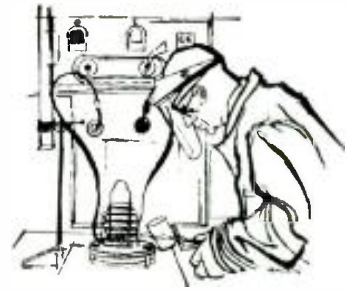
Repair and Maintenance

Many of our readers in the servicing field are wondering if the repair and maintenance of induction heating equipment does not offer a new field for the electronic service technician. A survey of the major manufacturers shows that service is usually handled by their own personnel. Induction heating generators are installed and tested at the customer's plant by the manufacturer's own engineers. After a short instruction period plant maintenance men or plant electricians are usually capable of replacing tubes, fuses, and similar parts by referring to the service manual and possible phone consultation. According to one of the leading manufacturers, service calls by field engineers are quite rare because of the extremely rugged design and ultra-reliable components used in this type of equipment. Much of the hardware inside a typical high- or medium-power generator consists of the cooling system and most maintenance people are capable of repairing leaky plumbing, worn out blower motors, water pumps.

There is a place for people with electronics training in the induction heating field, but it is usually as an employee with the manufacturer. Here knowledge of electronics need not exceed amateur radio experience or a general theoretical understanding of radio equipment, but there should be a strong background of metal working, machine shop, and production processes. Jobs in the induction heating field are not too hard to find and most firms are on the lookout for capable electronic technicians. —30—

COVER STORY

Melting Silicon For Semiconductors



THE cover photograph shows D. R. Ginter, a technician in the Semiconductor Laboratory of the Chemical and Metallurgical Division of Sylvania Electric Products Inc., at Towanda, Pennsylvania, operating equipment for the melting and casting of silicon. The silicon is being melted under a protective cover by power supplied from a radio-frequency oscillator through a fourteen-turn coil. The resultant eddy currents cause intense heat to be produced.

Molten silicon at 2600 degrees Fahrenheit is an extremely reactive material and will attack and dissolve nearly all substances. The silicon is being melted, prior to casting, in a quartz crucible in an argon atmosphere. The argon prevents oxidation of the silicon while quartz is the only refractory material with which the molten material does not react appreciably. The radio-frequency field of the coil causes a graphite susceptor, into which the crucible fits, to become hot enough to melt the silicon.

The power for the operation is supplied by a 10-kilowatt radio-frequency unit with an output frequency of 450 kilocycles. The unit is manufactured by the Lindberg Engineering Co., Chicago, Ill. Silicon, which has a high melting point and is an extremely reactive material in the molten state, must be kept out of contact with all metals and with almost all nonmetals. The use of radio-frequency power, rather than some other method of heating, allows the melting chamber to be kept free of resistance units and other heater elements which would contaminate the silicon. This is extremely important because much of today's electronic-grade silicon has a total impurity content of one atom or less in one billion atoms of silicon.

The molten silicon will be cast into rods to permit further processing in one of the many and exacting steps in the manufacture of diodes, transistors, and rectifiers.

Silicon in rod form is necessary for "floating zone" purification required for special types of transistors. In this process a long uniform rod of silicon has a transverse zone melted through it by induction heating. This "floating" molten zone receives its only support from silicon above and below, and comes in contact with no other substance. The zone is made to travel the length of the rod a number of times. The impurities, which remain in the liquid state, move to one end. They are subsequently removed simply by cutting off the end of the rod. If the operation is carried on in a vacuum, some impurities will also be lost by sublimation. In addition, silicon rods are made in various diameters which are then cut into ingots for crucible melting and drawing of doped single crystals.

Sylvania is a leading producer of silicon that is used in the fabrication of single crystals which are cut into wafers, shaped, and processed into transistors, diodes, and other semiconductor devices. The performance of all semiconductor devices is dependent ultimately on the purity of the basic material used. Extremely minute quantities of any contaminant can seriously hamper the performance of a semiconductor device. Therefore, every possible precaution is exercised during production to maintain the highest purity. —30—

(Cover photo by John Miller)

ELECTRICAL SHOCK:

FACT and FICTION

By DANIEL P. PETERS

MEDULLA OBLONGATA

RIGHT AURICLE

DO YOU BELIEVE THAT . . .

Electricity kills by burning its victims to death?
Small currents are less harmful than large ones?
Low voltages are not lethal?
There are no harmful after-effects if you survive?
If so, here is the shocking truth.

ANY MAN on the street can probably supply you with the information that an electrical shock can be lethal. However, surprisingly few people actually know how or why. For those who work in the presence of voltages and currents that may be harmful, ignorance of the true nature of shock is dangerous. Knowing what actually happens is the first step toward taking the proper precautions and, in the case of electrical shock, there are all too many misconceptions. For example:

FICTION: *Electricity kills by burning its victims to death or "shorting" them out.*
FACT: Medical records prove that electrical currents great enough to cause actual burning kill less often than do currents of much lower magnitude. The notion that an electrical current "shorts out" its victim in the way that lightning can short out an electrical circuit, while closer to the truth than the "burn" theory, is still misleading. Actually, electricity kills by overriding the control that the nervous system exercises over the body.

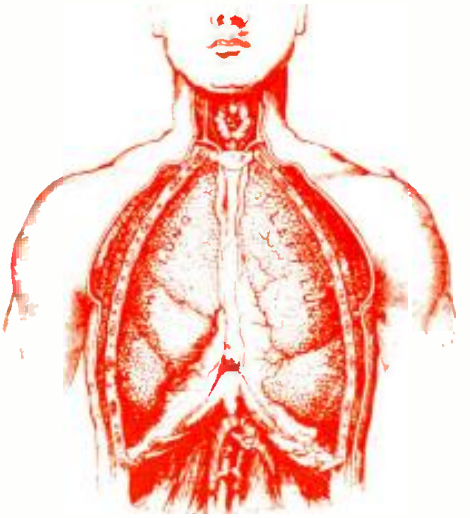
The human body has sometimes been compared to an automatic factory. Muscles are its motors. Master-minding the operation of these motors is that fabulously complicated calculator—the brain. This message center sends instructions to the controlled parts of the body *via* an intricate electro-chemical network we know as the nervous system. Doctors take advantage of the electrical nature of the nervous system with electrocardiographic and electroencephalographic equipment, which measure the small impulses associated with heart and brain, respectively.

If overridden by an outside current, the electrical impulses of the nervous system lose control of body functions. During brain surgery, for example, doctor's have applied small potentials to various sections of the brain that have caused movements of limbs and induced mental images. Through such electrical prodding, much is being learned about the mysteries of the mind.

Not so helpful, however, are the *uncontrolled* currents that flow during electrical shock—currents that swamp out the signals going to various parts of the body. Particularly dangerous are such currents that enter the heart and respiratory centers. Thus, a key factor in death by electrical shock is the path of the undesired current within the human body, as well as its magnitude.

Death following shock is generally caused by one of two direct effects: *ventricular fibrillation* or *respiratory-center paralysis.*

To understand ventricular fibrillation, we should know a little about how the heart operates. Basically, it is a pump forcing blood through the body. Controlling the heart muscles is a minute, electric current occurring periodically in the right auricle of that organ. If the conduction system of the heart is disturbed, say by an outside electric current, the muscles respond in a haphazard fashion, rendering the organ useless as a pump. Known as



ventricular fibrillation, this phenomenon generally causes death since the vital body organs are not supplied with fresh blood.

Respiratory-center paralysis is the second most lethal effect of electrical shock. Normal breathing is controlled by a stimulus from a section of the hindbrain known as the *medulla oblongata*. The electrical stimulus travels through a complex nerve network to the breathing muscles and lungs. An outside current can easily paralyze the network and cause breathing to stop. Actually death from shock can be caused by respiratory-center paralysis, by ventricular fibrillation, or by both.

FICTION: *Small currents are less harmful than large ones.*
FACT: For obvious reasons, the exact intensity of current that will cause death in a human being is not easy to determine. However, much research has been conducted in this direction. One careful study in this area was undertaken by researcher L. Alexander and published by medical organizations on this continent about two decades ago. Table 1 presents key information extracted from his report. There are other complications showing somewhat different tabulations—such factors as whether males or females are involved, whether the current is a.c. or d.c., and the methods used in research may affect the data—but the table will serve as an illustrative guide.

Currents of .07 to .09 ampere generally cause death by ventricular fibrillation, if they pass through the chest. However, *much lower* currents can also prove fatal. A current of only .015 ampere passing directly through the chest can render the victim incapable of releasing himself from the circuit, while simultaneously paralyzing the muscles of the diaphragm needed in breathing. Unless he is released from the circuit with outside help, he will die from asphyxia even though the heart and respiratory centers are not affected directly.

From the chart we can also see why people say that a charged conductor "holds" its victim. Once muscle paralysis occurs, he can do nothing to free himself. However, in some cases, muscles contract with enough violence to "throw" the victim. This, of course, may cause secondary injuries if he hits something in his flight, but also may be the means of saving his life. A larger current would be more likely to do this than a smaller one. More will be said on this score later.

FICTION: *Low voltages are not lethal.*
FACT: Thus far we have considered only the effects of a *current* passing through the body. However, voltage is the force that determines current magnitude. The amount of current for a given applied voltage, of course, depends on resistance—and the resistance of the human body varies widely. It depends, among other things, upon the path of current; the health of the individual; the duration of the current flow; the condition of the skin (wet, dry, etc.); and the area of contact. Measure the resistance of your body from arm-to-arm under various conditions: you will find that, while perspiring freely on a warm day, the resistance is so low that 25 volts could produce sufficient current to cause death. Confirming this, there are cases on record of deaths caused by 32-volt farm lighting systems. Yet, under more favorable conditions, the 120-volt house lighting system would cause only a tingle!

FICTION: *High voltages are always more dangerous than low ones.*
FACT: Strangely enough, shock from potentials greater than 1000 volts may be *less* dangerous than those from lower voltages. The reason for this is that the high currents associated with high voltages may cause all muscles —including those of the heart—to contract suddenly and violently. The heart muscles may contract to such an extent that fibrillation *cannot* occur. In such cases, the heart may resume normal action if the victim is released in three or four minutes. A recovery rate of 62 per-cent among cases where persons were knocked out by potentials above 1000 volts was observed during a study made in 1933. The corresponding rate at much lower voltages was only 39 per-cent.

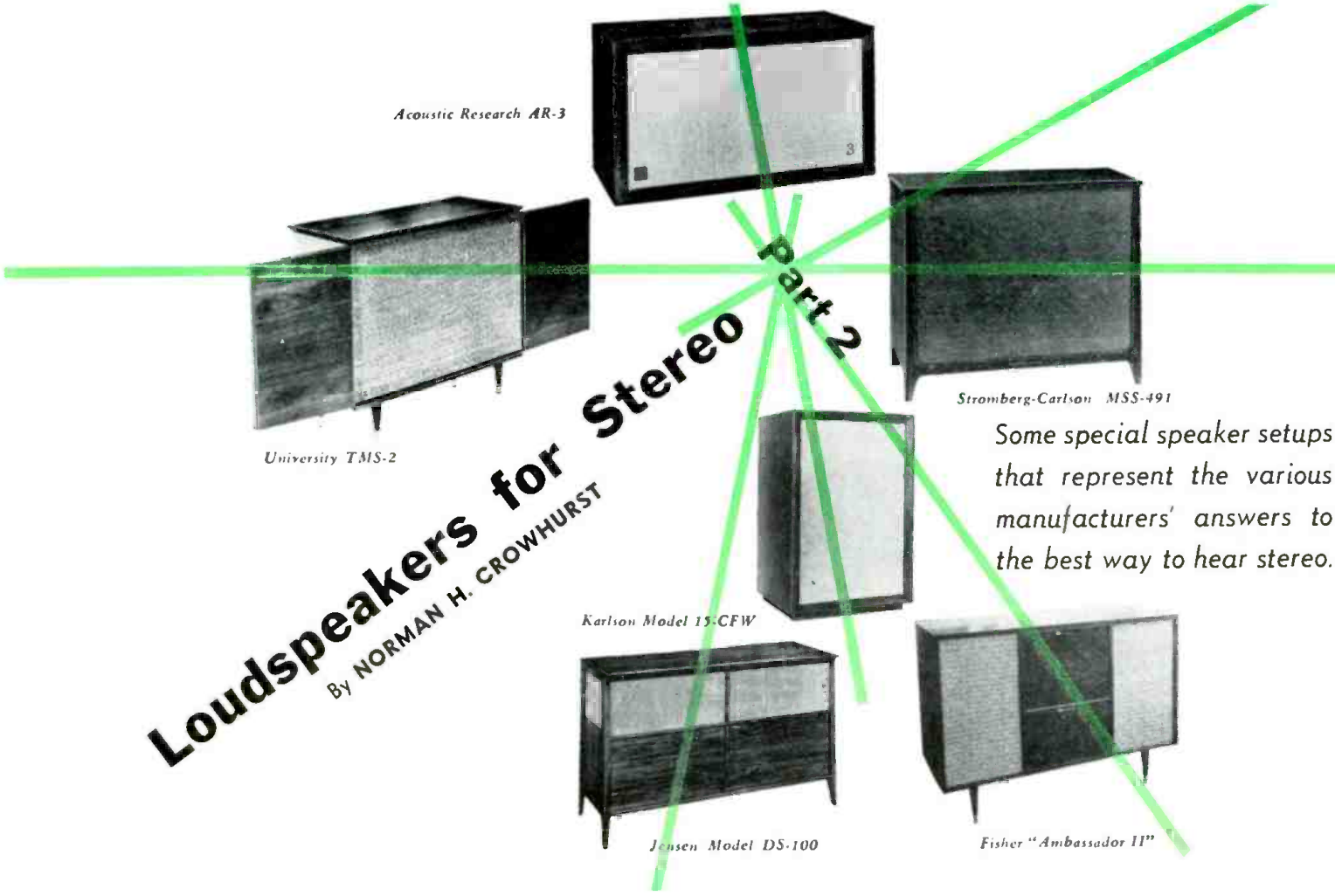
Not only the voltage and current magnitudes but also the current *body paths* are important. Any route involving the heart or brain is dangerous, as pointed out earlier. The "Journal of Industrial Hygiene" reported in 1925 that, of a number of cases involving fatal shock at voltages below 250, 90 per-cent of the victims had marks on their left hands. This indicates that shocks through the left hand—hence, nearer the left side and heart—are much more dangerous than those through the right hand. Thus, if you tend to keep one hand in your pocket while near live circuits, make it the left.

FICTION: *There are no harmful after-effects if you survive a shock.*
FACT: If you suffer a shock and have sustained no apparent injury, it may not mean that your troubles are over. Electrical shock *sometimes* damages nerve tissue. This may cause

(*Continued on page* 118)

Table 1. Shock current intensities and their effects.

CURRENT IN AMPERES	EFFECT
.0002-.0003	Tap
.00075	Pinch
.001	Grip
.005-.015	Unpleasant stimulation
.015-.019	Paralysis of muscles through which current flows
.025	Possible permanent damage to tissues and blood vessels
.07 and higher	May be lethal



Loudspeakers for Stereo Part 2

By NORMAN H. CROWHURST

Some special speaker setups that represent the various manufacturers' answers to the best way to hear stereo.

A GOOD many loudspeaker manufacturers have put in a lot of work finding out just what "makes stereo." They may have come up with different conclusions (which adds to the confusion), but one can credit them with honest effort, both for their research and in making available products consistent with their "findings."

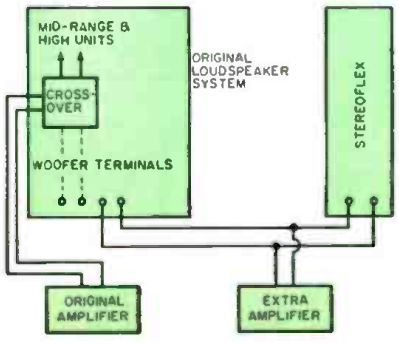
We discussed the reasons for these differences in Part 1 of this article—so now let us consider some other aspects. Some manufacturers have been quite "purist" and produced only systems that give stereo in its best or "final" form; if you want stereo, according to them, don't settle for any half measures. Others have catered to people who have monophonic hi-fi and want to convert to stereo by adding a channel (as a first step, at least) or for people with practical limitations: no room for the "conventional" set-up or an awkward shaped listening area.

"Add-On Units"

Early in the field of the "add-on" market was *Electro-Voice* with the "Stereon." This is a versatile unit intended to take the mid-range and highs of the second channel (left or right) while the bass of both channels is fed to the bass unit of the original system. A filter is provided to do this, as shown in Fig. 7. *University* has also introduced three add-on "Stereoflex" units. However, with some *University* woofers, the dual voice-coil makes the filter for diverting bass from the second channel to the original woofer unnecessary. One voice-coil of the "common" woofer is fed from each amplifier output by a relatively simple connection (Fig. 5).

This add-on approach is not favored by other manufacturers, however. They feel that in most instances the add-on unit will eventually be abandoned in favor of a more ideal system. While this is probably true, there may also be some places where "one large, one small" fit so well they will remain. It can give quite good stereo presentation, although admittedly, where circumstances allow, better arrangements are possible.

Fig. 5. This is the connection possible with the University "Stereoflex" as employed along with double-wound woofer.



Another approach that can be considered as an "add-on" one is the *Stephens* "Stereodot," although this is really a system approach. However, it can be added on to an existing hi-fi system by including two "Stereodot" side speakers (which are very small) and the control unit. It is an extremely versatile system because the small "Stereodot" units can be mounted almost anywhere. It also provides for "center fill" by feeding a mixture of middle and high frequencies to the original wide-range loudspeaker, as well as using it for the bass of both channels (Fig. 8).

A very versatile system in this category is one used in several *Columbia* consoles. This is not so much an add-on deal as it is a unit with which you can do many things. Primarily designed as the master unit of the "Isophonic" system (mentioned in Part 1) when used this way the console speaker handles common bass only, with the left and right mid-range and highs (above 250 cps) being fed to the small "Isophonic" units. The difference between this arrangement and the *Stephens* system was explained in the previous article. Additionally, a jack-plug arrangement permits the same console to be used with another full-range speaker system, feeding one channel (left or right)

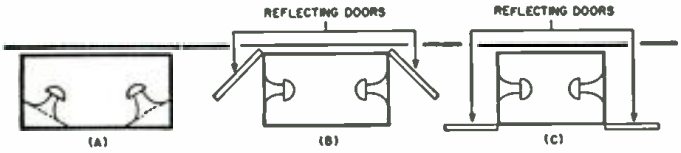


Fig. 6. Three basic constructions used for unitized cabinets.

to the external speaker and one to the internal speaker. The possible combinations are shown in Fig. 9.

Of course, many other systems can be built on the add-on principle, merely by buying another unit similar to the one you already have and installing the additional electronics somewhere.

It would be impossible to describe here the variety of ways in which this can be done. But we should warn against buying a second *very large multi-unit system*. Not only will the distaff side probably object to your hobby occupying too much of the living room, you will not get the best stereo —in fact you may not get stereo, period! Speakers for stereo *must* give an impression of point-source radiation, if you plan to use two alike, spaced apart in the conventional manner. If you already have one of these large "superdupers," I have two suggestions: either buy a complete separate stereo system and keep the original for mono only or else buy one of the add-on systems, utilizing your single system for part of the stereo—but not for just one channel.

"Unitized" Approach

So much for the add-on approach. Next we turn to the "unitized" approach—putting a complete stereo loudspeaker system for both channels into one cabinet. Several people have done this—in slightly different ways.

Most of these are essentially an approach for the small-to-medium sized room. Some angle the speakers outward for direct radiation (Fig. 6A); some point them out opposite ends with movable reflectors (Fig. 6B); and at least one (*University* "Trimensional") does this with the reflectors in front of the units (Fig. 6C) so as to further utilize wall reflections. Some of them use common and some separate woofers. The *University* version uses a common woofer with twin voice-coils and utilizes radiation between the cabinet back and room wall to improve the low end.

Each of these arrangements uses outward-facing units for the mid-range and high frequencies. Used on stereo material, they each can project sound that appears wider than the piece of furniture from which it actually comes. Choice should be governed by the acoustics of the room in which you will install it, bearing in mind that too little reflection can sound "dead" while too much results in confusion. The direct radiator, without reflectors, will perform best in recreation-type rooms while a type provided with doors that bounce sound off the wall deliberately are better in a room that is "well upholstered."

Quite another type of single-piece-of-furniture entry is the *Ranger-Lansing* "Paragon" (Fig. 10) and its junior version, the "Metregon." These cross-fire the sound into a curved reflecting surface, the object of which is to even out the mean path distance from each unit to the listener in various parts of the room, thus spreading the area of acceptable stereo. The reflector alters the apparent position of the two units according to where you sit, so as to optimize stereo in different positions.

This optimizing of the presentation in different positions in the room should not be confused with providing "center fill." Actually the latter is best done by using better microphone techniques in recording. Where this has not been done, a center loudspeaker may help to a limited extent. At the same time, this hole-in-the-middle effect can be more noticeable with some types of loudspeaker than others. The horn type produces an effectively large area sound source and is more prone to exhibit the effect just mentioned than some other types.

For this reason, Paul Klipsch, who advocates horn-type loudspeakers at opposite ends of the longer wall of a room (Fig. 11) developed his "Heresy" for the middle position, together with a simple phantom circuit for connecting it to virtually any pair of stereo amplifiers, so it receives a matrixed signal. This is also the philosophy behind the remixing of middle for the center speaker in the "Stereodot" system.

But optimizing stereo, so its effect can be heard in positions other than center is another thing. This is what various approaches try to do in different ways. The deviant sources of Fig. 6 do it by changing the type of sound distribution from each unit received in different parts of the room.

The cross-fire-with-reflector system on *Ranger-Lansing* does it by shifting the apparent loudspeaker unit positions according to where you sit. The "Isophonic" system of *Columbia* utilizes the radiation pattern in yet another way, to modify receiver intensity from each unit according to where you sit. Each of these three methods works, but produces *different* results. Which is best?

While, as we have said, this may vary with individual rooms in which they are tried, the difference is also subject to individual hearing faculties and experience and although I may not be very helpful in saying this, the only way to know which suits you best is to

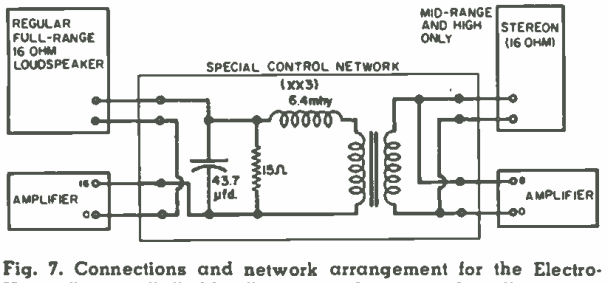


Fig. 7. Connections and network arrangement for the Electro-Voice "Stereon" "add-on" unit is shown in this illustration.

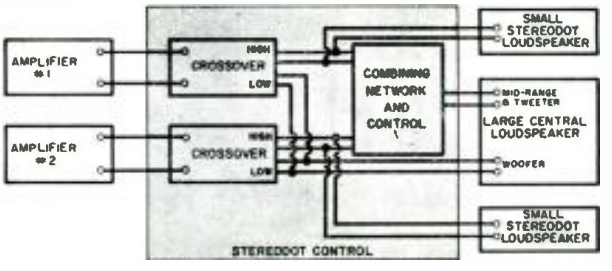
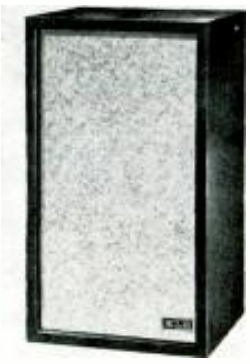


Fig. 8. Block diagram and connections that are utilized in the Stephens' "Stereodot" loudspeaker arrangement. See text.

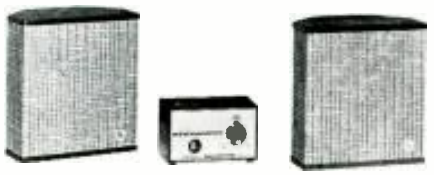
Table 1. Composite stereo assemblies with speakers for two channels in one unit.

MAKER	MODEL	SINGLE OR SEPARATE WOOFERS	SOUND DIRECTIVITY VARIABLE BY	SOUND DIRECTIVITY FIXED	SOUND RE-FLECTOR USED?
Ampex	A-423	Separate	—	Divergent	—
Bozak	B-304	Separate	Hinged Doors[1]	—	Yes
Fisher	Futura II	Separate	—	—	—
Fisher	Ambassador II	Separate	—	—	—
Frazier	Stereorama I	Separate	—	Divergent, 30°	—
Frazier	Stereorama II	Separate	—	Divergent, 30°	—
Frazier	Stereomaster	Separate	—	Divergent, 30°	—
Hartley	217-Duo	Separate[2]	—	Divergent, 40°	—
Jensen	DS-100	Separate	Swivel Mount	—	—
Lansing, J.B.	Paragon	Separate	—	Cross-fired	Curved
Lansing, J.B.	Metregon	Separate	—	Cross-fired	Curved
Tannoy	Lanseer	Separate	—	Divergent, 12°	—
University	Trimensional	Single	Hinged Doors[3]	—	Yes

Notes: 1. Hinged behind end-faced units to reflect sound forward.
2. Hartley 217 extended-range units carry whole range in each channel.
3. Hinged in front of end-faced units to further reflect sound against room walls.



KLH Model Six



Stephens' "Stereodot"

Argos Model DSE-1

Frazier "Stereorama II"

bass that is supposed to be there, so stereo should have just plain, good bass.

Some of the earlier small bass units relied on harmonic generation to give a "false bass"—like the car radio bass, but more modern approaches have resulted in units that do give real bass from much smaller units than hitherto was believed possible. Some manufacturers claim that trying to get big bass from small speakers is defying "the laws of physics." I think it would be more accurate to say that some designs have found some "loopholes" in these "laws."

But do satisfy yourself that the unit you buy does give genuine, clean bass that is adequate for the room in which you will play it and working from the amplifier you will use.

Two Identical Units

So much for the "system" approaches, some of which come pretty much "ready-made" while others give plenty of scope for experimentation. But another approach that offers wide appeal for two reasons is of the two-identical-unit variety.

This may come either as separate loudspeakers which connect to an equipment cabinet or with the equipment included in one ensemble with a companion speaker to match. In achieving stereo, both offer similar prospects. Also some systems come as a matching set of three which can stand close together thus simulating the one-piece system or be spaced farther out if this is found necessary in a particular listening room.

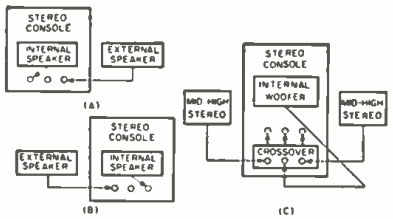


Fig. 9. Arrangements used in Columbia consoles: (A) and (B) use 2 full-range speakers; (C) combines lows in central woofer and mid-range and highs to external units.

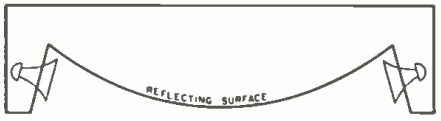


Fig. 10. Basic arrangement used in Ranger-Lansing "Paragon" and "Metregon" units.

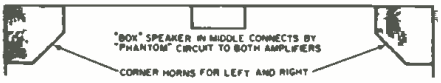
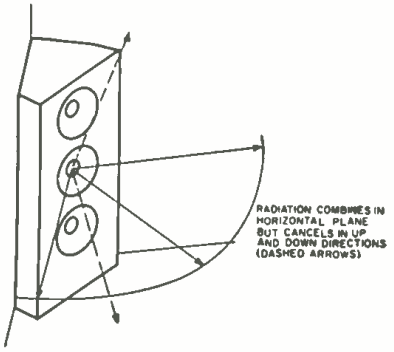


Fig. 11. Klipsch's recommended setup, with 2 corner horns and "phantomed" center unit.

Fig. 12. Method of getting good horizontal distribution and avoiding unnecessary vertical spread with extended-range units.



MAKER	MODEL	BRIEF DESCRIPTION
Columbia	360,626,637	Central unit for mixed lows, part of console; small side units for stereo highs, above 250 cps; jack arrangement, see text.
Electro-Voice	Stereon	Add-on unit consisting of mid-range and tweeter speakers working above 300 cps. Bass in both channels handled by low-frequency speaker system.
Jensen	Stereo Director	Ducted-port enclosure for woofer. Mid-range and tweeter units are swivel-mounted to permit varying of directivity.
Klipsch	Heresy	Corner horns with sealed back enclosure for center fill, phantom-connected to amplifiers.
Stephens	Stereodot	Central unit for mixed lows and controlled mixture of highs for center fill; small side units for stereo effect, above about 400 cps.
University	Stereoflex	Add-on unit consisting of mid-range and tweeter speakers working above 150 cps. Bass in both channels handled by dual voice-coil woofer.

Table 2. Here are some of the special stereo systems with brief descriptions.

conduct some careful listening tests of your own.

Stereo Bass

In going over different systems– or for that matter, individual speakers too —you will find a further area of conflict lies in the *kind* of unit used to provide bass response. Paul Klipsch won't hear of anything but a corner horn, except for the center fill. Other manufacturers maintain — as almost anyone would have until a year or so ago—that a speaker must be big to get good bass. Edgar Villchur (of *Acoustic Research*) says that there is merit in a low-efficiency and small bass system.

So what kind of bass is good for stereo? As was explained in Part 1, pure bass is not materially stereophonic in any ordinary sized living room. But music is deficient without

Directivity

But we now get into another difference over which to choose: directional or diffuse radiating (omnidirectional) type loudspeakers? On this score most speaker manufacturers belong to one school or the other.

The omnidirectional school uses diffuse radiators so that sound exclusively from one unit will be identified with it —wherever you are in the room. Cor-

(*Continued on page* 126)

TV Shop Uses Two-Way Radio

From his shop, Devin can advise on home repairs, re-route vehicles economically, or approve purchases of used sets.

◀ Field technician Jerry LeCompte can check on late calls for fast service, get shop advice, or OK's on old sets.

Many dealers are becoming interested in selling or maintaining two-way mobile radio. Here's one who uses it himself—to his advantage and profit!

EDITOR'S NOTE: *With everybody (including* ELECTRONICS WORLD*) talking about service opportunities in two-way mobile radio, opened up by the virtually unlimited applications in all businesses, let's not overlook a key possibility. A service business can benefit as much from this medium as can any endeavor using vehicles! In addition, what could help you push two-way sales and service more than a living example?*

Incidentally, don't confuse the Business Service with operation on the Citizens Band, which is permissible without type-approved equipment. For information on the latter, see "Citizens Radio Faces the Future," November 1958, and "Build This Citizens Band Transceiver," March 1959.

THE NEW Business Radio Service is a natural for TV sales and repair organizations seeking an efficient 2-way radio system. Just ask Lee Devin, owner of *Lee Devin's TV*, 929 N. W. 10th Ave., Oklahoma City, Oklahoma.

Devin was one of the first Oklahoma businessmen of any kind to apply for a license in this service: his *Motorola* system was installed shortly after the Federal Communications Commission opened the service on August 1, 1958.

His initial system consisted of a 25-watt a.c. utility base station, an "Isoplane" antenna on a 50-foot telescoping TV mast, and two 25-watt mobile units. The two mobile radiophones were originally installed in Devin's car and the service station wagon. When he traded in his auto, he had a new 60-watt, transistor-powered mobile unit installed in the new car and the original set put in the company's pickup truck.

The original system provides 10-15 miles range, sufficient to cover most of Oklahoma City's metropolitan area. In order to cover the fringe areas beyond this, Devin plans to erect a 100-foot tower and a high-gain antenna.

Besides operating a widespread TV repair service, Devin is heavily engaged in buying, renovating, and reselling used TV receivers. He finds two-way radio is most useful in both his sales and service activities.

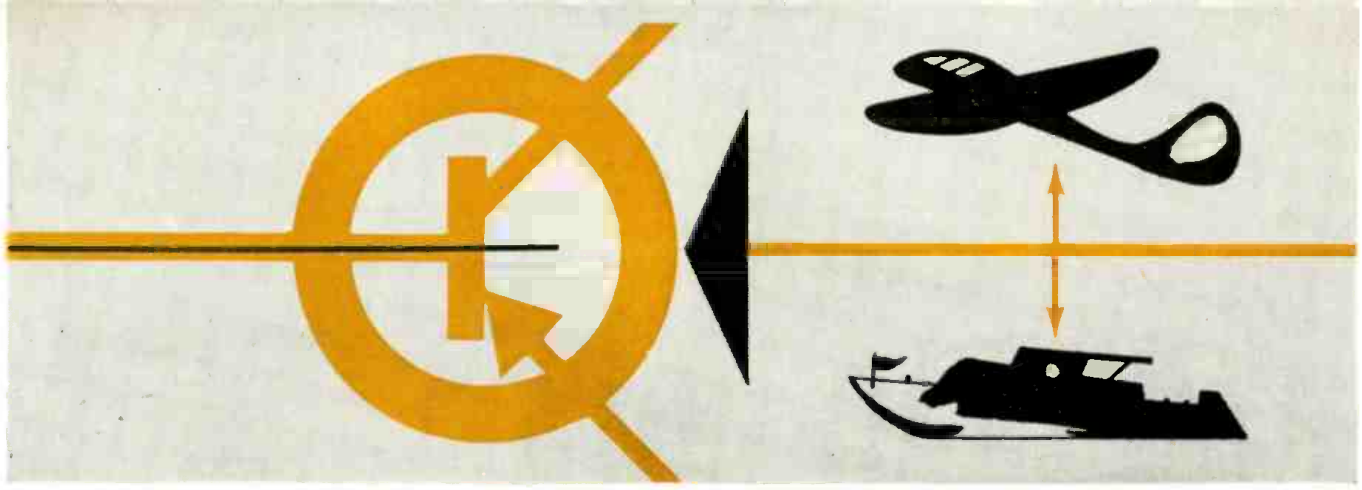
Dispatching service calls to technicians in the field is a "natural." By relaying new calls to the men in the field, efficiency and productivity can be increased greatly, since waste trips back to the office are eliminated. Devin feels his three-man organization should be able to handle 10 per-cent more calls through radio. This means increased income and also lower operating costs, since gasoline and vehicle wear are cut through the elimination of waste mileage.

On puzzling service calls, the technician can also use the radio to get fast assistance from the shop. This avoids using the customer's phone, often a cause of embarrassment.

Devin reports that an uncommonly competitive situation exists in the used receiver market in Oklahoma City. Oftentimes when a family wishes to get rid of a set, it will call three or four companies. Then bidding for the receiver (if it's in reasonably good condition) takes it out of the "good buy" category. Devin says that a 2-way radio call to a man in the field enables him to "beat the crowd" to the seller's home and thus often snap up the set at a price that leaves room for a good, fair profit.

One of Devin's men, Jerry LeCompte, says the radio is very helpful to him in passing certain decisions on to Devin. He says, "I really appreciate not having to stick my neck out on bids when I appraise a set. With radio, I can ask Lee how high I can go." The same situation exists in set sales at the store when Devin is out. A prospect offers a set price for a receiver. Devin can be contacted immediately to say "yes" or "no" to the deal. Fast action like this saves many sales that might otherwise be lost if the prospect were told, "I'll let you know this afternoon."

In summary, Devin says that his new 2-way radio system, made really effective through the Business Service, provides the means for tight, efficient operation of all phases of the TV sales-service business. —30—



Experimental Transistor Motor Control

By **HAROLD REED**

Simple, inexpensive circuit for direct or remote control of small motors. Useful for model control.

ONE of the many, and perhaps most useful, uses for transistors is in connection with control applications. A minute current applied to the input of a transistor circuit will trigger or operate many different electronic or electro-mechanical devices which require greater operating current.

Most of the published transistor control circuits have been designed to operate some very sensitive device, such as a relay, requiring a small input control current and a larger, but still small, operating current. Now that inexpensive power transistors are available, the experimenter may construct useful transistor circuitry for control of devices less sensitive, that is, demanding greater operating current. One such application that occurred to the author is the control of small d.c. motors as described in this article.

Miniature Motors

The d.c. motor around which this circuit was designed is called the "Supermite" and measures only 1" x 1⅜" x 1¼". Its dual shaft extends ⅜" from each side of its case and the shaft diameter is 3/32". It weighs just 2 ounces. It will run on 1½ to 6 volts d.c. and its rotation is reversible. This motor was designed to power model boats and planes, toys, moving display signs, and other mechanically driven devices. Another motor that the constructor may use is the "Mighty Midget" which will operate on 3 to 6 volts d.c. It is supplied with 7:1 reduction gears and pulley. Both motors are available from *Lafayette Radio*.

Circuit Analysis

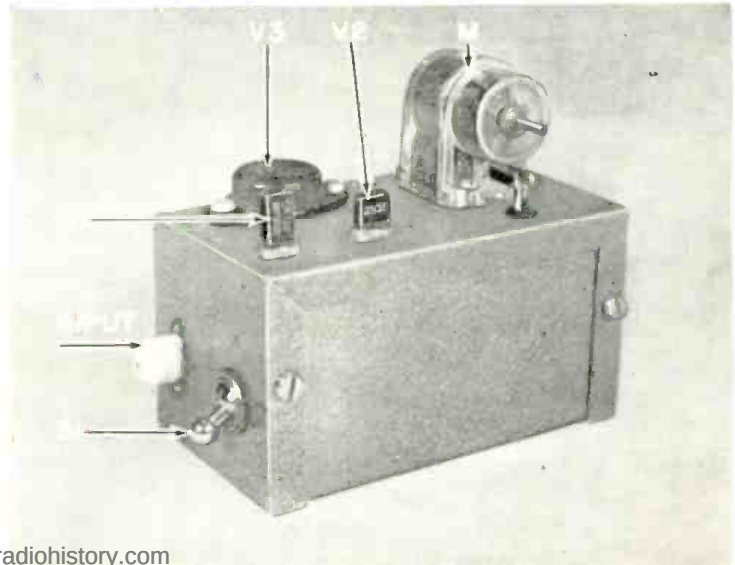
The manner in which this motor control idea is applied can be understood by analyzing the schematic diagram of Fig. 1.

The complementary characteristics of *n-p-n* and *p-n-p* junction transistors, whereby use is made of the opposite action of these devices, is utilized, and therefore, direct coupling is employed between all stages. An original circuit design for direct coupling was given by George Sziklai of *RCA*, in which a *p-n-p* transistor preceded an *n-p-n* unit.

The circuit of Fig. 1 uses a small *p-n-p* junction transistor for the input stage. This is followed by a small *n-p-n* type which works into another *p-n-p* unit of the power type. When a control current of the correct polarity is applied to the input circuit of V_1, an amplified collector output current is obtained. This current flows through the base-emitter path of V_2 and a greater amplified current is available at the V_2 collector circuit. Likewise, this further amplified current flows through the base-emitter circuit of V_3, which results in increased current in the collector circuit of V_3 (the power transistor) of sufficient strength to operate the motor. The first transistor, V_1, obtains its negative collector voltage through the base-emitter path of V_2. Also, the second transistor, V_2, gets its positive collector potential by way of the base-emitter path of V_3. This arrangement makes it possible to employ a single battery supply to provide the correct operating polarities for the different transistor types.

An input signal control current of less than 100 microamperes will operate the motor, thus the device may be radio-controlled, using a small transmitter and crystal rectifier receiver of the type employed in model control. Also, the circuit may be operated directly from a photo-electric cell with no auxiliary source of voltage. With a small, inexpensive photo-electric plate connected directly to the input, the motor could be controlled with a flashlight from across the room. The tiny selenium plate was not very sensitive.

The standby current drain of the circuit and the required input control current vary with the value of resistor R_1. If the value of R_1 is increased, the standby current of the circuit is greater but the required control current is smaller. When the value of R_1 is decreased, the non-operating current is



less but the necessary starting control current must be greater.

The circuit may be tested with the component parts shown within the dashed box at the input of V_1. These will provide a signal control current of about 100 microamperes when R_1 is 3300 ohms as shown in Fig. 1.

Total current drain with the motor running is 450 milliamperes. This may be compared with the current required for a flashlight using two size C batteries. A lamp used in a flashlight containing two of these batteries is the *G-E* PR2 rated at 500 milliamperes. Thus, it can be seen that the transistorized motor control device draws less current than the flashlight bulb. If the constructor requires more power for the motor, B_1 can be increased to 4½ volts.

A less sensitive circuit that was tried is given in Fig. 2. It consists of just two direct-coupled transistors, an *n-p-n* and *p-n-p* type. With this circuit, a signal control current of 0.3 milliampere is sufficient to start the motor and when this current is increased to 0.5 milliampere, the motor runs at full speed. It is to be noted that the polarity of the control signal is the reverse of that required for the circuit of Fig. 1.

Construction Notes

No particular construction pattern need be followed. In fact, the physical layout will depend entirely on the particular application. It may be desirable to locate the motor away from the other component parts, for instance, when the device is used in model working activities. The author built up the circuit of Fig. 1, in the manner shown in the photograph, for experimental applications.

All the parts are attached to the upper half of a 2¼" x 2¼" x 4" aluminum *Bud* "Minibox." The three transistors and motor are mounted on the top side and the two flashlight batteries are located on the bottom side. A small, dual-type battery holder secures the batteries. The "on-off" switch and miniature connector for the control signal are placed on one end of the box. Two sockets are provided for the smaller transistors. The 2N256 transistor is attached directly to the box with two 6-32 machine screws. It is to be remembered that the case of this transistor is part of the collector circuit and therefore other connections must not be made to the metal box. Other equivalent transistor types may be used instead of the ones shown.

Two connector inserts, removed from a miniature tube socket, are slipped over the base and emitter pins of the power transistor for electrical connection. Wires should be soldered on these clips before placing them on the transistor pins.

The small pulley on the shaft does not come with the motor. It is a small wheel taken from a pulley used for pull-type curtains and draperies.

Although just two motors have been mentioned, electronic mail order houses have advertised miniature motors rated at various voltages from 1½ to 8 volts and current ratings from 200 to 500 milliamperes. Weights have been given from 10 grams to 5 ounces at prices ranging from 85c to over $5.00.

Motors requiring higher voltage ratings may be used in the circuit by increasing the value of B_1 and adjusting R_1 as required. Collector voltage ratings of V_1, V_2, and V_3 are −22, 25, and −12 volts, respectively. Collector current ratings are −10, 50, and −500 milliamperes. The V_3 values are those recommended when employing a heat sink. Be careful not to exceed the maximum current ratings of V_1 and V_2.

This transistor motor control device is one of those hobbyist's "delights" because of its interesting possibilities and applications. The reader interested in model control projects will find many useful applications for the circuit. It is also a good project for the newcomer to transistor circuitry, since it is easy to assemble, has few component parts, and is simple to operate. Total cost of the three transistors and motor is less than $5.00 -30-

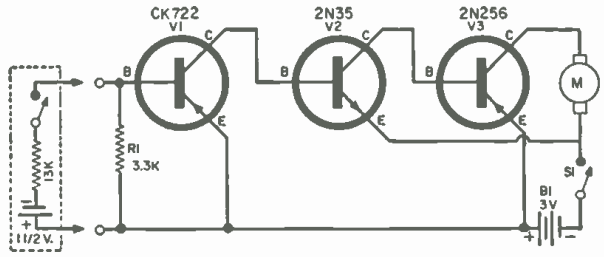


Fig. 1. Schematic diagram of the motor control circuit. The motor will operate with an input control current of less than 100 μa. The section within the dashed box is used to test circuit.

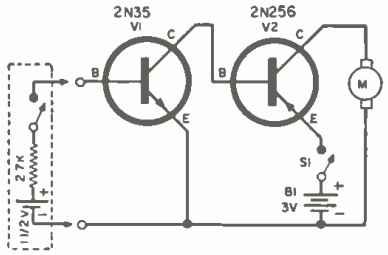


Fig. 2. Diagram of a less sensitive motor control circuit. An input control signal of ½ milliampere will operate the motor. The several components within the dashed lines may be used for testing the circuit. These will provide an input control current of ½ ma. A penlite cell may be employed.

▲ **The underside view of the completed unit is shown here. Wiring and layout are simple and only a few connections are needed.**

The completed motor control unit. All that is needed to start the motor is to apply a minute control current to white plug.

◀

▶ **Photo of all the component parts for the motor control device. Note that all holes have been made in the metal box and everything is ready for the assembly.**

profit & growth

You must keep charges realistic—in step with changing times—to insure prospering business.

By
WILLIAM LEONARD

ONE OF the most important things a service dealer can do to stimulate the stable growth of his operation is to make a studied effort to gear himself and his business to the right habits. Most experienced dealers know that a rigid system of "time control" or "time management" is vitally important in a service business. As a result, habits that make the most effective use of time are built-in features of all successful service businesses.

One basic weakness of the service industry generally has been the ingrained habit of underpricing time and labor. The result is that a high percentage of independent electronic service businesses continue to operate on the fringe of financial disaster.

Recently the Indianapolis Television Technicians Association, through its house organ, conducted a survey of charges for electronic service made by dealers in the Hoosier capitol city. In publishing the results of the survey, the "Hoosier Test Probe" said:

"Many Indianapolis service operators are giving service away. Some fees charged are so low that no funds for the replacement of equipment could possibly be accrued, much less paying the shop owner a decent living wage.

"In a survey of fees for service taken by the 'Hoosier Test Probe,' every TV service shop in Indianapolis was called. Data was taken from everyone willing to cooperate."

The survey disclosed the following average charges:

Home TV service calls—$4.21 per call.

Labor charges for minor repairs, shop service—$2.70 per job.

Labor charges for major repairs, shop service—$8.97 per job.

Labor charges for radios brought to the shop—$2.29 per set.

Car radio service requiring bench work—$2.99 per set.

Pull and re-install car radios— $3.18 per job.

Labor charges to repair and adjust 3-speed record changer—$4.29 per job.

Recently a successful service dealer, commenting on the financial distress of a couple of his compeers, said, "You cannot run a discount operation on service and stay in business. Service dealers have been affected by the spiraling cost of living and doing business just like everyone else. It costs more money to do business today than it did five years ago. Average cost figures for providing TV service in the home five years ago were about $4.50 per call. These were *average* costs of efficient service business operations that had enough volume to keep their technicians busy all the time they were on duty.

"In the past five years, there has been a fifteen to twenty per-cent increase in the cost of doing business. The dealer who fails to raise his charges in the face of these mounting costs is trying to run a discount operation. He just can't win. The economics of the situation will whip him."

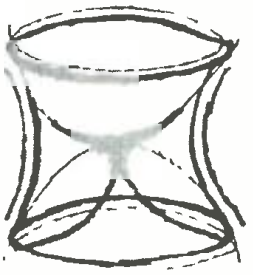
Last year Robert S. Geran, general service manager for the *Kelvinator Division* of *American Motors Corporation*, stated that "it costs $6.02 an hour currently in a typical large U. S. city just to keep a service man on the street." He said that cost included basic wages and fringe benefits, truck operating costs, and some overhead, with no allowance for special expenses or profits. Mr. Geran also pointed out that this cost was only $3.77 per hour ten years ago.

The latest chart covering Standard Labor Charges for Television Service and Repairs, compiled and published by Harold Chase, editor of the "TSA News," 16311 Grand River, Detroit, Mich., lists $5.00 for the first fifteen minutes involved in handling a home service call. After the first quarter hour, there is a charge of $1.50 for each additional fifteen minutes required to complete service on a set.

In the Indianapolis survey, only one-third of the shops reporting made a charge of $5.00 or more for home TV service calls. All of the rest were under $5.00 per call with a few reporting their charges as low as $2.00 per call.

Statistically, it is impossible to reconcile subnormal charges with a profitable service operation where the technician uses standard tubes and parts and charges the customer only for those required to complete the job. Performance records of a large number of service shops indicate that, under normal circumstances, an efficient technician can complete an average of forty home service calls in a five-day week, working eight hours per day and devoting his time exclusively to field service. At $5.00 per call, this average technician would produce a gross income of $200.00 per week from the sale of his time.

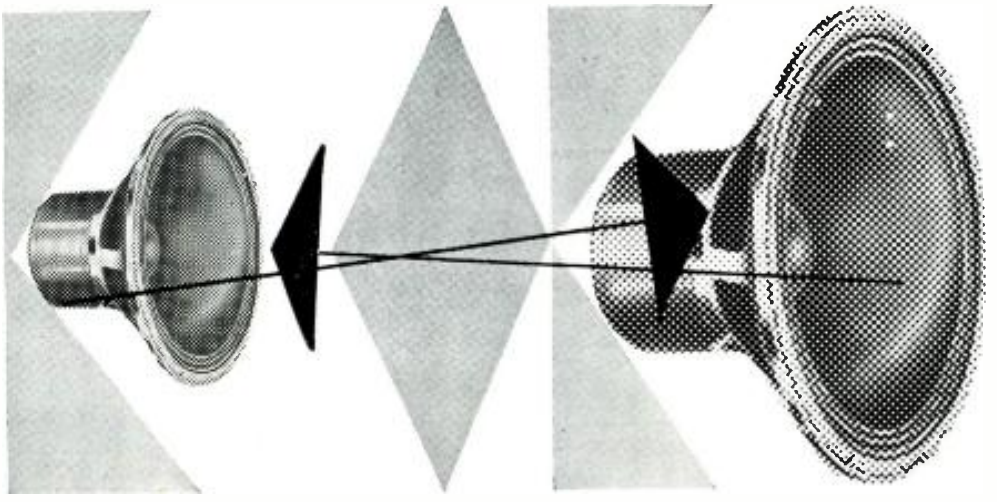
At current wage levels, the dealer would have to pay out a minimum of $125.00 per week in wages, taxes, fringe-benefit costs, etc., for this technician's time. Out of the remaining $75.00 per week he would have to pay the operating, maintenance, and depreciation expenses for the technician's car or truck, the premiums on the several liability and property-damage insurance policies he must carry, plus the advertising and promotional costs involved in maintaining a sufficient volume of business to keep the technician busy with an average of forty service calls per week.



In addition to these costs, the dealer must maintain all of the business machinery necessary for handling customer contacts, such as adequate and efficient telephone service, the service headquarters, and a substantial back-up stock of tubes, parts, and supplies. Considering all of the costs involved, the dealer would be extremely fortunate to break even on the income from a technician's time charged at $5.00 per call.

This analysis does not take into account the gross profit realized from the

(*Continued on page* 154)



Part 2. Constructing the Network

HI-FI Crossover Networks

By ABRAHAM B. COHEN & PAUL D. COHEN
Advanced Acoustics Co.

How to design and put together home-built precision networks for 2- and 3-way systems.

IN Part 1 of this article (in April 1959 issue), the principles behind the design of multi-speaker networks were generalized so that this article on the actual construction of the networks would not be interrupted by some of the more general thoughts concerning the application of networks. With the exception of the earlier reference to 6 db and 12 db attenuation per octave, a more complete treatment of the actual values involved in construction of a network was left for this part.

Now we must deal a little more specifically with this matter of the 6 db *versus* 12 db roll-off characteristic of the network to determine the source of the particular values chosen. These are not arbitrarily selected values—they are specifically related to the values of the choke or capacitor element that will provide a given crossover point for a given impedance.

Voltage Division at Crossover

By definition, the crossover point is that frequency where the drooping output of the low-frequency branch of the network crosses over the rising characteristic of the high-frequency branch (as indicated in Fig. 3 of Part 1). For a 6 db-per-octave network, the value of the capacitor in the tweeter branch and the value of the choke in the woofer branch are chosen to provide an a.c. impedance across those two respective elements, at the crossover frequency, which will be equal to the speaker impedance. Fig. 8 shows a simplified circuit of a two-way network with a low-frequency branch and a high-frequency branch, both tied across a common voltage source. Let us assume that the speakers are both 8-ohm units and that it is desired to design a network to cross over at 2000 cps. We will have to find an inductor and a capacitor that will each present an impedance of 8 ohms at this frequency. Having found such components (more details later on actually finding these) and inserting them in the network of Fig. 8A, we see that the voltage in the low-frequency branch has been equally divided across the choke and the woofer. In a similar manner, the voltage across the high-frequency branch has been divided equally between the capacitor and the tweeter. Consequently, the voltage across the woofer is equal to voltage across the tweeter. This is the crossover point where the drooping low-frequency characteristic crosses the rising low-frequency characteristic.

6 db/Octave Attenuation

Now we come to the matter of the octave rate of attenuation of these drooping and rising characteristics. Consider, first, the drooping woofer branch characteristic of Fig. 8A. If it a crossover frequency of 2000 cps the inductance in the woofer circuit is equivalent to 8 ohms, then at 4000 cps (one octave higher) this inductance will present a 16-ohm impedance since the impedance is directly proportional to the frequency. When this 16-ohm impedance is now considered in series with the 8-ohm woofer, Fig. 8B, then the voltage across the choke becomes twice that across the woofer. On a db basis ($db = 20\ log\ E_2/E_1$) a 2 to 1 voltage ratio becomes 6 db. Thus, *after the crossover point*, the voltage drop-off across the woofer progresses at a rate of 6 db-per-octave. Thus, if we go up another octave the choke impedance doubles again, going from 16 ohms to 32 ohms, while the woofer still remains 8 ohms. The voltage in the woofer branch, Fig. 8C, is now at a 4 to 1 ratio. On a db basis, a voltage ratio of 4 to 1 represents a *total* drop of 12 db or, again, 6 db over the previous octave.

The same analysis may be applied to the tweeter branch and it may be shown, in identical fashion, that the tweeter circuit capacitor, when necessarily chosen to be equal in impedance *at the crossover frequency* to the tweeter impedance will, *below* the crossover point, continue to roll-off at the gradual rate of 6 db-per-octave. So it is seen that the *automatic 6 db rate* of this type of network arises from the simple necessity of choosing reactive elements in the two branches to divide the voltages equally across the various elements in the circuit so that the individual speaker terminal voltages will be the same at the crossover frequency.

12 db/Octave Attenuation

In Part 1 we discussed the general method of pairing off a capacitor with an inductance in each speaker circuit to convert a 6 db-per-octave network into a 12 db system. While "pairing off" is the general procedure, the values to be used in converting from a 6 db to a 12 db network need some modification. Thus, if a choke had been originally selected to have an impedance of 8 ohms at the crossover frequency (and equal to the speaker impedance), then it would have to be multiplied by a factor of 1.41 when the systems were changed to a 12 db-per-octave network as indicated in Fig. 7 of Part 1. Similarly, the capacitance of the component which had been originally chosen for the tweeter circuit of the 6 db-per-octave network would have to be divided by a factor of 1.41 when the conversion is made. Once these new values have been determined by modifying the 6 db values, they may then be paired off to provide the 12 db network. Calculations similar to those in Fig. 8 may be made when using these revised values to plot out the network branch voltage which will drop at the rate of 12 db-per-octave *after the crossover*

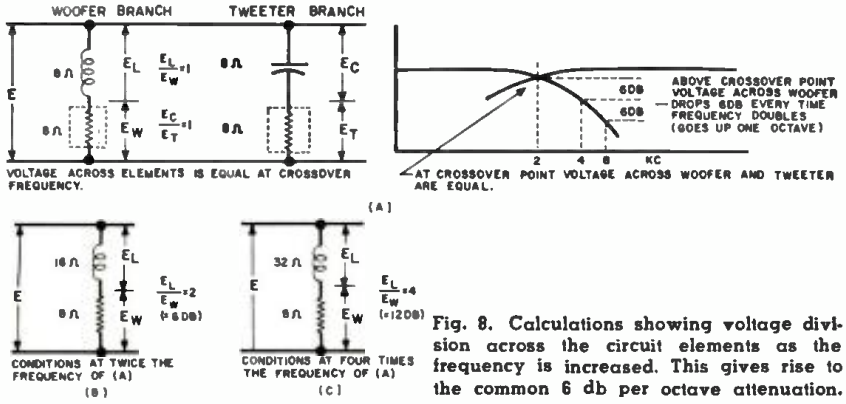


Fig. 8. Calculations showing voltage division across the circuit elements as the frequency is increased. This gives rise to the common 6 db per octave attenuation.

point when going in either direction.

Inductance Variables

It may seem that we put the "cart before the horse" in giving details on how to convert from a 6 db to a 12 db-per-octave network before we had discussed how to select the simple values for the 6 db network. However, since we had treated such conversion last month as part of the general philosophy of network design, it was deemed logical to carry over that discussion in terms of "numbers" so that a transition might be made to the problem of selecting real values of inductances and capacitances for a particular network.

Of the basic elements found in the common network, the components such as capacitors and volume controls may be readily purchased, with the inductors not so widely available. However, this should prove no obstacle to the man who wants to build his own network. Invariably all instructions for building these chokes are predicated on "air-core" (non-magnetic core) design, for two reasons: first, air-core chokes completely eliminate distortion due to iron saturation and, second, laminations of a quality good enough for audio chokes are not easily obtained by the average home constructor. Wooden dowels, Masonite, and wires are, however, readily available.

Easy as it is to build a choke, the initial design is far from simple. We cannot simply say that so many turns of wire constitute a given inductance. As a matter of fact, a given number of turns may yield widely different values of inductance depending upon the manner in which the turns are wound. The total inductance of a coil depends on the geometry of the coil. A long one-layer solenoid will have a far different inductance than a flat pancake coil of the same number of turns simply because the flux linkages of the various turns in one case are completely different than in the other. Even after having started with one given coil configuration, it is not a simple matter to guess what inductance a similar coil of more turns would be. It is true that, in general, the inductance is proportional to the square of the number of turns, but there are additional factors involved that determine the final inductance of the coil. For the purpose of this discussion, the inductance formula as derived by Maxwell was used in calculating the inductance characteristic of the coil.

Building the Coil

The practical reader need not become discouraged nor distressed at this point. The calculations have all been accurately carried out and checked on an actual model so the constructor may use these inductance values "as is." *All he need be concerned about is the desired crossover frequency and the speaker impedance of his system.* Chart 1 (on the fold-out page) supplies the basic details he needs to know about building the coil. These details include not only the number of turns, but the number of layers of wire, and, most important, the weight of the wire. It is discouraging to go out and buy a quantity of wire for an inspired evening of coil winding and then discover that you are short of wire.

Although Chart 1 provides all of the practical details for making the coil for any given impedance and for any given crossover frequency, we have included another chart for the purist who still wants to know the inductance of his coil. If one were truly ambitious, he could wind one master coil with several taps along the depth for experimental purposes. Charts 1 and 3 give the actual curves of an experimentally checked master coil wound of #18 enamel wire on the coil form shown on the chart page. Along the abscissa are four scales: first, the number of layers, then the number of turns, then the pounds of wire that are necessary for a given inductance, and finally the coil depth. The coil form is made with a 1" wooden dowel as the core and the end pieces of hard ¼" Masonite. A series of ⅛" holes were drilled along a radius of one of these end pieces so taps could be brought out anywhere along the depth of the coil.

It is recommended that care be taken to insure that the coil is layer wound rather than random wound. Not only will there be considerable satisfaction in seeing a job well done but, what is more important, the final value of the coil will be more nearly correct for a given number of turns. Layer winding of the coil will be facilitated if separators of heavy fish paper or several layers of masking tape or sealing tape are interposed between every two layers of windings. Thus there will always be a comparatively smooth surface for the subsequent layers. It is suggested that the end Masonite pieces be secured to the center dowel by means of a brass bolt at least 2" long. This will permit the end of the bolt to be inserted in the chuck of a hand drill. The drill may then be held secure in a vise and the coil form slowly turned while the wire is guided onto the form by the drill handle.

Using Chart 1

Chart 1 gives the details of the coil configuration for any desired frequency and speaker impedance. Choose the speaker impedance on the vertical scale, move over horizontally to the curve which represents the desired crossover frequency, and then move down to the horizontal scale which gives *all* the vital statistics on the coil for the conditions selected for a 6 db-per-octave network.

To use Chart 1 for 12 db-per-octave networks multiply the value of the speaker impedance by 1.41 and proceed as above. This, in effect, increases the inductance value by 1.41 times, a requirement for a 12 db-per-octave network.

The corresponding capacity to go along with the chosen inductance is easily determined. One may make a simple calculation of capacity by using the formula: $C = 1/2\pi f X_c$ where f is the crossover frequency and X_c represents the reactance of the capacitor chosen to be equal to the speaker impedance at the crossover frequency. C will be the capacity required for the tweeter branch. Alternately, Chart 2 may be used to pick off the actual capacitor value for a given impedance at a given frequency. Here, again, as in the case of the coil, the value found for the capacitor is for a 6 db-per-octave network. For a 12 db-per-octave crossover, divide the capacitance value obtained by 1.41.

Typical Three-Way Network Parts

The very important matter of the type of capacitor to use deserves individual treatment, but consideration of this point will be deferred to the last so that we may illustrate the actual selection of component values for a typical three-way system. Let us assume an 8-ohm system with a crossover at 300 cps between the woofer and the mid-range and an upper crossover at 5000 cps between the mid-range and the tweeter. This system was shown in Fig. 7 of Part 1. The choke for the woofer is selected from Chart 1 by coming in from the 8-ohm point (speaker impedance) on the vertical scale to the 300 cps curve and then down to the horizontal scale where it is indicated that very nearly 16 layers (or 500 turns) of wire will be required on the coil form, that just under one pound of wire will be needed, and the

(*Continued on page* 55)

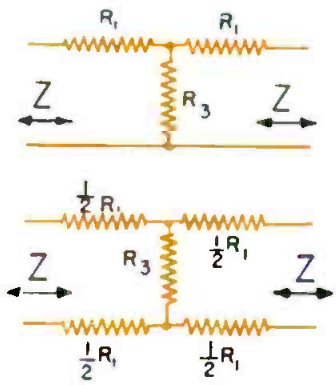
SYMMETRICAL T AND H ATTENUATORS

A nomograph for designing symmetrical attenuators when the terminal impedance and required loss are known.

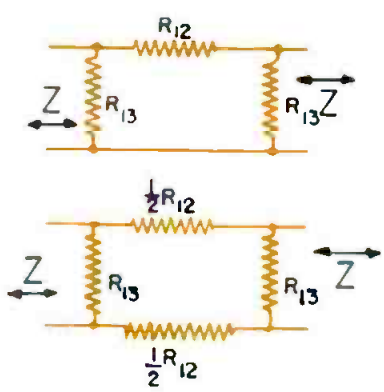
A straight line through "Decibels for R_1" and "Impedance" gives value of R_1. Another line through "Decibels for R_3" and "Impedance" gives value of R_3 for T and H attenuators. Example shows design of a 500-ohm attenuator with a 5-db loss. The value of R_1 is 140 ohms and that of R_3 is 822 ohms.

For symmetrical π and O attenuators, the nomograph is used to determine values of R_1 and R_3. The values of R_{12} and R_{13} are then given by the following equations:

$$R_{12} = Z^2/R_3 \qquad R_{13} = Z^2/R_1.$$



T AND H ATTENUATORS



π AND O ATTENUATORS

Courtesy of Federal Telephone and Radio Corp.

CHARTS

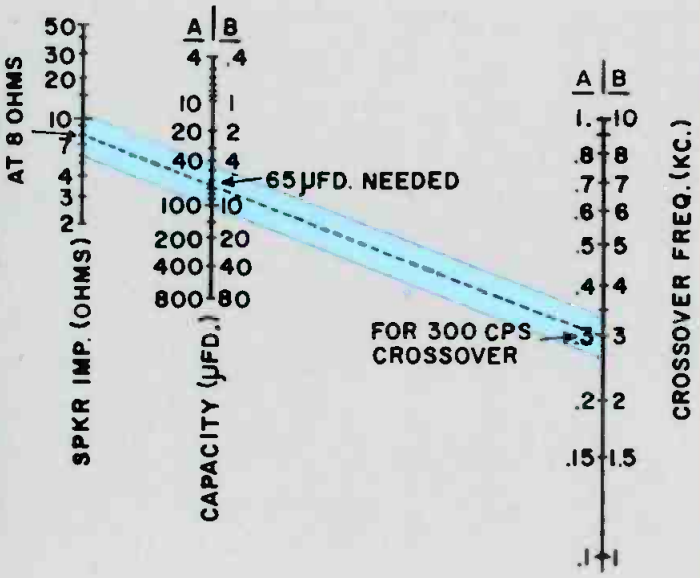
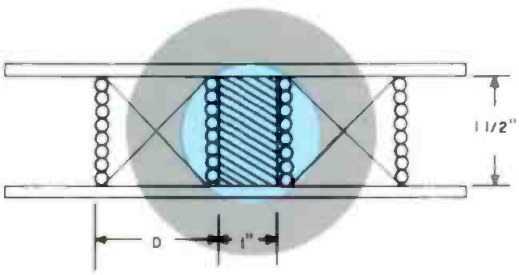
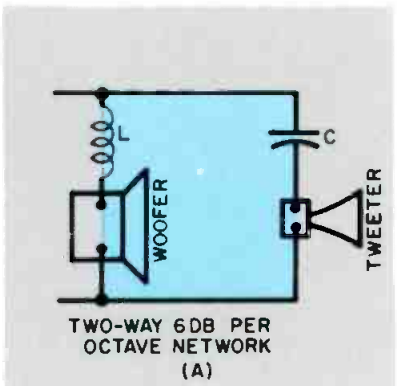


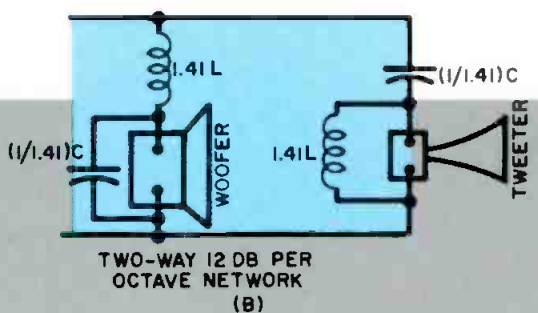
Chart 2 (Left). Auxiliary chart to be used in conjunction with Chart 1 for determining the value of capacity needed to cross over at a given speaker impedance. To use chart, simply lay a straight edge between the point on the first column representing the impedance of the speaker and the point on the last column representing the crossover frequency desired. The point where the straight edge crosses the center column is the value of capacity required. Be sure to use the two columns marked "A" together, or the two columns marked "B" together. This chart is to be used for a 6 db per octave network only. In order to obtain capacity values for a 12 db per octave network it is only necessary to divide the value of capacity obtained by 1.41. For the lower values of capacitance, oil-filled capacitors are preferred. For the higher values, electrolytics are employed.

Chart 3 (Below). The actual inductance values of network chokes used in the master Chart 1 are given here. This chart makes it possible to wind coils of given inductance if the construction details shown along the bottom axis and in the drawing at the center of this page are followed. Inductance values from about .03 up to 20 millihenrys are covered here.

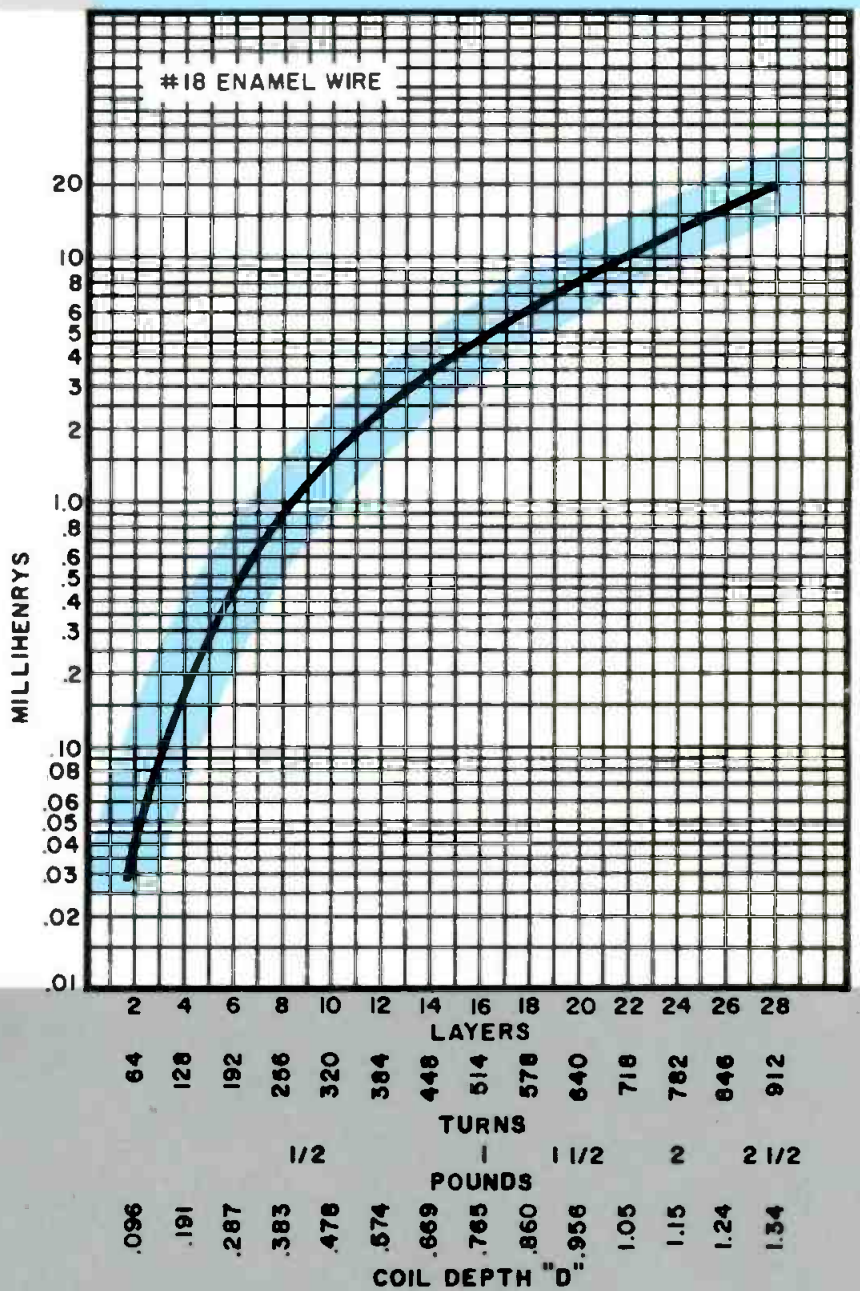




TWO-WAY 6DB PER OCTAVE NETWORK (A)



TWO-WAY 12 DB PER OCTAVE NETWORK (B)



HI-FI CROSSOVER NETWORK DESIGN

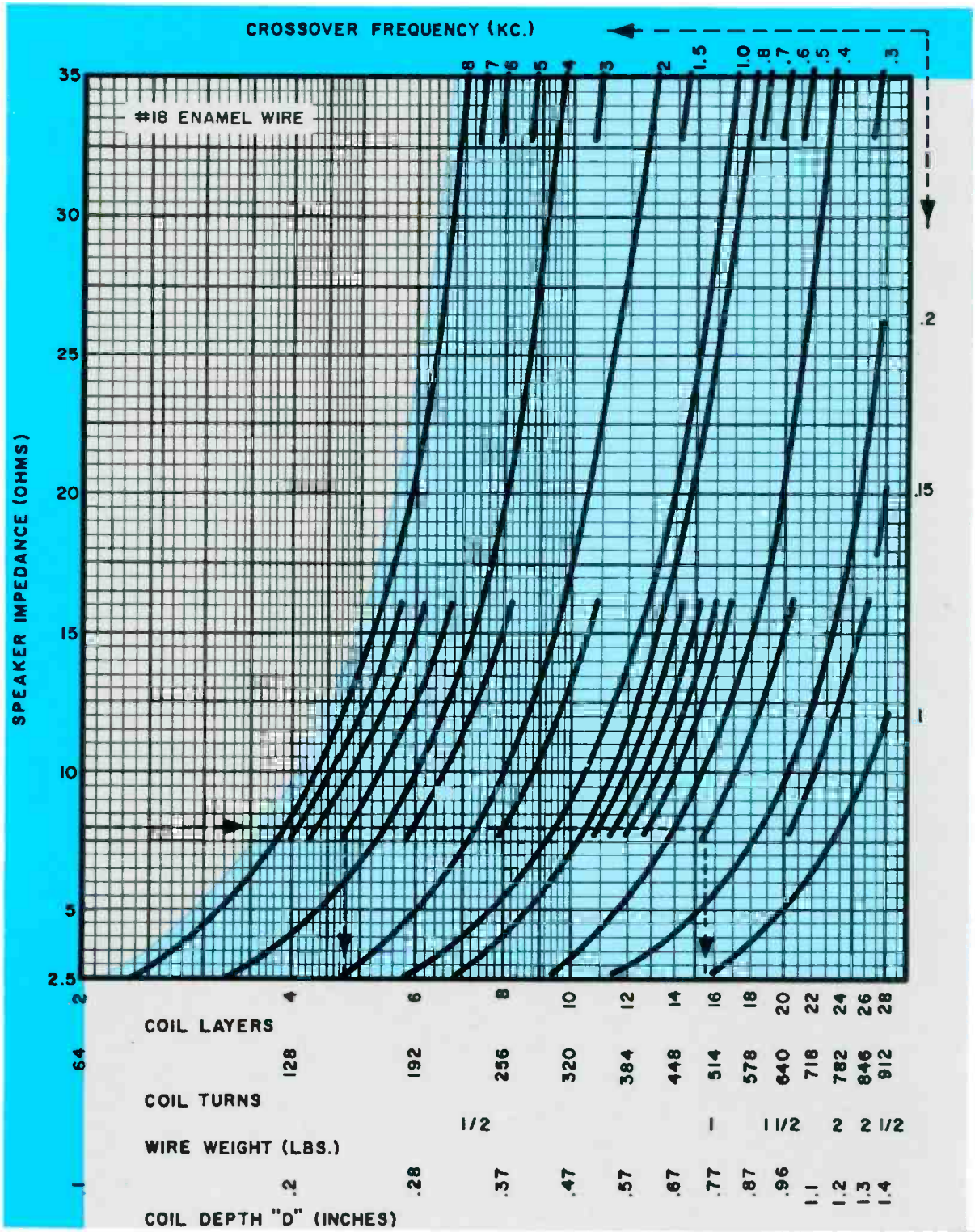
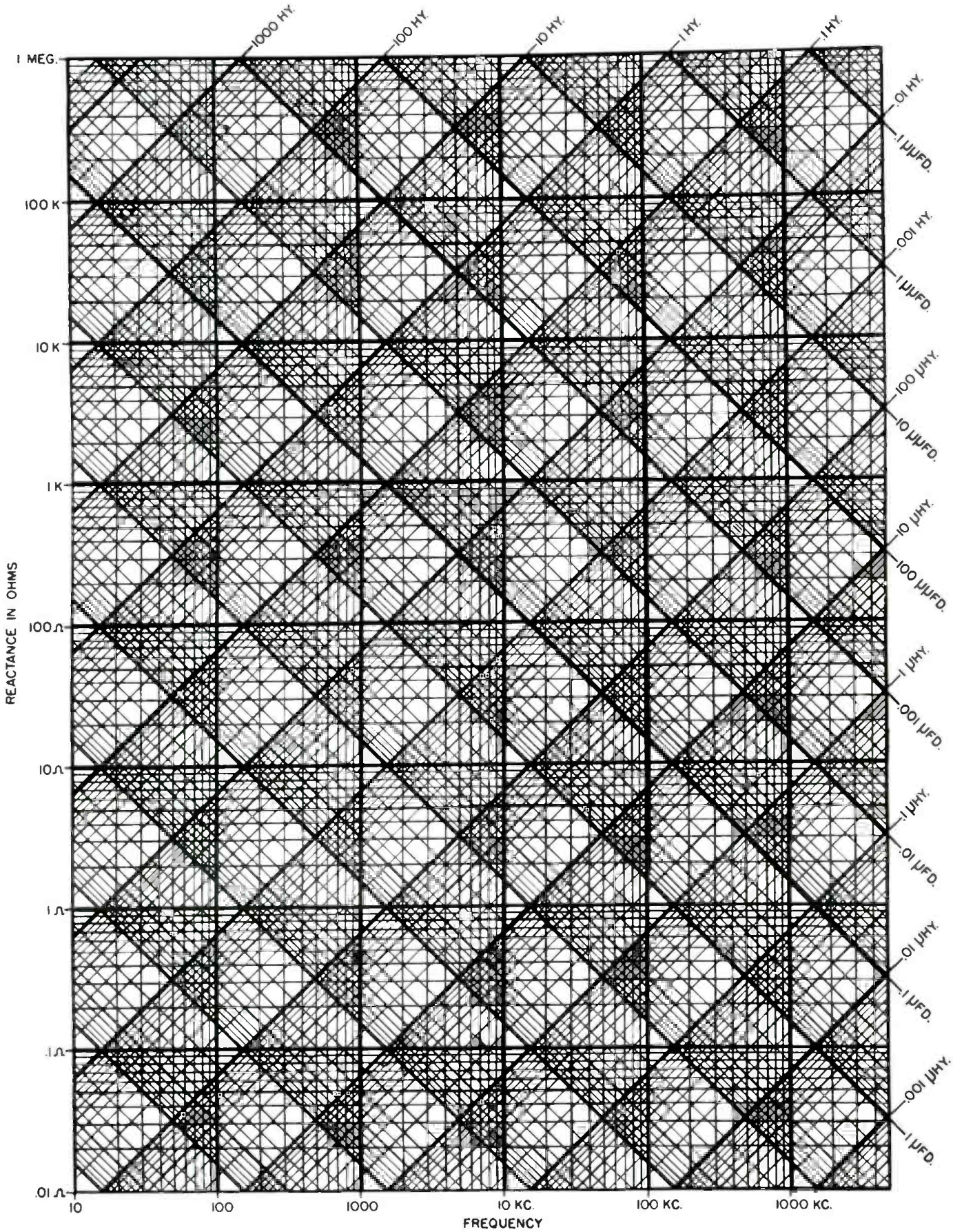


Chart 1 (Above). A master chart giving all physical winding data for crossover network chokes based on speaker impedance and desired crossover frequency. Choose the speaker impedance on the vertical scale, move over horizontally to the curve which represents the desired crossover frequency, and then move down to the horizontal scale which gives all the vital statistics of the coil needed for the chosen conditions for a 6 db per octave network, shown in circuit (A) to right. To use chart for 12 db per octave network, circuit (B), simply multiply speaker impedance by 1.41 and proceed as above. The physical make-up of the choke coil that is employed must be as shown at the center of this page.

Formerly RADIO & TV NEWS
ELECTRONICS WORLD

REACTANCE CHART



coil depth will be approximately ¾". This is all the information required for winding this woofer circuit coil.

Now, the low-frequency blocking capacitor of the mid-range circuit will have to be equivalent in impedance to the speaker at the 300 cps crossover frequency. From Chart 2 the value of this capacitor turns out to be 65 μfd.

Moving to the upper crossover frequency of 5000 cps, the high-frequency limiting choke in the mid-range circuit should have an impedance of 8 ohms at this frequency. Again from Chart 1, we select 8 ohms on the vertical scale, move horizontally to the curve representing 5000 cps, then vertically down the horizontal scale where we find that the coil will consist of 5 layers of wire (160 turns), will utilize approximately ¼ pound of wire, and will be about ¼" thick. The corresponding tweeter branch capacitor at this crossover frequency point will also have to have an impedance of 8 ohms and from Chart 2 this turns out to be 4.2 μfd. (call it 4). Thus all the details for winding the coils and choosing the right capacitor values are readily available if you know the speaker impedances and the desired crossover frequencies.

To convert this network into the 12 db system shown in Fig. 7D, Part 1, the inductance values of the chokes should be multiplied by 1.41 and the capacities divided by 1.41 and then paired off as previously described.

Type of Capacitors

We must now discuss the controversial question of the type of capacitor to be used in audio dividing networks. It has been generally conceded that one can't go wrong if he uses good oil-filled or paper capacitors. However, there is the matter of cost for such units. A 60 μfd. capacitor, even one rated at comparatively low voltage, may not fit one's pocketbook as well as it does the network data. This problem has been overcome in commercial equipment by using non-polarized electrolytic types where large capacities are required. These are comparatively cheap but they do have their shortcomings. In practice it has been found that the actual capacity of a batch of electrolytics, all rated the same but measured at the higher frequencies, may vary by as much as 25 to 30% from the rated value. In some instances it has also been found that the impedance of the non-polarized electrolytic may climb at the very high frequencies causing a tweeter loss.

This latter loss may be easily overcome by shunting the electrolytic with a small paper capacitor, 1 μfd., for example, which will serve to keep the impedance of the capacitor section of the tweeter branch low at the high frequencies. The earlier question of the capacity variations is a more ticklish one. It is not generally possible to measure capacity before the capacitors are purchased. The next best thing is to buy two or three capacitors of the nominal rating and to select from these the one that comes nearest to the required impedance at the desired frequency. To make such a selection means, of course, the use of an audio oscillator, a voltmeter, and a potentiometer. With these items, an impedance substitution test may be made to determine which capacitor comes closest to the required value. It is desirable to choose one that is a little low in value since, if required, the value may be brought up to the proper capacity by shunting it with a small additional capacity which will aid the very high frequencies.

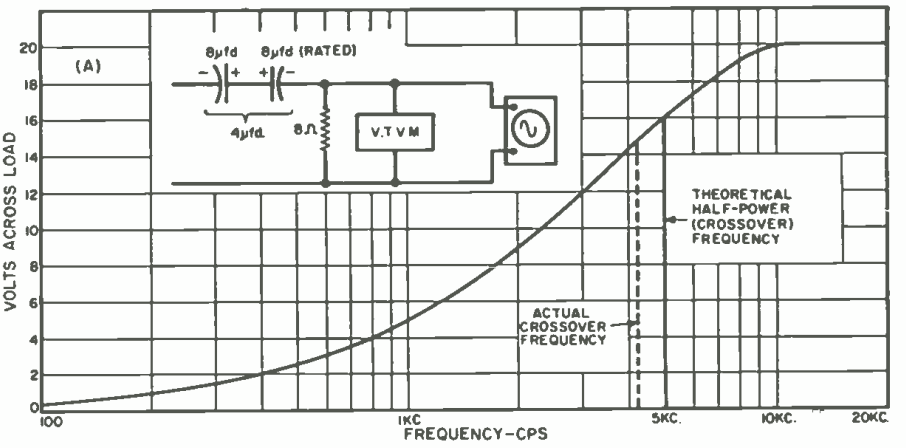
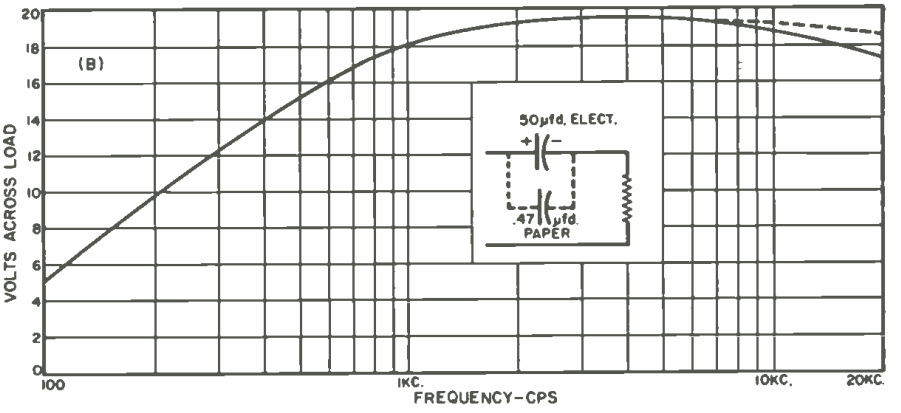


Fig. 9. Transmission curves of back-to-back or non-polarized (A) and polarized (B) electrolytic capacitors for maximum undistorted power transfer. Refer to the text.



Such closely controlled electrolytics have been successfully used in commercially available networks for many years and they have withstood the element of time very well. They have, however, been of the non-polarized variety, such as the motor-starting type. The hobbyist has had equivalent success by putting two electrolytics of the polarized type "back-to-back" to provide a non-polarized capacitor.

Recently there has been discussion on the use of the simple polarized type of electrolytics for these audio networks and the writer approached the problem with some trepidation. On the surface, it seemed heretic to use a polarized element in an audio circuit that was to pass alternating waveforms unmarred and untarnished. However, in view of the fact that all these doubts could be resolved by definitive measurements, an analysis was made of the operation of polarized electrolytics and non-polarized electrolytics from the standpoints of reactance change, waveform distortion, and power transfer. The basic facts that were being sought were those concerned with the manner in which the waveform was passed through either type of electrolytic, the voltage rating of the capacitor, and the power to be passed on to the load by the capacitor. Tests were made at both low-level power and at high-level power with waveform and amplitude distortion observed on a scope over the entire audio spectrum.

The non-polarized variety, made by backing up two standard polarized 8 μfd., 450-volt electrolytics, was tested first. A test run was made from 100 to 20,000 cps feeding this combination into an 8-ohm load resistor. Since these two 8 μfd. capacitors were connected in series back-to-back, their resulting capacity was 4 μfd. This value of capacity has a reactance of 8 ohms (to match the load at crossover point) at approximately 5000 cps. Under these conditions a frequency run was made of the maximum *undistorted* voltage that appeared across the 8-ohm load resistor, starting at 100 cps and proceeding to 20,000 cps. The output voltage of the amplifier was continually adjusted to give the maximum amplitude clean waveform at the load resistor, as seen on the scope. The plot of this run is shown in Fig. 9A. At the approximate crossover point, 5000 cps, there was the equivalent of 30 clean watts delivered to the load resistor,

(*Continued on page* 129)

By **JERRY B. MINTER**
President, Components Corp.

Here is how the "Electronics World" stereo-monophonic test record was made and how you can get the most from it.

Making & Using a Stereo Test Record

IN the past it has been customary to use frequency records for testing the frequency response of phonograph pickups.

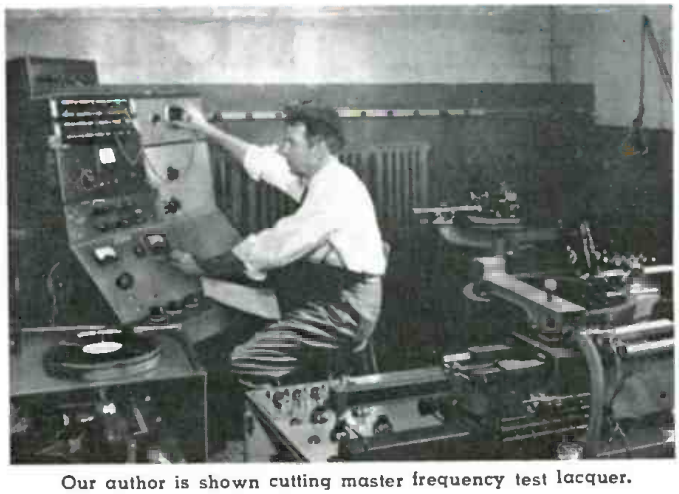
These records are lateral cuts of either stepped frequency tones or slowly varying (gliding pitch) tones. They may be made without pre-emphasis of the higher frequencies, in which case they are called "constant velocity"; or pre-emphasis may be included according to the RIAA curve for check of playback system equalization. Usually the pitch of the tones is identified by voice announcements or by bands on the disc between each tone. A standard reference level of 1000 cycles-per-second is usually recorded at the beginning for setting level (adjusting volume control).

In order to make certain that the master record has been properly cut, measurements of the recorded velocity can be made optically, as shown in the photograph on the opposite page. The wider the reflected light pattern, the greater the velocity and the louder the recorded tone when played back.[1]

Side B

A lateral frequency record can be used for measuring stereo as well as monophonic pickups. To facilitate the use of ELECTRONICS WORLD's test record No. 1, Side B for testing stereo pickup equalization, the tone bands have been divided into two groups: the first group of frequencies is recorded at the highest level which is tolerable for reliable tracing of 15,000 cycles. The tones below 1000 cps are recorded at a higher level to prevent masking, at the lower frequencies, by the presence of turntable rumble, hum, and surface noise. One-kilocycle reference tones are included prior to the start of each group for proper adjustment of level (volume).

It is possible to make rough measurements by listening to the output from the speaker when the test record is played, but variations in room acoustics, placement of the loudspeaker, non-uniformity of human hearing, and many other variables reduce the accuracy of this approach. It is far better to use some sort of output indicator such as an oscilloscope, a.c. vacuum-tube voltmeter, or other a.c. voltmeter connected across the speaker leads (voice coil). Such a direct electrical connection eliminates room acoustics, etc. and permits the use of a lower output level without errors introduced by the variation in sensitivity of the ear at these lower levels (so-called Fletcher-Munson effect).



Our author is shown cutting master frequency test lacquer.

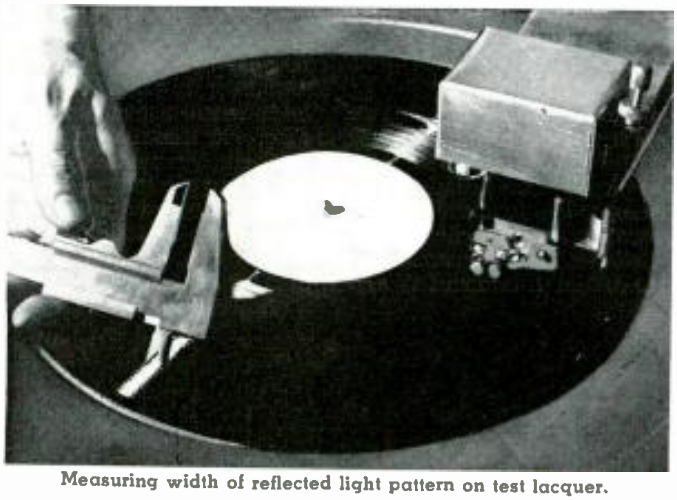
The wide popularity of electronic kits has resulted in the home construction of many instruments—many of which will serve nicely as output indicators. Almost any city block is sure to have one or more kit builders who would be willing to "oblige" if you have no equipment of your own. If such is not the case, however, the simple arrangement shown in Fig. 1 can be used for indication of output. The few parts can be purchased for less than a dollar at most

radio parts supply houses. No special tools are required to connect these parts together. In operation this simple "lamp comparator" utilizes the fact that the human eye is an accurate instrument for comparing the relative brilliance of two bulbs. The reference lamp is operated from a battery at reduced voltage (moderate red color). The volume control of the amplifier is adjusted slowly upward from zero until the output lamp is the same brilliance as the reference lamp when the 1000-cps reference tone at the beginning of Band 2 of the test record is played. While the various subsequent tones are played, the lamp should remain at approximately the same relative brilliance throughout the first group (down to 1000 cps); then the volume control must be reduced and reset on the next reference tone to prevent possible burn-out of the lamp as the level increases on the low-frequency group. Each stereo channel should be tested in sequence. (Note: Turntable rumble, hum, and surface noise may make it difficult to use a lamp or an output meter for the frequencies from 15,000 cps down to 1000 cps. In such cases, a listening test or the use of an oscilloscope is mandatory.)

If the equalization for each stereo channel is set at "RIAA" and the lamp or other output meter indicates a non-uniformity of output, the treble control can be used to correct for the higher frequency group, while the bass control can be used to correct for the lower group.

If the frequency response is not perfectly uniform, satisfactory stereophonic reproduction may be obtained, if the two channels are approximately balanced in response. For this purpose, each lamp can be connected to the output from each respective channel and the two channels thus compared for relative frequency response. The brilliance of the lamps should vary a minimum amount and in unison.

If an oscilloscope is used as the output indicator, the observed waveshape should be sinusoidal. A departure from sinusoidal shape at the higher frequencies may indicate a defective stylus or insufficient tracking force (weight). At the lowest frequencies a departure from sinusoidal may indicate improper damping of tonearm resonance. If an oscilloscope is not available, the purity of the reproduced tone or lack of tonal color will serve as an indication except at the frequencies above 5000 cps. Above 5000 cps the human ear does not detect small departures from sinusoidal response on *single* tones.



Measuring width of reflected light pattern on test lacquer.

Fig. 2 indicates a method of using three flashlight lamps to indicate relative output. The center lamp is connected to the speaker terminals and the volume control of that channel is adjusted on the 1000-cps reference tone until the center lamp is midway in brightness between the other two reference bulbs. The ratio of power applied to the two reference bulbs is approximately 6 decibels—a commonly used measure of relative loudness as perceived by the human ear--thus the system will be flat to within ±3 db if the center lamp brilliance remains in between the two reference lamps while the different tones are played on the test record. A system which is flat within 3 db electrically will be more uniform than the acoustical output of most loudspeakers in common use.

A serious deficiency in response at the higher frequencies accompanied by fuzzy tones (rough, raspy tones) may be caused by a worn or dirty stylus assembly. See the next section on the use of the stylus test bands (Bands 1 and 3).

On the same side of this test record there are two stylus wear test bands. These bands are recorded with a 1000-cps tone at approximately 7 cm/sec. velocity. The outer band (Band 1) should sound pure and clean (without tone color) when played with an LP stylus at 33⅓ rpm. If the inner band (Band 3) sounds fuzzy or rough by contrast, it is likely that your stylus tip is worn or flatted. If neither band sounds pure (free from harmonics) have your stylus inspected at once. If inspection indicates that the stylus is not flatted and it has a tip radius of 1 mil or less, have your cartridge checked. Sometimes foreign particles will partially fill one of the gaps in a magnetic cartridge and create serious distortion. These particles can usually be removed with a soft brush. Cellulose tape can also be used to pick magnetic particles out of the gap. Simply fold a small piece of the tape, with the sticky surfaces outward, and insert in the gap. All dirt and other particles will cling to the adhesive surfaces.

A poorly centered stylus moving system can also cause distortion. In certain pickups having damping blocks on either side of the stylus armature, inspect both blocks for rigidity. If one of the blocks is loose, asymmetrical damping results—and considerable distortion. Application of a minute quantity of Pliobond or other suitable cement will usually secure the damping block.

In cartridges using a trailing cantilever arm for attachment of the stylus to the moving system, it is sometimes possible that the trailing arm is displaced to one side. If this arm does not line up (tangent) to the grooves at the center of the record, distortion will result on the inner band. Inspection of the pickup resting in the groove will disclose any such misalignment. In most pickups realignment of this cantilever arm must be done at the factory.

Close-up view of the master recording lathe that was used.

The recorded level of the stylus test bands is such that there should be no difficulty in tracking the outer band with a monophonic pickup while the inner band can be tracked if there are no large flats on the stylus. When testing stereophonic pickups an additional factor must be considered—the vertical response. To minimize distortion from this factor it is suggested that the two pickup leads be connected in parallel, as shown in Fig. 4. Connecting the stereo pickup leads in parallel should also be done when playing monophonic records in order to minimize the distortion which would otherwise result from the vertical "pinch-effect" component of groove modulation.

Side A

The record industry has standardized placement of the right and left channels with respect to the groove as fol-

lows: the left channel will always be recorded on the inner wall while the right channel will always be recorded on the outer wall of the groove.

The first band on Side A has channel identification tones to make certain that the left channel is connected to the left speaker and the right channel to the right-hand speaker.

If the channels are reversed, merely interchange the speaker leads from the amplifiers. Interchanging the pick-up leads will, of course, provide the same result.

The second band has a metronome beat recorded on it. When played through a stereophonic system, the source of the sound should appear to come from half way between the two speakers. A slight differential gain (volume) adjustment may be required to accomplish this illusion. In order to make this test, the speakers should be placed several feet apart and the listener should stand equidistant from each speaker (in front, of course) about the same distance as the speaker spacing.

The third band is a phasing test. A low-pitched tone (100 cycles) is recorded first in-phase on both channels and then out-of-phase. If your speakers are properly phased, the first tone should appear louder than the second. If the relative loudness of these two tones appears reversed, try reversing the leads to *one* of your two speakers and repeat

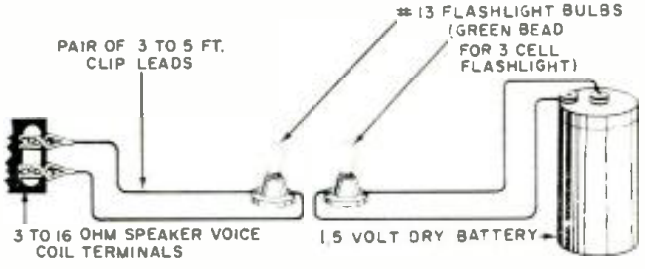


Fig. 1. Simple lamp comparator as is discussed in the text.

the test. Reversing one of the speaker leads will of course reverse the phasing between the two speakers by 180 degrees.

In order to record this phasing test, it was necessary to cut the first 100-cycle tone laterally (no vertical or difference component) while the second 100-cycle tone was recorded vertically (no lateral or sum component). In the event a definite phasing check cannot be made on the system, it would be well to test the pickup and amplifier as follows: connect the amplifiers as shown in Fig. 3 and leave the volume and balance controls as set previously on the metronome test. A definite difference in loudness between the two 100-cycle tones will indicate proper operation of the pickup and two amplifiers. This leaves the possibility that the trouble may be in the dissimilarity of the two loudspeakers or their placement in a particular room. Relocation of the two speakers or at least a reduction in spacing may effect a marked improvement. A compromise with room acoustics should permit satisfactory phase results after relocation of the speakers.

On the other hand, a failure to obtain appreciable difference in relative loudness between the two 100-cycle tones with the connection of Fig. 3 is indicative of either a defective pickup or some differential phase error in the two amplifiers. The amplifiers can be cleared by connecting them according to Fig. 4. Here the two stereo pickup leads are paralleled as for playing a monophonic recording and connected to either of the two amplifiers. Failure to obtain a marked difference between the two 100-cycle tones with the connection of Fig. 4 places the difficulty directly in the pickup cartridge. Before discarding the cartridge, try shorting the two hot terminals of the cartridge together right at the base of the cartridge. This eliminates defective connecting leads from the cartridge to the amplifier as a possible cause of the trouble. If there is still no appreciable difference in the two tones, the cartridge should be returned to your dealer for service and repair.

The fourth band on Side A is provided for testing turntable rumble. Monophonic recordings are more tolerant of turntable rumble since only the lateral vibrations of the turntable are involved. Stereophonic 45/45 disc recordings are equally sensitive to vertical and lateral rumble and many older type record changers have far too much vertical rumble to be satisfactory for stereo applications.

The rumble test band (the last band) has several reference tones at 100 cycles, which are recorded in successively lower steps, as an aid in judging how well your particular turntable is performing. The first tone is recorded at −20 db down from standard level (7 cm/sec. at 1000 cps). Almost any turntable should have a residual rumble of less than −20 db.

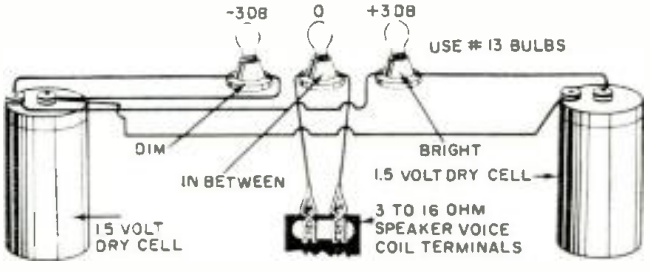


Fig. 2. A somewhat more accurate lamp output meter is shown.

The next rumble reference tone is at −30 db, then one at −40 db, and finally one at −50 db. A record changer in good working order should have rumble about −40 db. Only the better grade turntables will be better than −50 db. This special test disc was recorded on a Hydrofeed® lathe to insure the lowest possible rumble level. Residual rumble on this lathe is better than −70 db.

When making rumble tests do not confuse stray hum pickup with rumble. One method of differentiating between stray hum and rumble is to lift the pickup arm slightly off the record surface and note whether the apparent rumble remains. Do not move the pickup away from the playing area since stray hum pickup (from the turntable motor in most cases) will vary with the position of the arm. Turning off the motor will usually reduce the stray hum field. Excessive rumble may mean that your turntable should be repaired. Note: When checking for rumble disregard high-pitched surface scratch and clicks.

After all of the above checks have been completed, one should have a fairly good idea of the performance of his hi-fi stereo or monophonic system.

REFERENCE

1. *"IRE Standards on Recording and Reproducing Methods of Calibration of Mechanically Recorded Lateral Frequency Records, 1958," Proceedings of the IRE, December 1958, page 1974.* —30—

Fig. 3. Method of using the phasing test as described above.

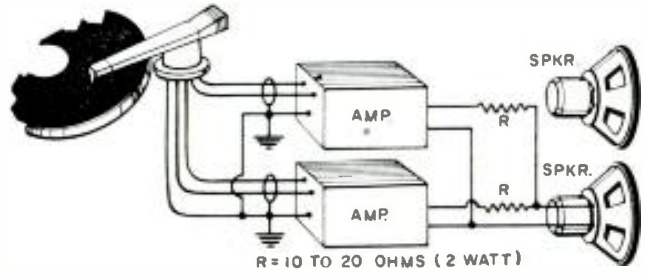
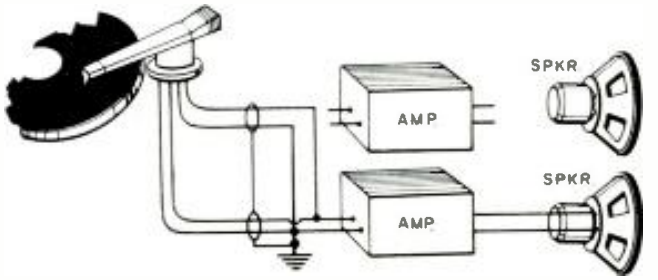


Fig. 4. This phasing check eliminates the amplifier from test.



Hi-Fi Product Test Report

ELECTRONICS WORLD

LAB TESTED

NEW RIBBON MICROPHONE

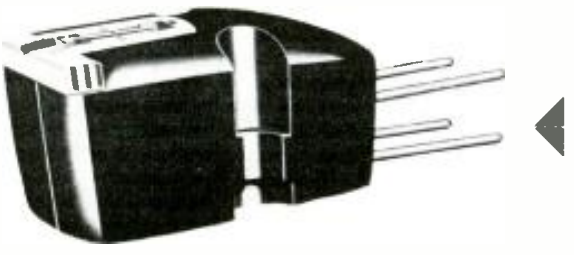
THE *Ercona Corporation* has just announced importation of the "Mark III" line of British-made *Reslo* studio microphones. Included in this line are various models with the differences being mainly in output terminating impedances.

Our particular interest, since they are all of the ribbon type, was in determining first-hand the durability of these microphones. There have been comments within the industry that ribbon microphones today are not as delicate as they were in years gone by. We tested one of the models, the CRH, which is designed for high-impedance output, by dropping it several times from a height of four feet directly on to a cement floor without it exhibiting any deleterious effects performance-wise. This obviously backs up the many comments we have heard. In the event that the ribbon element is damaged, the ribbon cartridge is detachable and replaceable.

Although these microphones are designed for p.a. applications as well as studio or home recording, care should be taken when used outdoors. The adverse effects of a strong blast of air against the ribbon still remain a problem. In the case of this microphone, however, the ribbon is shielded by nylon and wire-cloth screens and the perforated shell. Proper rotation of the microphone will, of course, alleviate part of this difficulty.

According to the manufacturer, the frequency response of this microphone is basically linear from 20 to 15,000 cps. Its characteristics are bi-directional but this may be altered by use of internal pads. Its bi-directional effects vary with frequency: at 1 kc. it has 2 db more sensitivity in front and at 10 kc., 20 db more. This feature can be used to advantage since the rear can be employed for low-frequency pickup and the front for the higher frequencies. The output level is −58 db. Although our tests were limited (as we did not have an anechoic chamber available), we feel quite confident that these microphones are entirely suitable for top-quality applications.

Prices, depending on the model, range from $64.50 to $84.95, audiophile net.



HIGH-COMPLIANCE SPEAKER SYSTEM

FOR those who are interested in a compact, high-compliance speaker system, we would like to call attention to *Allied Radio's* "Knight" KN-2000. The system incorporates a specially designed 12-inch woofer, an 8-inch mid-range unit, and an exponential-horn-loaded compression high-frequency tweeter. The enclosure is fully sealed and lined with acoustic material. All three speakers are fed by a three-way crossover network with an externally operated control to adjust the high-frequency level. The system has an input impedance of 16 ohms and will handle 20 watts average power. It is a compact unit measuring 13⅞" x 26⅜" x 12¾" and is available at a cost of $84.50.

The speakers used in the "Knight" KN-2000 system have obviously been made especially for this unit. The woofer seems to be extremely well designed with a long-throw voice coil and, as is usual with units of this type, it has an extremely low resonance frequency—approximately 38 cps unmounted. The mid-range speaker seems to be a fairly conventional unit except that the basket is a complete solid enclosure around the cone, producing a hermetically sealed chamber. The tweeter appears to be a conventional type.

The over-all response is quite smooth, particularly at the low-frequency end. The system does not have the exaggerated bass that can be found in some bass-reflex type speaker enclosures which, incidentally, some people may prefer. Audibly, the system seems to take hold at about 55 cps and extends at the high end beyond this reviewer's limit of hearing.

To be extremely critical we did note a slight attenuation of response between 100 and 200 cps and at approximately 2000 cps. Again, only a very critical ear could determine this and then only by A-B testing against another speaker unit known to be flat in this range.

Another point of importance concerns the efficiency of the speaker system. Normally, high-compliance units go hand-in-hand with low efficiency. Apparently, and justifiably, *Allied* has compromised in this case since the efficiency of the system was not as low as was expected.

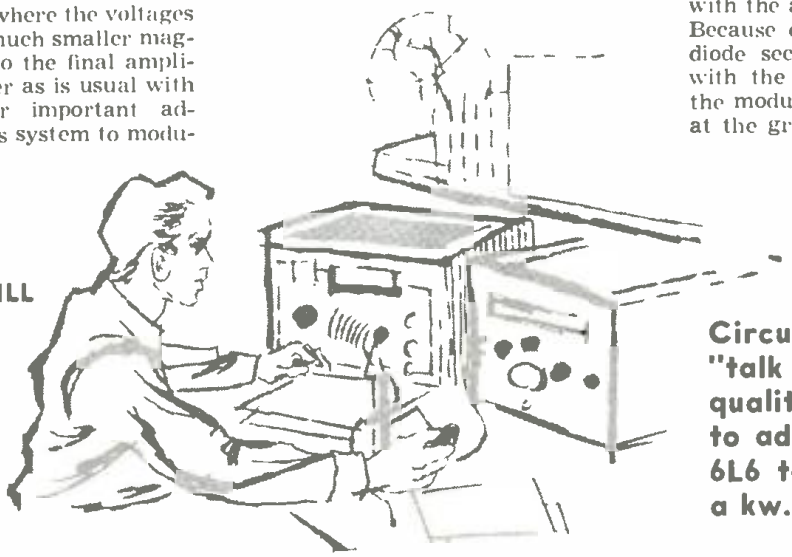
STANTON STEREO "FLUXVALVE" PICKUP

STEREO cartridges are still coming in at a high rate. We have four on the bench now awaiting our tests. The most recent one checked is the *Pickering* Model 371 "Fluxvalve." It is a moving iron magnetic type and is an improved version of a previous model. The pickup has a .7 mil diamond stylus and is recommended for use with a tracking force of three to six grams. Our tests showed that it has uniform response up to 3000 cps, dropping slightly by 1.2 db at 7000 cps, followed by a resonance that increases the output to +4.2 db at 12,000 cps. Response then drops off rather rapidly to 15,000 cps. The sharp rise is inherent in quite a few of the cartridges we have tested in the past and, according to *Pickering*, it is not detrimental since it is at the very high end. Actually, this

(*Continued on page* 153)

Low-Level Clamp Modulator

By
MARVIN L. GASKILL
W2BCV



Circuit provides high "talk power," good voice quality, and is easy to adjust. Permits single 6L6 to fully modulate a kw. of peak power input.

WE HEAR a lot these days about the value of "talk power" especially from the gang now using SSB. Although not directly comparable to SSB, the modulation system to be described provides a signal with very high effective modulation percentage and unusually high "talk power." It is capable of excellent voice quality, is easy to adjust, and a single tube such as the 6L6 will fully modulate up to a kilowatt peak power input.

The schematic of the modulator, Fig. 1A will be recognized as basically the circuit of the original clamp modulator first introduced in 1950 as a simple and economical step from c.w. to phone operation. Minor modifications of the original circuit, as shown in Fig. 1B, include use of an ordinary 6L6 in place of the 6Y6, elimination of the self-bias resistor which is not required in this system, and substitution of the vacuum tube diodes of a 6SQ7 for the crystal diode generally used.

Similarities between conventional clamp tube modulators and this system, however, end at the modulator. As shown in Fig. 2, modulation in this system is applied to the screen of the r.f. driver, or buffer, where the voltages and currents are of much smaller magnitude, rather than to the final amplifier of the transmitter as is usual with clamp tubes. Other important advantages in using this system to modulate at low level are explained in the following paragraphs.

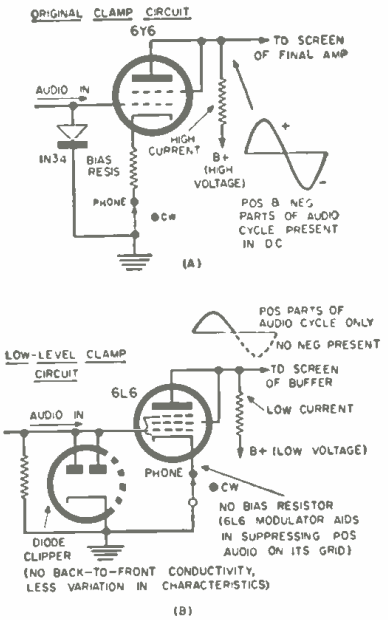
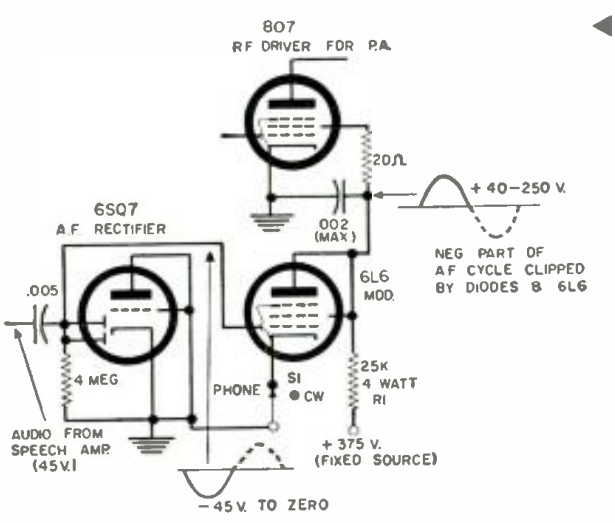


Fig. 1. Changes made in early clamp-tube circuit to allow low-level modulation, less power consumption, and lower voltages.

Operation of Modulator

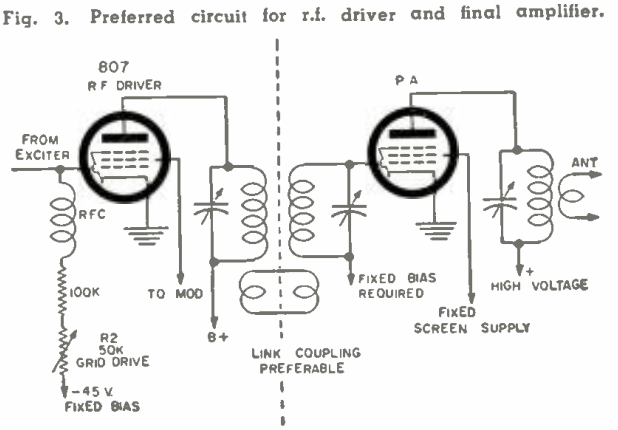
Fig. 2 shows the method of clamping on the screen of the driver, which in this case is an 807. The d.c. is fed from a fixed 375-volt source through the 25,000-ohm, 4-watt resistor, R_1, to the screen of the 807 and also to the plate and screen of the triode-connected 6L6 modulator.

With no audio signal at the control grid of the unbiased 6L6, the plate and screen of the tube draw approximately 13 ma. through R_1, producing a voltage drop of 335 volts and thus placing the screen of the 807 at 40 volts. This, of course, causes the 807 to operate at reduced r.f. output which, in turn, reduces the transmitter carrier output. On the other hand, speaking into the microphone produces an audio signal which is rectified by the diodes of the 6SQ7 and applied as negative bias (45 v. peak) to the grid of the modulator. This causes the modulator plate/screen current to decrease and the 807 screen voltage to rise, reaching peaks of 250 volts in accordance with the amplitude of the audio signal. Because of the clipping action of the diode section of the 6SQ7, combined with the zero-bias operating point of the modulator, positive peaks of audio at the grid of the modulator are neg-



◀ **Fig. 2. Triode-connected 6L6 modulator is clamped to r.f. driver screen. Modulator draws current of only 13 ma. on zero audio.**

Fig. 3. Preferred circuit for r.f. driver and final amplifier.



ligible. Consequently, the voltage waveform at the output of the modulator and on the screen of the 807 consists of positive half-cycles of audio. This is an important requirement. See "Transmitter Adjustments."

Tests have shown that the power output of the 807 buffer on modulation peaks is four times that of the stage under conditions of no modulation or "idling." Also, with proper adjustment of R_1 as well as buffer and final amplifier grid drive (which is quite easily obtained), the resultant carrier power is proportional to the voltage change on the screen of the 807. (Note: This does not mean that the plate current of the 807 is also proportional to screen voltage change.)

Resistor R_1 provides excellent load for the output circuit of the modulator. Its value is fixed at 25,000 ohms and requires no initial or periodic adjustment. Also, it will be noted that the resistor handles a maximum current of only 10 to 13 ma., so that the power rating need be only 4 watts, and a minimum of source voltage is required.

Design of R.F. Stages

Conventional input and output circuitry is employed in buffer and final amplifier stages, as shown in Fig. 3. Important design requirements are: (*a*) sufficient drive for each stage to provide recommended operating grid current values for the type tubes used; (*b*) a fixed source of grid bias and screen supply voltage for the buffer and final amplifier; (*c*) complete isolation of stages to prevent both regenerative and degenerative feedback; and (*d*) provision for r.f. drive adjustment to both stages. Of course, the plate supply sources for both stages should have reasonably good regulation to prevent peak clipping. Also, the antenna system to be used with the transmitter should be capable of loading the transmitter to at least 75% full power output. Inadequate antenna loading results in a lower depth of modulation than is otherwise obtainable.

The r.f. drive adjustment for the buffer, and to some extent for the final amplifier, is provided by the adjustable grid resistor R_2. Other methods can be employed for the purpose, of course, but if more than ample drive power is available from the preceding stage, the adjustable resistor method is particularly effective; moreover, it has the advantage of maintaining high efficiency in the buffer and thus high peak-power output from the stage. Optimum grid current values for the final amplifier can be obtained conveniently by readjustment of the tuned grid circuit. In fact, use of the tuned circuit in this manner is the preferred method of adjusting the grid current for the final stage.

One more point should be mentioned in regard to r.f. design and that is the advisability of using a slightly higher "*Q*" in the plate circuit of the buffer and in the grid circuit of the final. This provides better load regulation for the large variations in r.f. current in these circuits.

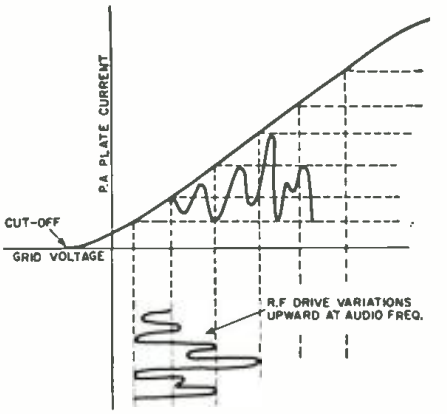


Fig. 4. How r.f. drive to power amplifier prevents p.a. cut-off, and constantly changes grid operating point at a.f. frequency.

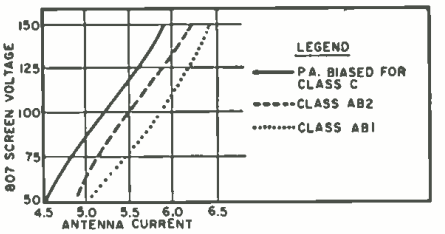


Fig. 5. Actual antenna current values for several values of buffer screen voltage.

Final Amplifier Efficiency

Fig. 6 is a diagram showing the pertinent elements and values of a 1 kw. input p.e.p. (peak-envelope-power) transmitter which is currently being used by the author on the 80-, 40- and 20-meter phone bands. It was originally a 500-watt rig, designed and built by the author in 1950, and utilized a pair of 803's in the final. QSO reports on the transmitter were excellent. In 1951 the 803 tubes were replaced by the new and more efficient 4-125A type tubes, which were operated from the original clamp tube exciter at the 500-watt p.e.p. input. Recently, however, the author obtained a new plate supply which provides the power increase.

Since modulation is applied to the driver stage, it might be assumed that the final amplifier is necessarily operated as a class B linear. This, however, is not the case. Those who are familiar with the 4-125A tubes will note that the grid bias value used is that specified by the manufacturer for class C c.w. operation. Also, the transmitter is initially tuned up for class C operation in the same manner as for any c.w. transmitter. This is possible because the system described is a form of "efficiency modulation," that is, the grid operating point of the final amplifier is constantly changing as modulation is applied to the preceding driver and remains at a fixed point only when no modulation is applied. Another very important reason is that modulation is applied to the driver, only in the form of positive cycles of audio, as explained under modulator operation. Thus, the driver screen (and plate) voltages never go negative with respect to the fixed d.c. potential ("B+") on the stage. This of course results in a grid operating point for the final amplifier which, although constantly changing, is never so far down on the plate current curve as to cause cut-off. Observation of the r.f. modulated waveform on an oscilloscope shows the negative modulation peaks to be only a small percentage of the amplitude of the positive peaks. See Figs. 4 and 5.

While it is practical to adjust this system so that the carrier will be near zero with no modulation, it is not considered desirable. It can be seen that the *average* carrier power will be lower. Experience with this system of modulation has indicated that it is preferable to maintain an unmodulated carrier

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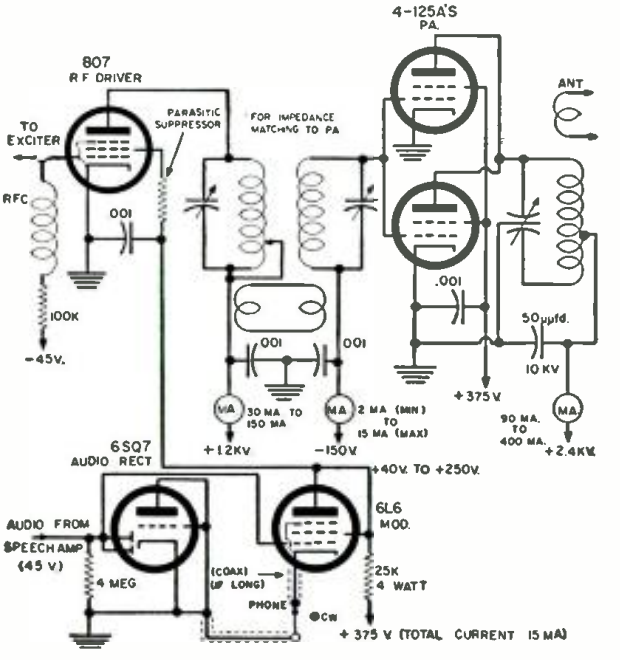
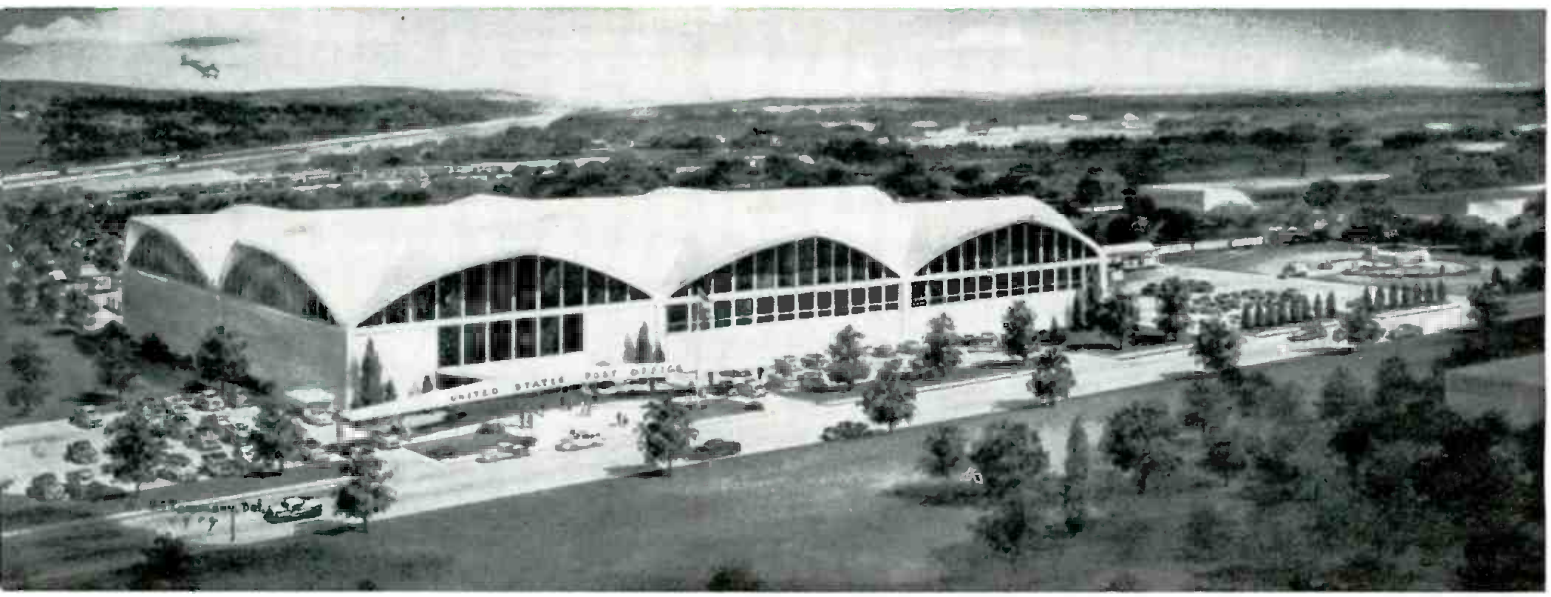


Fig. 6. Shown at the right is the schematic diagram of the modulator, buffer, and the final power amplifier stage of the one-kilowatt (peak-envelope-power input) transmitter that is employed by the author. Refer to the text for a complete description.

recent developments in electronics



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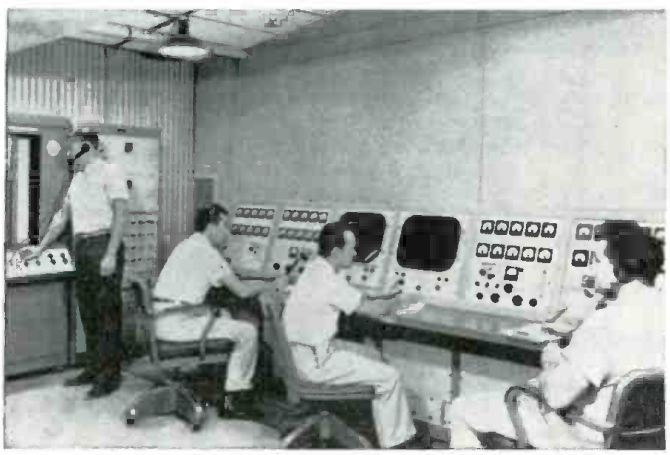
Post Office of Tomorrow

Electronics will play an important part in the operation of this new, fully mechanized mail processing plant and post office at Providence, R. I., which will be built by *Intelex System, Inc.*, (subsidiary of *ITT*). The estimated cost of the post office is $20-million and it will be leased to the Post Office Department for 20 years. The new facilities will speed delivery of all mail in the Providence area, including 14 surrounding areas. The entire project is scheduled for completion in September, 1960. The post office, known as "Project Turnkey," will come complete with equipment ready to go at the turning of a key. Operations will be supervised from an elevated control room, which will serve as a nerve center. This center will have a visual and an electronic view of all activities, and will control synchronized conveyer movements of mail in and out of the facility.



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Testing Station for Research Planes

Technicians and engineers operate plotting board and monitor console at new space range for testing the mile-a-second X-15 research airplane which will fly at 100 miles altitude. The testing station, located in the Nevada wastelands, was developed and built by the *Electronic Engineering Co. of California*. It will provide 600,000 answers per second to electronic questions on the safety of the pilot and the condition of the airplane when the rocket-powered airplane drops from a B-52 bomber and roars into space.

Hot-Dipping Antenna Towers

Hot-dipped galvanizing facilities at *Rohn Mfg. Co.*, Peoria, Ill., were increased 600 per-cent in capacity when a new, modern galvanizing plant was put into operation recently. A portion of the new facilities is shown in the photo below.

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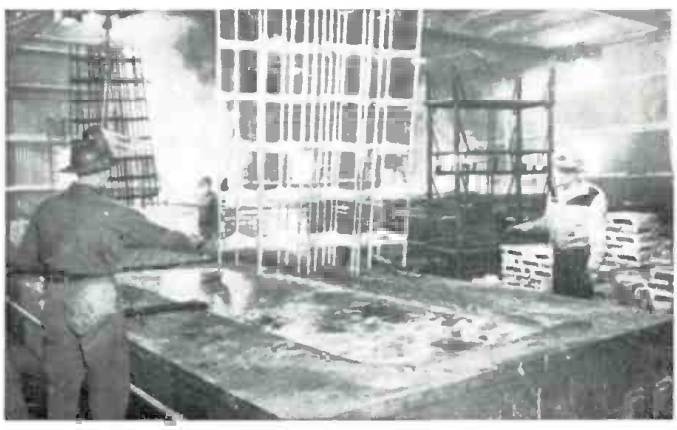

"Vanguard" Tape Recorder

Heart of the communications system in the Vanguard "Cloud Cover Satellite" now circling the earth is this basic tape recorder. Only 5½ inches wide, this 1-pound, 5-ounce device records pictures of weather on a global scale. It first became famous in December as the larynx of man's first talking satellite—the Atlas communications satellite which sent President Eisenhower's voice to earth from outer space.

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Luminescent Panels in 6 Colors

With the aid of an electronic measuring device, an *RCA* engineer at the company's Lancaster, Pa., plant checks the performance of developmental electroluminescent panels which emit a soft glow of light in any one of six specific colors: green, greenish yellow, deep yellow, deep blue, white, and red. Electroluminescent panels have possible uses for house numbers that glow in the dark, night lights, and softly lit instrument panels.

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Expanded Military Closed-Circuit TV

A closed-circuit television broadcast in progress at the studios of WMTV, the U. S. Army Signal School's vastly expanded system for education and training purposes at Fort Monmouth, N. J. Largest military educational TV system in the world, WMTV boasts seven channels that could reach 15,000 persons simultaneously.

◄

Largest Private Reactor

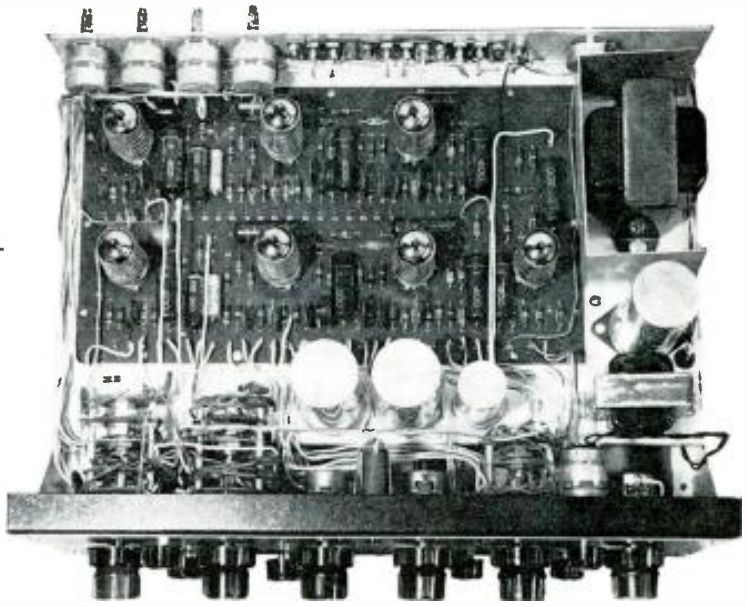
This 87-foot aluminum dome near Plainsboro, N. J., houses the world's largest nuclear reactor entirely owned and operated by private industry. It was constructed by ten companies in non-competing fields to conduct basic scientific research. It is now starting operations through a jointly owned company called *Industrial Reactor Laboratories, Inc.*

Over-all design of this stereo preamp has attractive and neat appearance.

ELECTRONICS WORLD LAB TESTED

"Stereo Master"—a Hi-Fi Control Center

A new hi-fi component that has extremely low distortion. Both lab and listening tests prove quality sound reproduction.



Top view shows printed circuit assembly and general arrangement of parts.

ONE of the most recent additions to *Lafayette Radio's* hi-fi component line is its Model KT-600 stereo preamplifier. It incorporates just about all the features one could hope to find on a single chassis. Evidently, considerable time and effort has been spent on its design, which was created by Stuart Hegemann in conjunction with Aaron Newman, chief engineer at *Lafayette Radio*. Stuart Hegemann is well-known and respected for his engineering achievements in the hi-fi field.

In addition to the usual controls such as bass, treble, loudness, and rumble and scratch filters, it has many other features. The entire righthand section, which includes the stereo function switch, bridge control, and volume-balance control, is identical to *Lafayette's* KT-315 stereo adapter unit. Its complete operation was described in last month's issue. Briefly, though, the stereo function switch provides for selection of normal stereo, reverse channel, reverse phase, and reverse phase and channel, in addition to either channel through both speaker systems or both channels together. It includes a calibration position which is unique in itself in that it permits proper electrical balancing of the two channels up to the inputs of the power amplifier. It is used in conjunction with a monophonic signal with both channels being handled by the preamp out-of-phase. Controls are adjusted and when proper balance is attained, a null occurs at the speaker outputs.

The "volume-balance" are individual controls for each channel but incorporating a clutch that can gang both together, converting them to a single level control.

The bridge control allows for combining a portion of each channel into the other channel to eliminate the so-called "hole-in-the-middle" effect. In its extreme position one can obtain 100% combination resulting in a monophonic presentation through both speakers.

The selector switch is used to permit a choice of six separate inputs; auxiliary, tape amplifier, tape head, tuner, and either magnetic or ceramic cartridge. Each channel has its own selector switch, thereby providing the flexibility of mixing any combination of program material. Four dual concentric-type input level controls are also incorporated. The outer shaft is used to adjust the inputs on one of the channels and the inner shaft of the control is used for the other channel.

Equalization is obtained by means of four separate controls, two for each channel. The turnover point is selected by one and the roll-off by the other. A choice of any combination thereby increases the flexibility to the user.

A third channel output is provided with a bridging control that would permit any desired combination of A and B channels. Not only can this output be used as a third channel for stereo, as another method of eliminating the "hole-in-the-middle," but it can serve as a monophonic channel for playback in any other section of the home.

Another unique feature that we have not run across in any of our previous tests on stereo units is the incorporation of a "presence control." The function of this control is to provide a slight boost in the mid-frequency range. Our tests showed a 6 db rise at 2500 cps and then a return to the

reference level at 600 and 6000 cps. The intentions are that this control be used when playing solo-type program material. The boost is in the upper voice range and thereby serves to emphasize the solo portion.

Tape output jacks are provided with facilities for monitoring. Level indicators and a microphone input are not included.

Test Results

The circuit itself is conventional. Counting the low-level stages, the preamplifier provides six stages of amplification on each channel, plus a stage for phase reversal and one for the third channel output. These 14 stages are handled by seven tubes, all of the same type. The tubes are 7025's, which is a new, improved version of the 12AX7. The power supply uses two selenium rectifiers, one for plate voltage and the other for filaments. The results of our tests are as follows.

Sensitivity: (1000 cps for 1 volt output) tape head, .0022 volt; magnetic cartridge, .002 volt; ceramic cartridge and auxiliary, tuner, and tape amplifier, .079 volt.

Frequency response: ±1.5 db from 30 to 15,000 cps, the limits of our test.

Equalization: ±1.35 db from the conventional RIAA standard curve.

Rumble Filter: −.4 db at 400 cps, −4.8 db at 100 cps, and −16.6 db at 30 cps. This is an extremely sharp and effective rumble filter.

Scratch Filter: A gradual attenuation from 0 db at 1000 cps to −12 db at 15 kc.

Bass Control: −17 db, +14.3 db at 30 cps.

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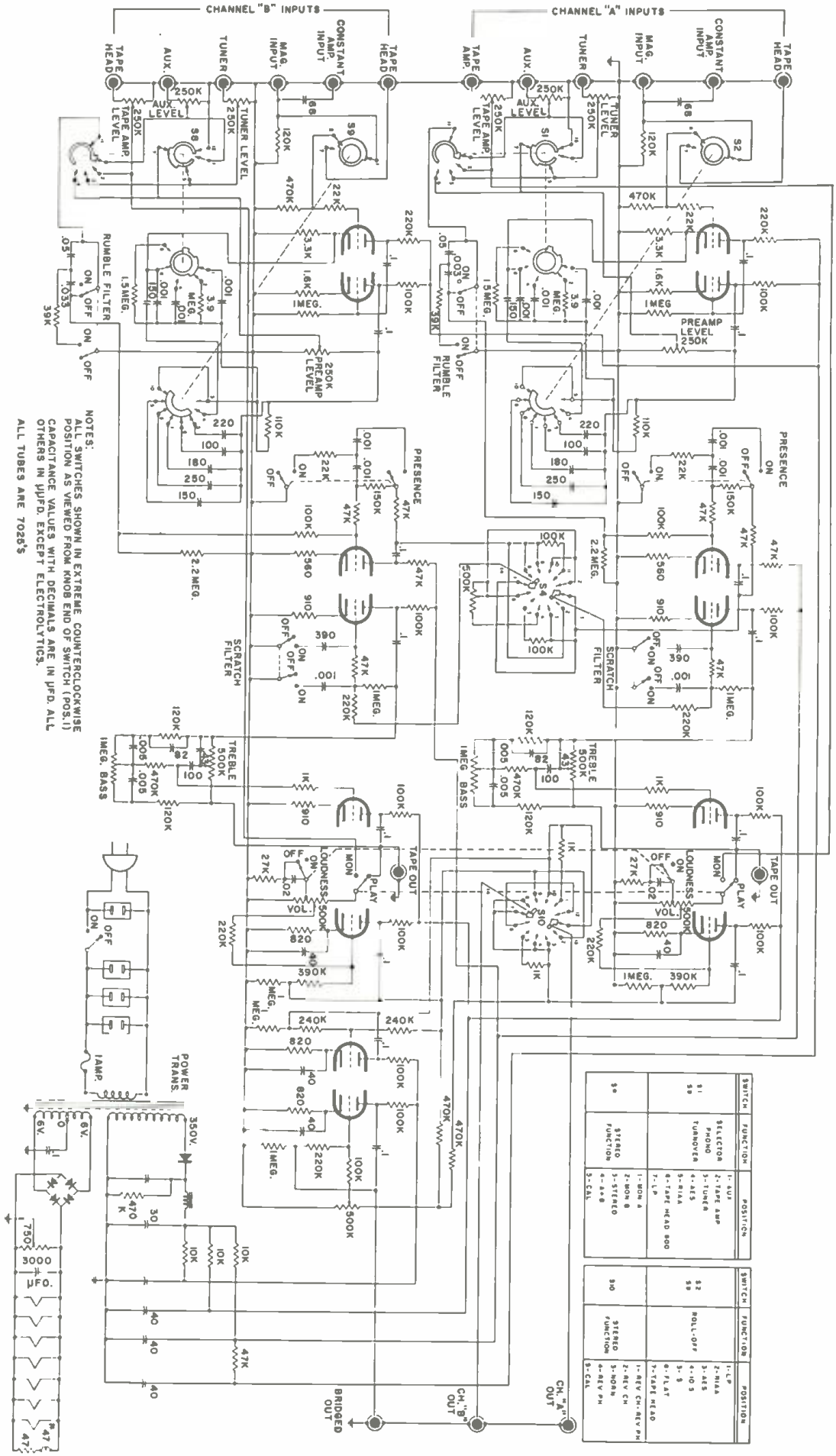
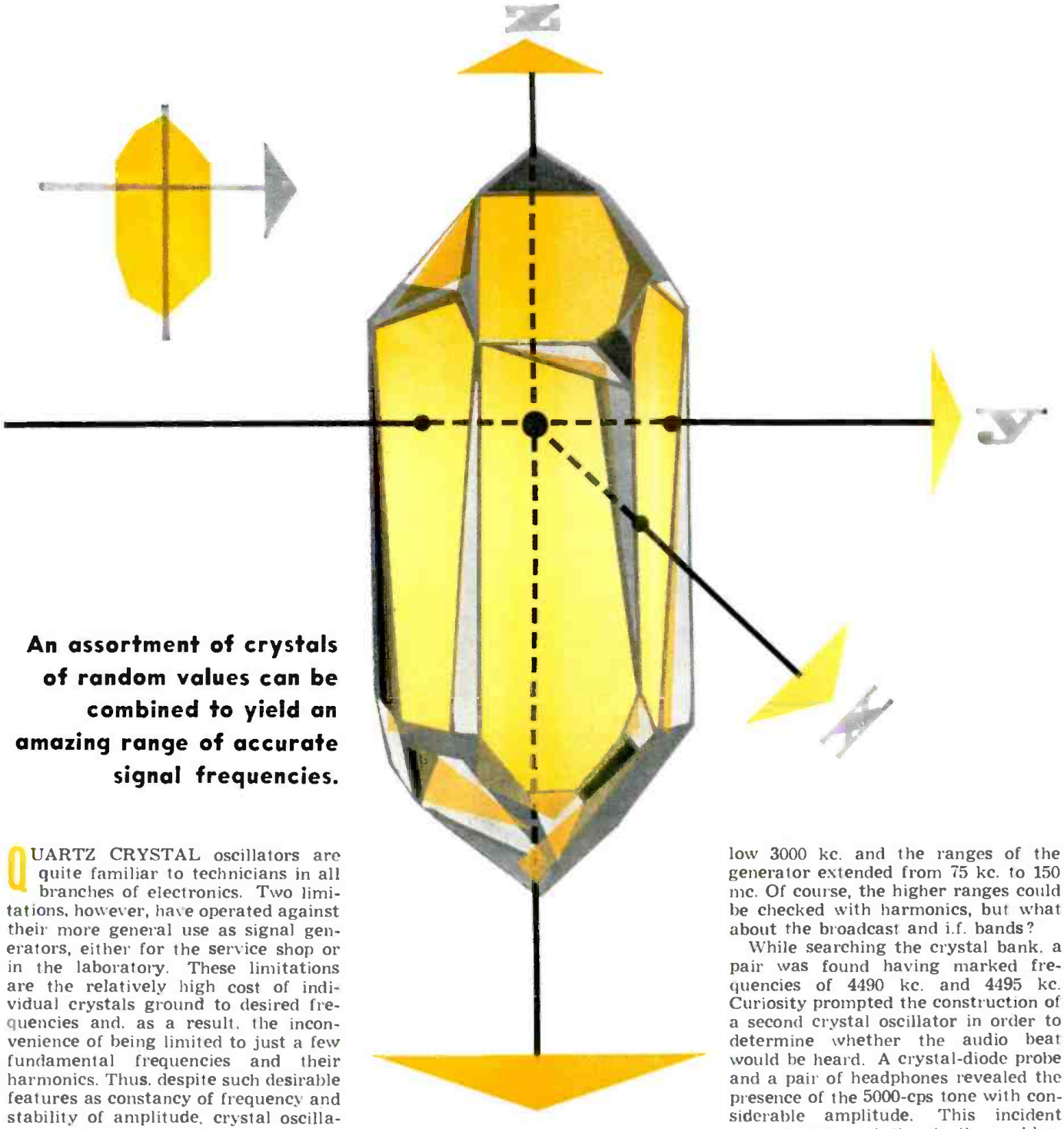


Complete schematic diagram of Lafayette Radio's Model KT-600 preamplifier unit.



An assortment of crystals of random values can be combined to yield an amazing range of accurate signal frequencies.

Generating Test Signals with Crystals

By
THOMAS DEANE HERRIMAN

QUARTZ CRYSTAL oscillators are quite familiar to technicians in all branches of electronics. Two limitations, however, have operated against their more general use as signal generators, either for the service shop or in the laboratory. These limitations are the relatively high cost of individual crystals ground to desired frequencies and, as a result, the inconvenience of being limited to just a few fundamental frequencies and their harmonics. Thus, despite such desirable features as constancy of frequency and stability of amplitude, crystal oscillator applications have been restricted.

Since World War II, the surplus market has offered "grab-bag" lots of surplus crystals at unusually low prices. Unfortunately, few of these are ground to frequencies directly usable in either radio and TV service or in laboratory apparatus. The method described here permits many of these inexpensive crystals to be used for any service function whatsoever: as markers for calibration of variable-frequency generators or even directly for circuit alignment.

The idea of this apparatus was conceived while using a conventional crystal oscillator with a number of surplus crystals to check the dial calibration of a new signal generator. This procedure worked well, as far as it could be applied. None of the crystals in the assortment had fundamentals below 3000 kc. and the ranges of the generator extended from 75 kc. to 150 mc. Of course, the higher ranges could be checked with harmonics, but what about the broadcast and i.f. bands?

While searching the crystal bank, a pair was found having marked frequencies of 4490 kc. and 4495 kc. Curiosity prompted the construction of a second crystal oscillator in order to determine whether the audio beat would be heard. A crystal-diode probe and a pair of headphones revealed the presence of the 5000-cps tone with considerable amplitude. This incident suggested the solution to the problem of calibrating the low-frequency ranges. Heterodynes were obtainable from *pairs* of crystals at fairly close intervals from below 75 kc., through the i.f. and broadcast bands, and well above! Most of the broadcast band could be checked at intervals of 20 kc. or even closer.

Twin-Crystal Oscillator

Fig. 1 shows the very simple circuit ultimately adopted for the twin oscillator. A separate mixer proved to be unnecessary; the common 7500-ohm cathode resistor provides adequate mixing. The optional output amplifier, V_{3a}, is helpful only in case audio or very low radio-frequency heterodynes are to be used. It will contribute little gain at high frequencies and the wide range to be covered precludes the use

of tuned amplifiers if the apparatus is to be kept simple and flexible.

The circuit is uncritical as to tube types, component values, operating voltages, etc. Component values shown in Fig. 1 are suitable for medium-mu triodes like the 6J5. However, a v.t.v.m. can be used to check output-signal amplitude while varying component values to secure optimum performance. For best frequency stability the "B" supply should be regulated (100 to 150 volts).

Because of the lack of critical features and components in the circuit and recognition of differences in personal preference, explicit construction details have been deliberately omitted. The crystals should, of course, be mounted where they will not be subjected to heating. Other variations are possible: pentodes might be used in place of triodes, ultra-compactness could be achieved with miniature tubes and a selenium-rectifier d.c. supply or by transistorization, and so on. An alternative method of signal take-off is illustrated in Fig. 2.

As to potential signal availability, consider the following: A single-crystal oscillator can give but one fundamental, plus its harmonics. Yet two crystals, used as described will give *four* frequencies, without counting any harmonics. These frequencies are F_1 and F_2, the frequencies of the individual crystals; F_1 *plus* F_2; and F_1 *minus* F_2. Three crystals, from which three distinct pairs can be made up, will give a total of *nine* separate signals. In fact, the number of frequencies obtainable from any number, N, of individual fundamentals, combined in different pairs, is N^2. Also available are the harmonics of the individual units, harmonics of the heterodynes, and heterodynes of the harmonics, such as $2F_1$ minus $3F_2$, etc.

Avoiding Confusion

This multiplicity of simultaneously available frequencies may seem confusing and may cause some apprehension lest an undesired signal be mistaken for the desired in use. Actually, it is not difficult to avoid errors. The untuned Pierce circuit, although giving an output rich in harmonics, produces a much greater fundamental amplitude even when using "harmonic" crystals. Consequently, the heterodynes of the fundamentals will have higher amplitudes than the harmonics of the heterodynes or the heterodynes of the harmonics.

The operator will usually know the approximate frequency of operation of the circuit being measured, whether it be a receiver or a generator. Hence, a quick pencil-and-paper calculation will reveal whether any confusing difference frequencies will be generated that are close enough to the desired signal to be mistaken for it. (That is, subtract the fundamental of each crystal from the harmonic of the other; also subtract the second harmonic of each from the third and fourth of the other, etc.) If any spurious frequencies are too close, a different pair of fundamental crystals may be selected to avoid errors. The use of harmonics of the heterodynes and heterodynes of harmonics is not recommended unless calculation shows that they may be used without danger of confusion with other simultaneously produced signals.

Although the harmonics of *sum* heterodynes are spread somewhat farther apart, their use is subject (to a lesser degree) to the same limitation as that of the difference heterodynes. As an example, 18 mc. could be produced by the second harmonics of the sum of a 4-mc. crystal and a 5-mc. crystal. However, if the crystals gave considerable 3rd-harmonic amplitude, the fundamental of each could beat with the 3rd harmonic of the other to produce 17 mc. and 19 mc. simultaneously. (4+15=19; 5+12=17.) Such a possibility should be checked and investigated before use.

There are also certain combinations of fundamentals that should be avoided. These occur where one of the fundamentals would be close to the desired heterodyne. For example, a 9-mc. heterodyne could be obtained with a 10-mc. and a 1-mc. crystal. However, the output would also include 10 and 11 mc., either of which might be confused with the desired signal.

A much better combination for producing 9 mc. might be 4 mc. plus 5 mc., or any other comparable combination of available crystals. With the latter, no fundamental (or other strong beat) would be close to the desired frequency. When use of a "close" combination is unavoidable, a careful search should be made to find *all* output frequencies. The desired one may be identified by its location relative to the others in their fixed sequence.

Using harmonics of crystal heterodynes is not especially recommended. However, the harmonics of a *single* crystal in conjunction with a generator is useful, to a point. Most crystals have useful harmonics at least to the 5th or 7th, often much higher. (Note that some are cut for better output on odd than even harmonics.) It is questionable whether harmonics beyond the 10th should be used, since it becomes increasingly easy to skip one harmonic after that point and such an error will result in incorrect identification of all subsequent overtones.

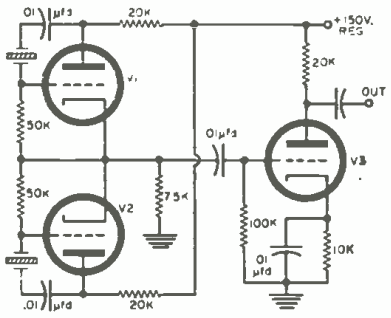


Fig. 1. A simple twin oscillator. Output capacitor may be .001 μfd.

Fig. 2. An alternate method for taking off heterodyne oscillator output.

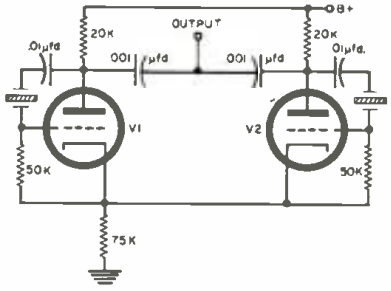
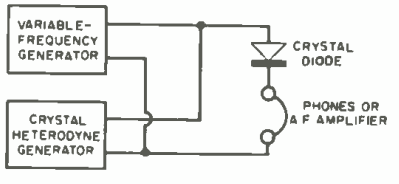


Fig. 3. Using the circuit to determine frequency of an unmarked crystal.



Frequency Errors

A word of caution is in order: when the plate voltage in a crystal oscillator is much higher than necessary, some crystals may have a tendency to produce a spurious fundamental several hundred kilocycles from the true fundamental. While this phenomenon can destroy the desired accuracy, it is fortunately easy to detect and correct. A slight reduction of plate voltage will render this spurious output very weak or eliminate it altogether. The true fundamental, when reached, will remain constant with further changes in voltage. The obvious remedy is using no more "B+" than is necessary.

Some readers may be wondering how accuracy of the heterodyned signals compares with output from single crystals. This accuracy may be as good as, poorer than, or better than that obtained with individual units. Since the user probably does not have facilities for measuring error, his starting point must be the rated tolerance of the crystals themselves.

The possibility of the greatest percent of error exists when two units, relatively close together and high in frequency, are used to generate a relatively low (audio or low r.f.) difference signal. Consider the very first case discussed in this article, in which a 5000-cps tone was developed from crystals rated at 4490 and 4495 kc. If both had rated tolerances of .01%, their individual errors could have been as much as 449 cps and 449.5 cps, respectively. If these errors should occur in *opposite* directions, the error frequency output would be the sum of the original error frequencies. This would be 898.5 cps— nearly 18% of 5000 cps! Such an error would, fortunately, be fairly easy to detect. Also, if the errors occurred in the same direction (both crystals above or both below rated frequency), they would cancel out in the heterodyned output resulting in the original per-cent of error—.01%, or .5 cps at 5000 cps.

(*Continued on page* 111)

By JOHN T. FRYE

Changer Chatter

"YOU know, Mac," Barney said to his boss working at the service bench beside him, "every time I begin to think I'm the most as service technicians go, one of these cussed little a.c.-d.c. receivers takes all the conceit out of me."

"I noticed you were having a rough time with the little monster," Mac said with a sympathetic grin. "What seems to be the trouble?"

"It oscillates," Barney explained. "Hear it? That whistle is there all the time, no matter how you tune the set. I've reached the place where I can't tell if it's an audio feedback whistle, an i.f. on the rampage, or sort of an over-all oscillation. The fact that I hear the whistle even when a station is not tuned in makes me think it's the audio; but when I ground the grid of the i.f. stage through a large capacitor the whistle goes away down, even though it doesn't change in pitch or stop. That sounds like it can't be the audio or i.f."

"Makes sense," Mac agreed; "is there any way you *can* stop it?"

"Yes; all I have to do is connect a bypass from oscillator grid to ground and the whistle stops. So does everything else, of course, for that kills the oscillator."

"Did you check the oscillator grid voltage?"

"I checked *all* the voltages. Oscillator grid voltage is about twice what it should be, but I figured that was caused by the unwanted oscillation driving the grid far into the positive region and making more grid current flow through the grid resistor."

"You check the grid resistor?"

"Nope, but I will right now. Say, the thing must be open! I'm getting a reading up in the megohms instead of the 20,000 ohms I should be getting."

"There's your trouble. The oscillator is actually blocking or 'squegging' at an audio rate and producing the musical tone. Is the resistor actually open or is it just a poor solder connection?"

Barney held the solder gun to the socket connection of the grid resistor for a few seconds and then took it away. The set stopped squealing and played perfectly normally.

"Poor connection!" he announced triumphantly. "Let me put this thing back in the case. I'm sick and tired of looking at it."

"Hold on," Mac said. "Maybe that poor connection was between the lead and the resistor element. Heat may have caused the lead to expand and bridge the broken connection temporarily. Give the resistor a shot of that freon gas to cool it down and let's see what happens."

Obediently Barney sprayed the resistor with a mist of the pressurized refrigerant gas. Instantly the set broke into the same whistling sound as before; and a check with the ohmmeter revealed the resistance from oscillator grid to ground had returned to near infinity. Barney snipped out the tricky grid resistor and replaced it with a good unit from the resistor chest.

While he was doing this, his employer had returned to the record changer on which he had been working for some little time. Barney heard him muttering to himself and looked over to see him using a slender pair of surgical clamps to fish the broken pieces of a flat key-washer from inside the mechanism.

"That's the first time I ever saw that happen," Mac remarked. "That little key slips in a groove on the end of the shaft holding the main gear of the changer. It broke and fell on top of the oil-covered gear. The two pieces stuck in the oil as though it were glue. They wouldn't fall out and you couldn't see them except when the light was exactly right. With the key gone, the gear could move up on its shaft a bare $\frac{3}{16}$" at a critical point in its revolution. Apparently that was all that was needed to upset the whole changer cycle. Sometimes it wouldn't trip; other times the set-down point would not shift from 10" records to 7" ones; still other times the crazy thing wouldn't stop cycling. I've got a hunch —and a hope—that all these troubles will end when I replace the broken key."

Sure enough, when a new key had been tortuously inserted in place, the changer worked beautifully.

Mac heaved a big sigh as he wiped the grease from his hands on a cloth.

"I've tried and tried," he admitted, "but I just can't seem to make myself enjoy servicing these changers. One thing that sticks in my craw is the fact it takes so long to be *sure* you have one working correctly. Practically every changer is a mechanical 'intermittent.' Some of 'em will act up when they are cold and work perfectly when warm. Others do just the reverse. Some will play a half dozen records perfectly and then refuse to cycle at the end of the seventh record. Now and then one will cut up on just one size of record. The upshot of the whole thing is you can't be confident the darned mechanism is operating correctly unless you've seen it go flawlessly through separate stacks of all sizes of records accommodated.

"That's not practical, of course; so the next best thing is to collect all the information possible from the owner: how does the changer misbehave? How often does this erratic performance show up? Does it occur only with one size record? If so, what size? Does it seem to happen more often with a full stack of records on the changer or when only one or two remain to be dropped? Does it usually occur when the player is first turned on or after it has been going a while? How long has this condition existed?"

"The only trouble with that is: the average customer is a pretty sloppy observer; moreover, the one who plays the changer is likely not the one who brings it into the shop. You know how many changers are simply dumped in here with the comment: 'My kid says something's wrong with this thing. Fix it.'"

"Yeah, I know; and when that happens, about the only thing to do is to make a dive for the record-changer manuals. Without service data on a particular changer, you can waste hours and hours."

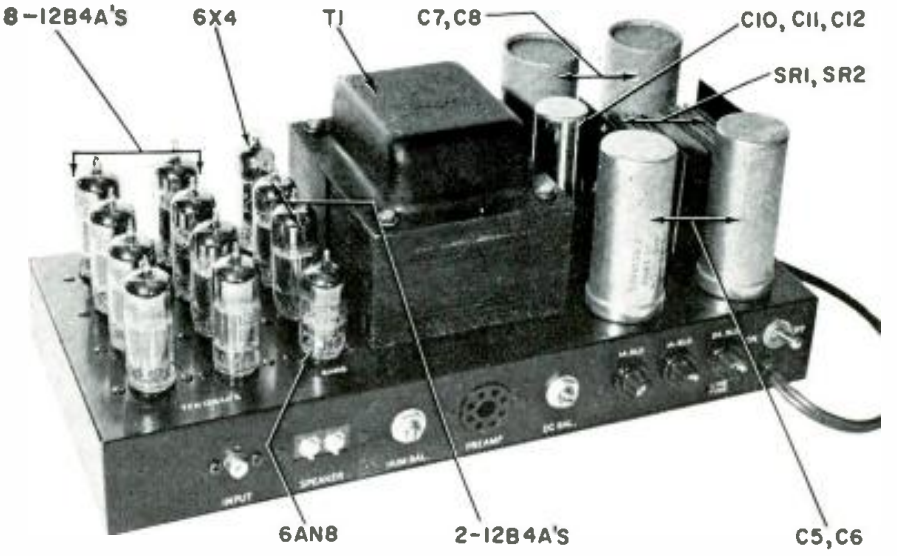
"You can ditto that. My favorite use for the manuals is as sort of a 'mug book' to identify a changer that doesn't carry a make and model number—something that happens too darned often. By leafing through the manuals and looking at the pictures, I can almost always find one exactly like the changer in front of me."

"True," Mac agreed; "but changer manuals do a lot more than help locate a particular changer. A feature that's of really basic value is the description of the complete change-cycle from the moment the trip device is actuated until the needle sets down on the next record. With only this and plenty of horse sense, a technician could, in time, spot the cause of any difficulty. All he has to do is mount the changer and

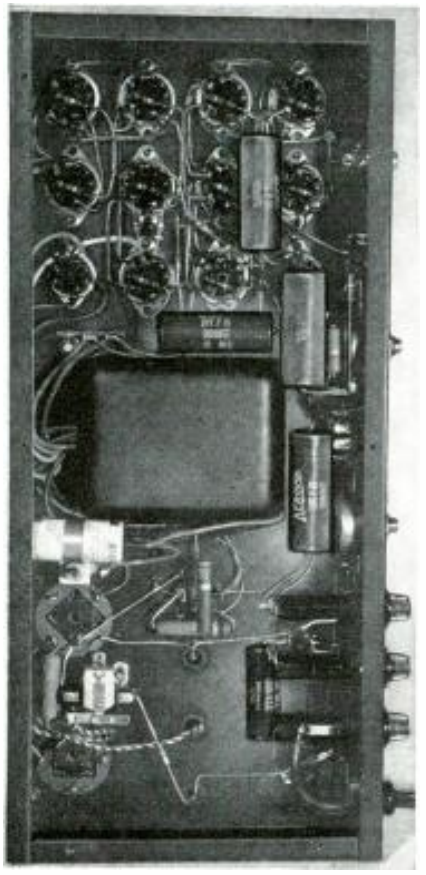
(*Continued on page* 103)

Ultra-stable OTL Hi-Fi Amplifier

By **JULIUS FUTTERMAN**



Over-all and under-chassis views of the ultra-stable amplifier are shown here.



Full construction details on output-transformerless amplifier that boasts a damping factor of eighty.

THE author has been intrigued with output-transformerless (OTL) hi-fi amplifiers for years. He felt that if the output transformer could be eliminated from an amplifier design, while keeping all other phase-shifting components to a minimum, then even with very large ratios of over-all negative feedback there would be no problem of instability. The present model, which will be fully described, is the culmination of several years' work. It is designed to operate with conventional loudspeakers. The only test equipment essential for its construction is a 20,000-ohms-per-volt multimeter.

The basic design is extremely simple. Referring to Fig. 1, a pentode, V_1, is operated as a high-gain voltage amplifier and is directly coupled to the phase-splitter tube V_2. The cathode load resistor of V_2 is returned to ground through the output load, which may be the 16-ohm voice coil of a conventional loudspeaker. Signal voltage developed across the plate load resistor of V_2 is applied between grid and cathode of output tube V_3. Likewise, signal voltage 180 degrees out-of-phase, developed across the cathode load resistor of V_2, is applied between grid and cathode of output tube V_4. Careful testing has substantiated the fact that with low values of cathode and plate resistors, the signals from this type of phase-splitter are balanced over the audio-frequency range.

The output tubes are connected in series push-pull and are biased for Class AB operation. The load for the amplifier is connected with its high side to the cathode of V_3 and plate of V_4 and its low side to ground. Each of the output tubes has its own power supply, consisting simply of a metallic rectifier SR and a capacitor C. Due to the balanced nature of the circuit there is no d.c. in the output load.

The potentiometer in shunt with the load has its arm in the cathode circuit of the voltage amplifier tube V_1. When the arm of the potentiometer is at ground, there is no over-all negative feedback and the full gain of the amplifier is obtained. With the arm at the high side of the load, there is 100% negative feedback and the gain of the amplifier is essentially unity. Because of the minimum of phase-shifting components in this amplifier, large amounts of negative feedback may be used. The author has constructed amplifiers of this type with as much as 60 db of feedback without any instability!

In this circuit, the output tubes are working as cathode followers and thus require large driving voltages from the phase-splitter tube. With this

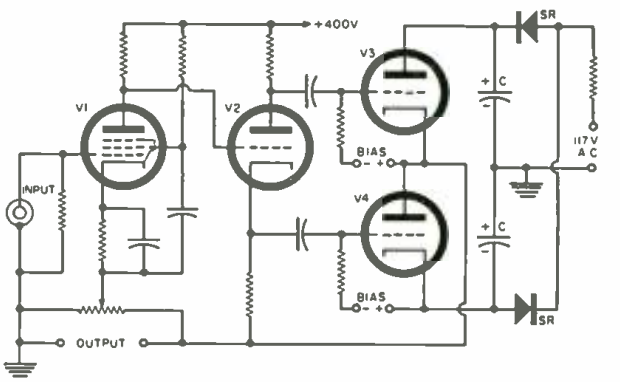


Fig. 1. The diagram shown here is the basic circuit arrangement employed in the output-transformerless hi-fi amplifier.

type of phase-splitter, the signal voltage across the plate and cathode resistors is essentially of the same magnitude as the input voltage to the tube. Normally, this would require a large voltage from V_1. Fortunately, because the speaker load is also in the input circuit of the phase-splitter tube and in the correct sense to provide positive feedback, a much lower voltage suffices. In fact, the peak signal voltage to the input of the phase-splitter need be only as high as the fixed bias applied to the power tubes, for maximum output. A novel feature of this amplifier, as will be noted in Fig. 1, is that the output load is part of the input circuits of all the tubes used in the amplifier for the purpose of obtaining both positive and negative feedback. This has been accomplished without the use of any reactive components which might produce undesirable phase shifts.

Amplifier Circuit

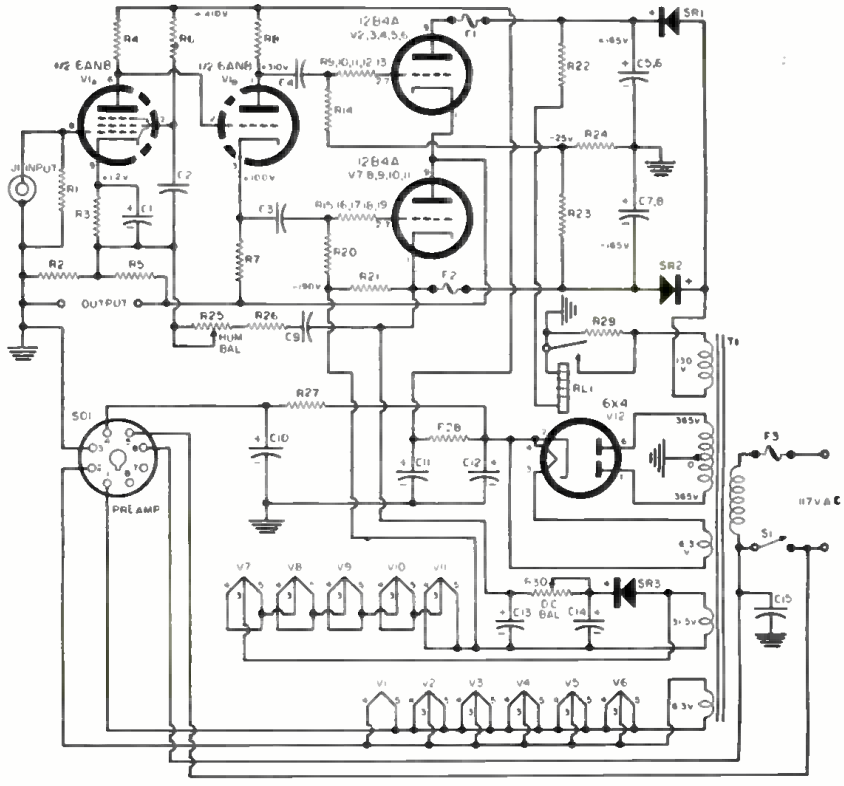
The complete amplifier is constructed on a 13½ x 6 x 1¾ inch chassis. The schematic is given in Fig. 2 and along with the accompanying photographs indicates the construction. A 6AN8 tube is used as a combined voltage amplifier and phase-splitter. The unusually large plate load resistor (1.8 megohms) of the voltage amplifier produces a gain of over 1000 from this stage and is entirely practical since the direct coupling to the phase-splitter eliminates the usual loading effect of the following grid resistor.

Each half of the series-connected push-pull output stage consists of five type 12B4A tubes connected in parallel. There are two identical plate current supplies for this stage, each consisting simply of a silicon or selenium rectifier and two 300 μfd. electrolytic capacitors connected in parallel. The power transformer is a special low-impedance unit in which the primary and the 130-volt winding feeding the power supplies for the output stage, each has a d.c. resistance of less than 1.5 ohms. This is essential so that the large current demands of the power tubes, when peaks of program material are handled, can be met. Despite the absence of filter chokes or resistors in these power supplies, the signal-to-hum ratio of the amplifier is very high, better than 50 dbm. This is because the amplifier itself acts as an electronic filter.

To prevent the initial surge of charging current through the 600 μfd. filter capacitors (two paralleled 300 μfd. units) from damaging the rectifiers when the amplifier is first turned on, a surge-limiting resistor of 300 ohms (R_{29}) is connected in series with the rectifiers. The function of the relay (RL_1) is to short out this resistor when the voltage across the filter capacitor C_{11}, C_{12} builds up to a value high enough to operate the relay. This usually takes approximately two seconds. The *Sigma* type 11F relay used here is an inexpensive unit selling for $1.80 at most parts distributors.

Fixed negative bias of 25 volts for the upper half of the output stage is obtained from a voltage divider R_{23}, R_{24} connected across the plate supply of the lower output tubes. These lower tubes also have a fixed bias of approximately 25 volts, which is developed across R_{23}, SR_3, C_{13}, and C_{14}, supply this voltage. The d.c. balance pot (R_{30}) is used to adjust this bias so that there is no d.c. in the speaker voice coil.

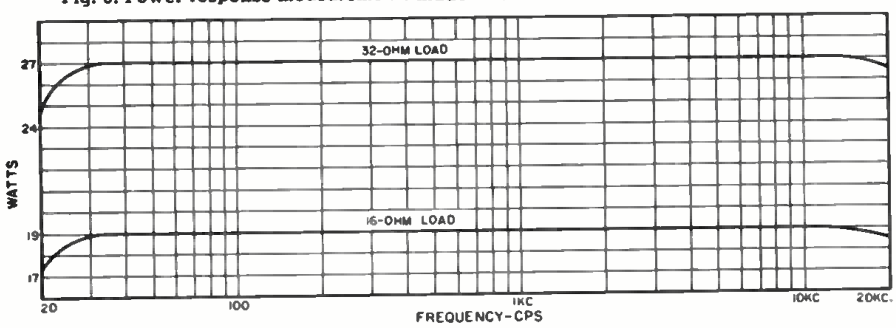
Plate voltage for the 6AN8 voltage amplifier and phase-splitter is obtained from a 6X4 rectifier tube (V_{12}). The current required is less than 6 ma. and is well filtered by C_{11}, C_{12}, and R_{28}. Plate voltage for an external preamplifier is available at the octal socket and is filtered by C_{10} and R_{27}. Most preamplifiers such as the *Heathkit* and *Dyna-*



R_1—270,000 ohm, ½ w. res.
R_2, R_3, R_{10}, R_{11}, R_{12}, R_{13}, R_{15}, R_{16}, R_{17}, R_{18}, R_{19}—100 ohm, ½ w. res.
R_3—5100 ohm, ½ w. res. ± 5%
R_4—1.8 megohm, 1 w. res. ± 5%
R_5—750 ohm, ½ w. res.
R_6—8.2 megohm, 1 w. res. ± 5%
R_7, R_8—18,000 ohm, 2 w. res. (matched with ohmmeter)
R_{14}, R_{20}—47,000 ohm, ½ w. res. ± 5%
R_{21}, R_{22}—15,000 ohm, ½ w. res. ± 5%
R_{23}—82,000 ohm, ½ w. res.
R_{24}—82,000 ohm, 1 w. res. ± 5%
R_{25}—250,000 ohm pot ("Hum Balancing")
R_{26}—22,000 ohm, ½ w. res.
R_{27}—6800 ohm, 1 w. res.
R_{28}—10,000 ohm, 1 w. res.
R_{29}—300 ohm, 5 w. res.
R_{30}—10,000 ohm pot ("D.C. Balancing")
C_1—50 μfd., 6 v. elec. capacitor
C_2, C_3, C_4, C_5—.22 μfd., 400 v. capacitor
C_6, C_8, C_7, C_9—300 μfd., 175 v. elec. capacitor (two paralleled, see text)
C_{10}-C_{11}-C_{12}—15/20/20 μfd., 350/450/450 v. elec. capacitor
C_{13}-C_{14}—10/10 μfd., 50 v. elec. capacitor
C_{15}—.047 μfd., 600 v. capacitor
SR_1, SR_2—500 ma., 130 v. a.c. silicon power rectifier (Sarkes Tarzian M500 or Audio Devices A750)
SR_3—20 ma., 65 v. selenium rectifier (Radio Receptor 4Y1)
J_1—Phono jack
RL_1—9000-ohm relay (Sigma type 11F)
S_1—S.p.s.t. switch (see text)
SO_1—Octal socket (to match preamp used with this amplifier)
F_1, F_2—1 amp fuse (Slo-Blo type)
F_3—3 amp fuse (Slo-Blo type)
T_1—Power trans. 365-0-365 v. @ 30 ma.; 6.3 v. @ .6 amp; 6.3 v. @ 5 amps; 31.5 v. @ .6 amp; 130 v. (d.c. resistance of winding to be less than 1.5 ohms), 117 volt primary with the d.c. resistance of winding to be less than 1.5 ohms (see text)
V_1—6AN8 tube
V_2, V_3, V_4, V_5, V_6,
V_7, V_8, V_9, V_{10}, V_{11}—12B4A tube
V_{12}—6X4 tube

Fig. 2. Complete schematic diagram and parts listing for the ultra-stable amplifier.

Fig. 3. Power response measurements made with both a 16-ohm and a 32-ohm load.



kit require a heater supply that is not grounded and this is also provided for at the octal socket. The line switch on the amplifier is a convenience. If it is desired to operate the amplifier from the "on-off" switch on the preamp, then the amplifier switch should be left in the "off" position and the preamp switch wired to pins 5 and 6 of the octal socket.

Construction

Actual construction of the amplifier is relatively simple. The parts layout shown in the photographs is recommended. It will be noted that the tubes which are the primary heat-producing elements are separated by the power transformer from the electrolytic capacitors and rectifiers. C_7 and C_8 are insulated from the chassis.

Wiring is point-to-point, as direct as possible. The 100-ohm suppressor resistors are conveniently mounted across pins 2 (grid) and 8 (unused) of each 12B4A tube socket. The pin 8 contacts are then connected in parallel. The only precaution necessary in wiring the amplifier is to keep the lead from the input jack to the grid of the 6AN8 tube (pin 8) short and direct. Particularly, dress it away from the high side of the output. If a different layout is used and this lead is more than 3 inches long, then use shielded wire.

Since the photographs of the amplifier were taken, silicon power rectifiers have become available in addition to the selenium units shown. The specific types recommended for this circuit are given in the parts list.

Except for the power transformer and possibly the 300 μfd. electrolytic capacitors, all the components used in this amplifier are standard items available at any parts distributor. The power transformer and capacitors, also the chassis with all holes punched, can be obtained from *Radio & Television Service Co.*, 2768 Broadway, New York 25, N. Y. Cost of the transformer is $11.90, each electrolytic is $1.85, and the punched chassis and bottom plate is $6.80.

Testing

In testing the amplifier it is advisable to adhere to the following procedure:

(1) Temporarily remove the two silicon power rectifiers. If they are of the pigtail type, unsolder one lead from each. Short the amplifier input by means of a phono plug, across which has been soldered a short length of wire. Connect to the output terminals a resistor of any value from 10 to 100 ohms.

(2) Connect the amplifier to the a.c. line and allow a one minute warm-up. Check to see that all the tubes are lit. Use the 20,000-ohms-per-volt range of the meter and measure the following voltages: (A variation of ±20% is permissible.)

a. Chassis to C_{11}; 410 volts.
b. Chassis to pin 9 of 6AN8 tube: 1.2 volts.
c. Chassis to pin 3 of 6AN8 tube; 100 volts.
d. Pin 1 of 6AN8 tube to C_{11} (across R_5); this voltage should measure the same as in step "*c*".

If the voltage measured in steps "*c*" and "*d*" is lower than 80 or higher than 120 volts, then either of the following two expedients may be adopted: (1) Substitute another 6AN8 tube and repeat steps "*b*", "*c*", and "*d*". (2) Parallel R_6 (8.2 megohms) with a resistor of 22 megohms (½ watt, 10%) if the voltage is high. If low, then series R_6 with a resistor of 470,000 ohms. Repeat steps "*b*", "*c*", and "*d*".

(3) Measure the bias voltage across R_{21} (15,000 ohms) plus side of meter to end of resistor that goes to pin 1 of the 12B4A tubes. Adjust this voltage to 25 volts by means of R_{30} (d.c. balance pot). Turn amplifier off and replace the two power rectifiers. Remove the 1-amp fuses F_1, F_2. Turn amplifier on again and note if the relay closes. (If the amplifier should be turned off at this point, it will take from 30 seconds to a minute for the relay to open. This is so because, with the power tubes not drawing any plate current, the filter capacitor takes a long time to discharge. In normal operation of the amplifier the relay will both open and close in approximately two seconds). Measure the bias voltage across R_{21} (15,000 ohms) plus side of meter to chassis. This should be 25 volts, ±10%.

(4) Replace the two fuses. With the voltmeter across the output terminals, and using a progressively lower range, adjust the d.c. balance pot (R_{30}) for zero volts. Again measure the two bias voltages (as in step "3"); they should be within one volt of each other. If not, then adjust R_{30} to equalize the bias voltages and, monitoring the voltage across the output, interchange the five

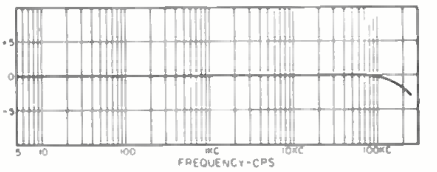


Fig. 4. Frequency response of amplifier.

Fig. 5. Square-wave amplifier response. (A) 20 cps. (B) 200 cps. (C) 2 kc., (D) 20 kc.

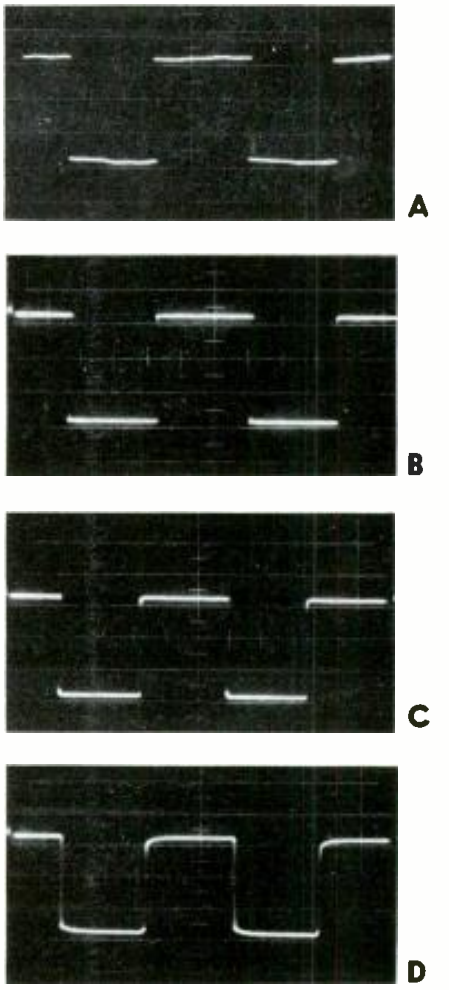
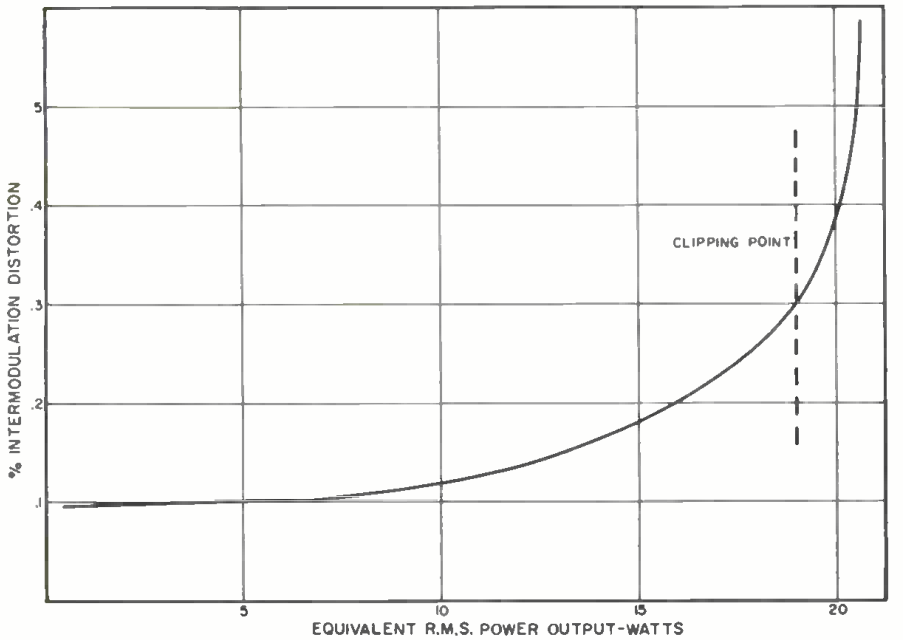


Fig. 6. Intermodulation distortion measurements with clipping point shown (16-ohm load).



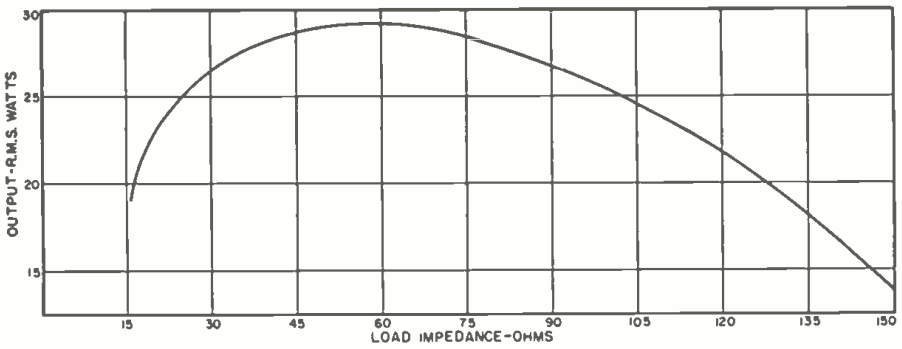
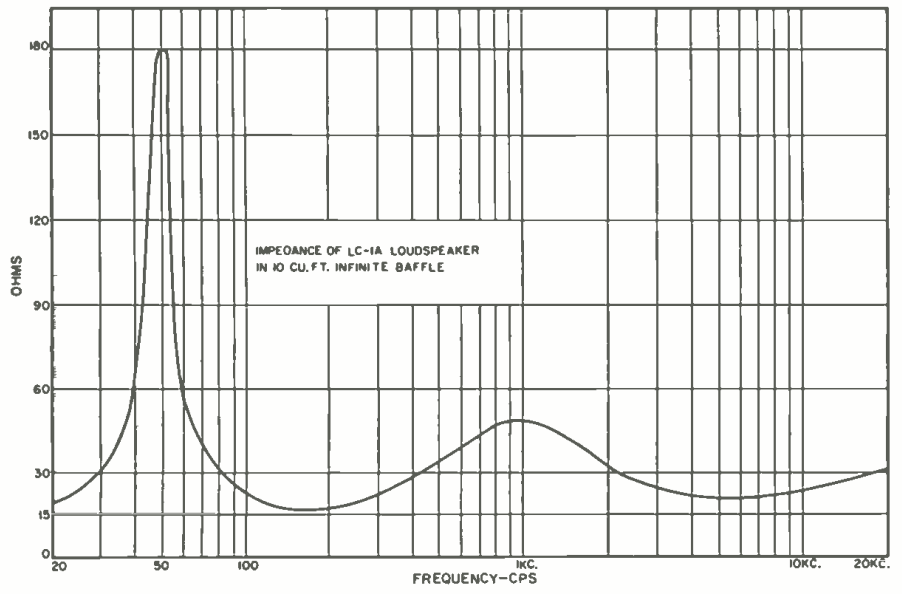


Fig. 7. The power output of the amplifier varies with amount of load that is presented.

Fig. 8. Impedance of RCA LC-1A speaker may be used to calculate the power.



upper 12B4A tubes with the five lower tubes (one pair at a time) for a minimum meter reading. It is not necessary to strive for a zero reading. This can be obtained with a slight re-adjustment of the d.c. balance control. This procedure results in maximum output from the amplifier and also assures that clipping will occur simultaneously on both positive and negative peaks at the overload point of the output signal.

(5) Turn amplifier off and remove either of the 1-amp fuses. Connect the meter to the fuse post terminals, using the 600 ma. range on the meter. Turn amplifier on. The meter will indicate the total plate current of the five 12B-4A tubes in one-half of the output stage. To insure low distortion on small output signals the plate current should be from 100 to 120 ma. If the plate current is low, then parallel R_{21} with another resistor (220,000 to 470,-000 is about right); if high, parallel R_{23} (82,000 ohms) with a resistor of about 1 to 2.2 megohms. Re-adjust for zero d.c. across the output with the d.c. balance control and check the plate current again.

(6) Remove the temporary load resistor from the output terminals and connect the loudspeaker. For this adjustment the amplifier should be close to the loudspeaker. Listen closely and adjust the hum balancing control (R_{25}) for minimum hum. The null point, where the residual hum voltages of the amplifier cancel in the output, is quite sharp, so it is advisable that this operation be performed in a quiet room. If a scope or a.c. vacuum-tube voltmeter is available it can be connected to the output, in parallel with the loudspeaker, so as to more easily ascertain the correct setting. Remove the input shorting plug (first turning off the amplifier) and the unit is ready for use.

Performance

It has been found that in all cases, the foregoing test procedure will result in the optimum performance designed into the amplifier. Of course, for those fellow experimenters who have access to more elaborate test equipment, such as a sine-square-wave signal generator, distortion analyzers, oscilloscope, etc., the following impressive specifications can be checked.

Frequency response: Measured with a *Hewlett-Packard* 200 CD oscillator and *Precision* 550 oscilloscope at 1-watt output, 16-ohm load. Flat from below 5 cycles to 100,000 cps, three db down at 250,000 cps with no peak in response at any frequency. See Fig. 4.

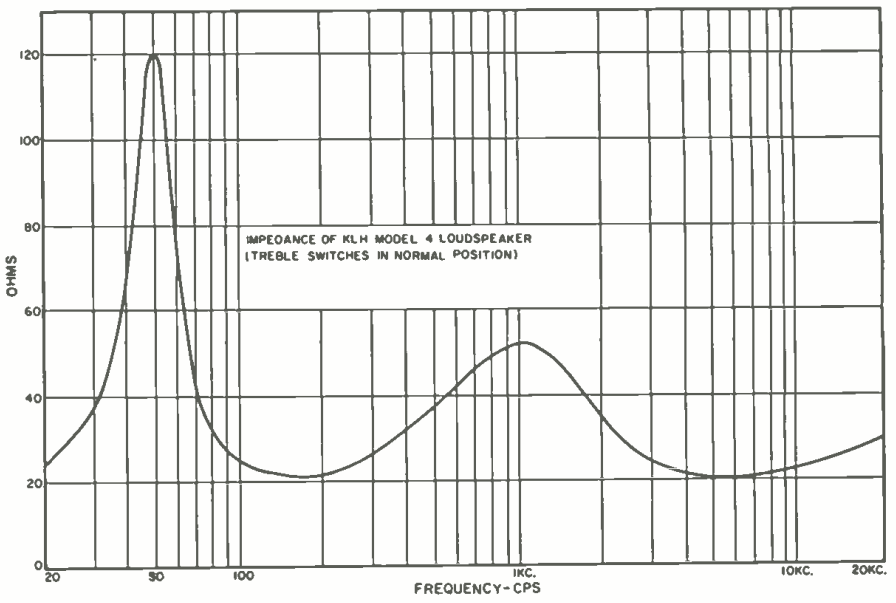
Power response: Flat within 1 db from 20 to 20,000 cps at maximum undistorted output. See Fig. 3. This was measured with both a 16- and 32-ohm load. The *Precision* 550 scope was used to monitor the output and the signal set to just below the clipping point at each test frequency. The power output was then determined. This procedure of testing for maximum output with a sine-wave signal has to be done quickly in order to avoid overloading the output tubes. This will be covered later.

Harmonic distortion: Extremely low at any frequency from 20 to 20,000 cps. No graph is shown and precise figures not given for the reason that with the test equipment available (*Hewlett-Packard* 200 CD oscillator and 330B distortion analyzer, also *Precision* E300 signal generator) the distortion measurements, at any output below overload, were in the realm of the residual figures of the instruments themselves. As an estimate we would say that the harmonic distortion, at any audio frequency below overload, is below 0.1 per-cent.

Intermodulation distortion: This is a more sensitive method of measuring

(*Continued on page* 110)

Fig. 9. Impedance curve of KLH Model 4 speaker may be used to calculate the power.



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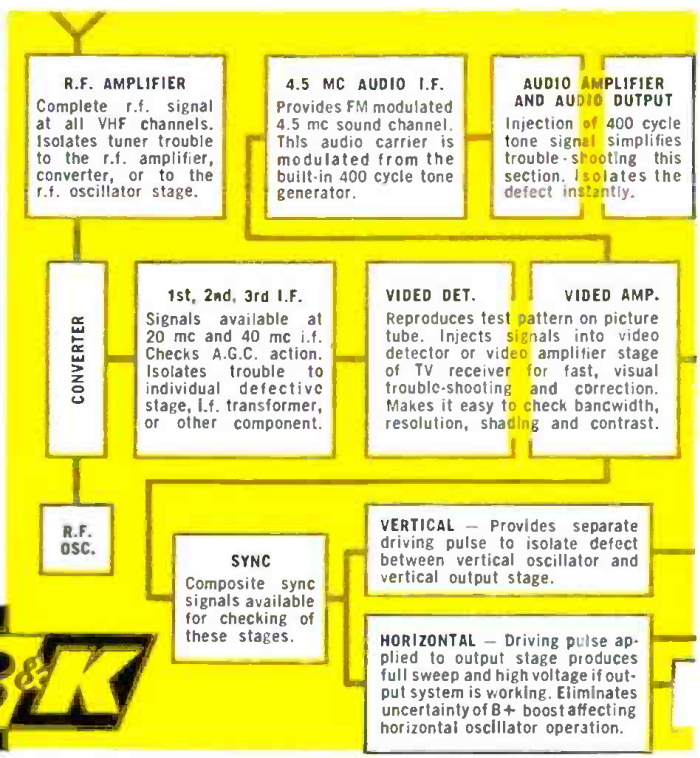

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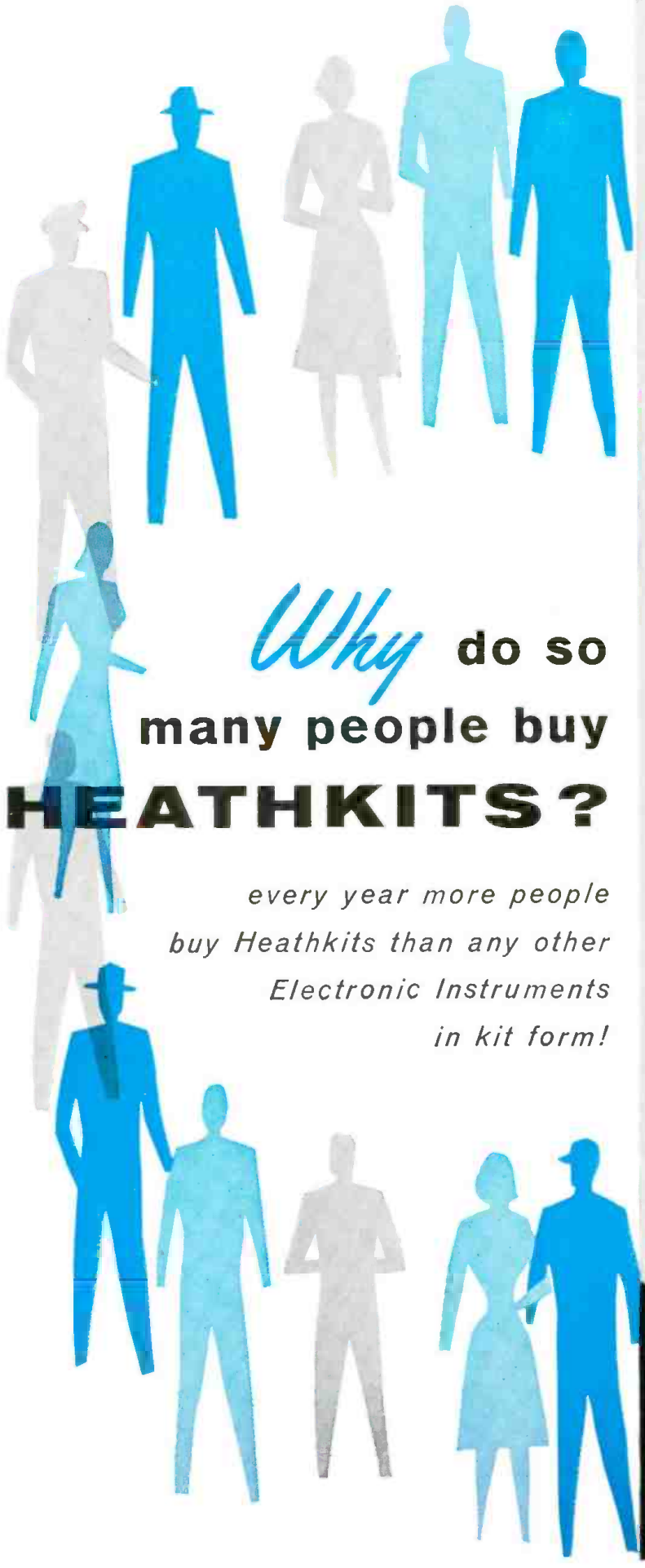

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Here are a few reasons why...

EASY TO BUILD

Heathkits are engineered for easy kit construction. You need no electronic or kit building experience whatsoever to successfully complete your own kit. Use of printed circuit boards and pre-wired, pre-aligned assemblies cut construction time. Manuals are carefully prepared, employing step-by-step instructions written in simple, non-technical language. Large pictorial diagrams and photographs show you exactly where each part goes.

LASTING QUALITY

Only top quality components go into Heathkits, assuring you of a finished product that is unsurpassed in performance, dependability and endurance. Rigid quality control standards are maintained at the Heath factory to see that each component lives up to its advertised specifications. Heathkits are conservatively rated. No performance claims are made that are not thoroughly proven and tested under the most stringent laboratory conditions.

ADVANCED ENGINEERING

Progress in electronics engineering never stands still at Heath. The latest developments in circuit design and components are exploited by Heath engineers, offering you superior performance at lower costs. New advances in all fields of electronics are carefully watched by Heath engineers to keep abreast of the rapidly growing industry. The modern, up-to-date styling of Heathkits make them a handsome addition to your home or workshop.

WORLD-WIDE REPUTATION

A pioneer in do-it-yourself electronics, Heath Company, over more than a decade, has established public confidence in its products both in the United States and abroad. Today, as the world's largest manufacturer of electronic kits, Heath stands as the leader in its field.

GREATER SAVINGS

Do-it-yourself Heathkits save you up to ½ the cost of equivalent ready-made equipment. Direct factory-to-you selling, eliminating middle-man profit, plus the tremendous Heath purchasing power mean even further savings to you. And the convenient Heath Time Payment Plan allows you to use and enjoy your Heathkit NOW, while you pay for it in easy installments.

HEATHKIT®

HEATH COMPANY

Benton Harbor 15, Michigan

a subsidiary of Daystrom, Inc.

TRANSISTOR PORTABLE RADIO KIT

Fun for the whole family, this easy-to-build 6-transistor portable radio is ready to go wherever you go. The modern molded plastic case with pull-out carrying handle and fully enclosed back add beauty and convenience to this splendid kit. Six name-brand (Texas Instrument) transistors are used for good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides "big set" tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of cunstruction. Transformers are prealigned making the radio ready for use as soon as kit is assembled. A built-in rod-type antenna assures good reception in all locations. Six standard flashlight batteries are used for power, providing extremely long battery life (between 500 and 1,000 hours) and they can be purchased anywhere. Stylish cabinet is two-tone blue molded plastic with gold inlay and measures 9" L. x 7" H. x 3¼" D. Shpg. Wt. 6 lbs.

MODEL XR-1L: Identical to XR-1P except in handsome leather case instead of plastic case. Leather carrying strap included. Shpg. Wt. 7 lbs.

LEATHER CASE: Can be purchased separately if desired. Fits all XR-1P and earlier XR-1 chassis. No. 93-1. Shpg. Wt. 3 lbs. **$6.95.**

HEATHKIT
MODEL XR-1P
$29.95

MODEL XR-1L **$34.95**

NAVIGATE BY PORTABLE RADIO

HEATHKIT
MODEL DF-2
$69.95

2-BAND TRANSISTOR PORTABLE RADIO DIRECTION FINDER KIT

Enjoy the safety, convenience and entertainment of this self-contained, self-powered, six-transistor superheterodyne radio direction finder. It receives aeronautical and marine beacons as well as standard band broadcasts with startlingly clear tone reproduction over a long range. Covering the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc, the DF-2 is designed to take directional "fixes" on both aircraft and marine beacons as well as standard broadcast stations, while providing the entertainment of a high quality transistor portable radio. You are able to receive aircraft weather reports every thirty minutes and constant Coast Guard beacons on the 200 to 400 kc band. A dial light is provided for night operation. Power is supplied by six standard flashlight batteries which will last you up to one year under normal operation. Shpg. Wt. 9 lbs.

MODEL PC-1
$24.95

POWER CONVERTER KIT

Now you can operate your TV set, radio, razor, and other AC electrical equipment directly from your 12-volt boat or car battery. With the Heathkit Power Converter you can enjoy the convenience of home electricity whether boat cruising or on automobile trips. Two power transistors are employed for years of trouble-free, dependable service. No moving parts to wear out, no tubes to replace. Shpg. Wt. 8 lbs.

MODEL IA-1
$59.95

ELECTRONIC IGNITION ANALYZER KIT

Ideal for use on automobiles, boats, aircraft engines, etc., the IA-1 checks ignition systems with the engine in operation (400 to 5,000 RPM). Shows the condition of coil, condenser, points, plugs and ignition wiring. Shows complete engine cycle or just one cylinder at a time. Two test leads are supplied, each 10' long, which will enable you to reach either the breaker points or the spark plug wires. Shpg. Wt. 20 lbs.

MODEL TI-1
$25.95

ELECTRONIC TACHOMETER KIT

Useful on inboard and outboard boats, as well as in automobiles, the TI-1 operates directly from the spark impulse of the engine. Use on any spark ignited 2 or 4 cycle engine of any number of cylinders. Completely transistorized, it works with 6, 8, 12, 24 or 32 volt DC systems. Indicates revolutions-per-minute from 0 to 6,000. Calibration control provided for adjusting to engine type. Easy-to-build and easy-to-install. Shpg. Wt. 4 lbs.

PROFESSIONAL OSCILLOSCOPE KIT

Everything you could possibly want in an oscilloscope is found in the new Heathkit model OP-1. Featured are DC coupled amplifiers and also DC coupled CR tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the waveform may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustment. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Handsome cabinet features silver anodized front panel with red and black lettering and matching knobs. Shpg. Wt. 34 lbs.

HEATHKIT MODEL OP-1 **$179.95**

VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

Invaluable in experimental and design work, the PS-4 eliminates the need for building up a separate power supply for each new circuit tried. It provides a convenient source of variable regulated B+, variable bias voltage and filament voltage for labs and work shops. The PS-4 supplies regulated B+ output continuously variable from 0 to 400 volts DC at up to 100 ma, bias voltage variable from 0 to —100 volts DC at 1 ma, and filament voltage of 6.3 volts AC at 4 amps. Separate panel meters continuously monitors voltage and current output. Rugged, top-rated components used throughout for long, reliable service. Shpg. Wt. 16 lbs.

HEATHKIT MODEL PS-4 **$54.95**

Your best dollar value...

HEATHKIT

HEATH COMPANY • Benton Harbor 15, Michigan

a subsidiary of Daystrom, Inc.

TEST OSCILLATOR KIT

Provides the test frequencies most often used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies (262 kc, 455 kc, 465 kc, 600 kc and 1400 kc) are quickly selected for troubleshooting or alignment of the IF frequency and high and low end of the broadcast band for proper tracking. Shpg. Wt. 4 lbs.

HEATHKIT MODEL TO-1 **$16.95**

HEATHKIT MODEL O-12 **$65.95**

"EXTRA DUTY" 5" OSCILLOSCOPE KIT

Laboratory quality at utility scope price makes this instrument an unusual value. The Heath patented sweep circuit functions from 10 CPS to better than 500 kc in five steps, giving you five times the usual sweep obtained in other scopes. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action are characteristic of this scope. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS-per-inch. Construction is simplified through the use of two etched metal circuit boards and precut, cabled wiring harness. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. An ideal scope for all service applications as well as in standard or color TV servicing. Shpg. Wt. 22 lbs.

MODEL SG-8 **$19.50**

RF SIGNAL GENERATOR KIT

A "must" for any beginning serviceman, this indispensable instrument is used for aligning tuned circuits quickly and tracing signals in faulty RF, IF and audio circuits. Covers 160 kc to 110 mc on fundamentals in five bands and from 110 mc to 220 mc on calibrated harmonics. Coils are prewound and calibrated. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

MODEL AG-9A **$34.50**

AUDIO SIGNAL GENERATOR KIT

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

MODEL TS-4A **$49.50**

TV ALIGNMENT GENERATOR KIT

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

MODEL CD-1 **$59.95**

COLOR BAR AND DOT GENERATOR

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

ETCHED CIRCUIT VTVM KIT

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

HEATHKIT MODEL V7-A **$25.95**

HANDITESTER KIT

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

HEATHKIT MODEL M-1 **$17.95**

20,000 OHMS/VOLT VOM KIT

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

HEATHKIT MODEL MM-1 **$29.95**

TUBE CHECKER KIT

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

HEATHKIT MODEL TC-3 **$39.95**

AUDIO VTVM KIT

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

MODEL AV-3 **$29.95**

MODEL CT-1 **$7.95**

IN-CIRCUIT CAPACI-TESTER KIT

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

MODEL BE-5 **$39.95**

LOW RIPPLE BATTERY ELIMINATOR KIT

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

MODEL T-4 **$19.95**

VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL C-3 **$19.50**

CONDENSER CHECKER KIT

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

"APACHE" HAM TRANSMITTER KIT

HEATHKIT MODEL TX-1
$234.95

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

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

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

New Styling...
New Features

HEATHKIT

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HEATHKIT MODEL SB-10
$89.95

SINGLE SIDEBAND ADAPTER KIT

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

MODEL DX-100-B
$189.50

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

DX-100-B PHONE & CW TRANSMITTER KIT

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

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

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

MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

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

"MOHAWK" HAM RECEIVER KIT

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

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

HEATHKIT MODEL RX-1 **$274.95**

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

ALL-BAND RECEIVER KIT

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

MODEL QF-1 **$9.95**

"Q" MULTIPLIER KIT

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

MODEL CA-1 **$13.95**

"AUTOMATIC" CONELRAD ALARM KIT

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

"SENECA" VHF TRANSMITTER KIT

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

HEATHKIT MODEL VHF-1 **$159.95**

MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

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

MODEL B-1 **$8.95**

BALUN COIL KIT

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

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

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

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

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

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

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

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

STEREO EQUIPMENT CABINET KIT

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

HEATHKIT MODEL CE-1 **$43.95** each

CHAIRSIDE ENCLOSURE KIT

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

Plan your own Hi-Fi System...

HEATHKIT®

HEATH COMPANY • Benton Harbor 15, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT MODEL RP-3 **$64.95**

HIGH FIDELITY RECORD CHANGER KIT

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

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

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

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

Assemble it in Just One Evening

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

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**

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

Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

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

"LEGATO" HI-FI SPEAKER SYSTEM KIT

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

Easy to buy...

Easy to build

Easy to use...

HEATHKIT

HEATH COMPANY

Benton Harbor 15, Michigan

High Fidelity AM and FM reception in a Single Set

HEATHKIT MODEL PT-1

$89.95

Professional Stereo-Monaural AM-FM Tuner Kit

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

MODEL FM-3A

$26.95

HIGH FIDELITY FM TUNER KIT

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

MODEL BC-1A

$26.95

HIGH FIDELITY AM TUNER KIT

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

MODEL W-6M $109.95

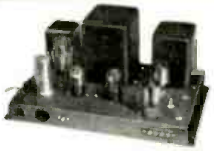
"HEAVY DUTY" 70 WATT HI FI AMPLIFIER KIT

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

MODEL W-5M $59.75

25 WATT HI FI AMPLIFIER KIT

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



MODEL W-4AM $39.75

SINGLE CHASSIS 20 WATT HI FI AMPLIFIER KIT

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

MODEL W-3AM $49.75

DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT

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

HEATHKIT MODEL SP-2 (STEREO) **$56.95**

Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

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

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

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

HEATHKIT MODEL WA-P2 **$19.75**

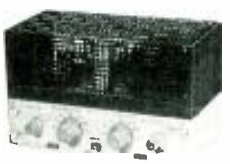
"MASTER CONTROL" PREAMPLIFIER KIT

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

MODEL W-7M
$54.95

"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

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



MODEL XO-1
$18.95

ELECTRONIC CROSSOVER KIT

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

MODEL UA-1
$21.95

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

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

MODEL A-9C **$35.50**

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

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

MODEL SW-1 **$24.95**

SPEEDWINDER KIT

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

NO. 401-6
$7.50

12" UTILITY SPEAKER KIT

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

MODEL TK-1 **$9.95**

COMPLETE TOOL SET

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

HIGH FIDELITY TAPE RECORDER KIT

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

HEATHKIT TR-1A **$99.95**

Includes tape deck assembly, preamplifier and roll of tape.

HEATHKIT TE-1 **$39.95**

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

Many more Heathkits to choose from

hi-fi: Amplifiers—Preamplifiers—Speaker Systems—AM/FM Tuners—Equipment Cabinets—Record Player—Tape Recorder—Electronic Crossover—Stereo Equipment.

test: Oscilloscopes—Voltmeters—RF Signal Generators—AF Generators—Analyzers—Battery Eliminators—Tube Checkers—Condenser Checkers—Computer—Color Bar & Dot Generator—Sweep Generator—Impedance Bridge—Power Supplies—Probe Kits—R/C Decade & Substitution Kits.

ham radio: Transmitters—Receivers—Antenna Accessories—Voice Control—Conelrad Alarm—Variable Frequency Oscillator—SSB Adapter—"Q" Multiplier.

marine: Direction Finders—Marine Converter—Rudder Position Indicator—Fuel Vapor Detector—Charge Indicator—Power Meter.

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

Save with Heathkits... the quality name in kit form electronics.

"BOOKSHELF" 12 WATT AMPLIFIER KIT

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

An Amplifier, Preamplifier all in one!

HEATHKIT EA-2

$28.95

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

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Compatible Stereo for AM Stations

Stereo channel transmitted by frequency modulating the AM station's regular carrier.

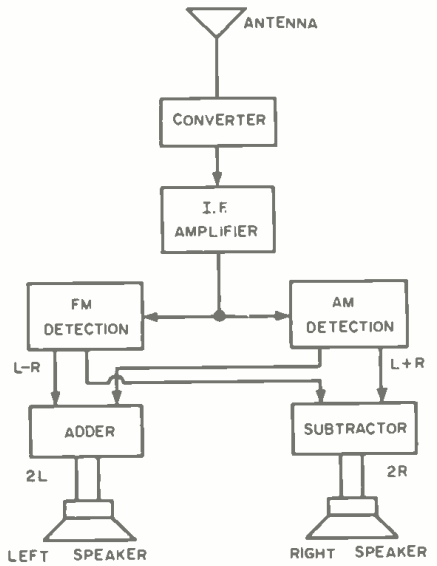
AN AM stereo broadcasting system using simultaneous amplitude and frequency modulation of the carrier was demonstrated recently by the *Westinghouse Electric Corp.* The new system allows a person with an ordinary AM receiver to pick up both stereo channels simultaneously, thereby resulting in a completely compatible monophonic signal. For stereo reception it is possible to use two ordinary AM receivers, but with one tuned slightly above the carrier and the other tuned slightly below. It is also possible to use a specially designed single receiver and auxiliary speaker as shown below.

In the new system, the sum of the two stereo channels is used to amplitude modulate the carrier of a regular AM station in the conventional way. The difference between the two channels, in a band from 300 to 3000 cps, is used to frequency modulate the same carrier simultaneously. Narrow-band FM is used (±3 kc. deviation) so that no adjacent channel interference is produced.

When ordinary AM receivers are used for this stereo system, they are detuned in order to recover the two stereo channels by means of slope detection. By detuning one receiver above and the other receiver below the carrier, a matrixing or mixing effect occurs that applies only the left-channel signal to the left speaker and the right-channel signal to the right speaker.

A proposal for a test on-the-air demonstration has been submitted to the FCC. When this authorization is received, test programs will be conducted. -30-

Block diagram of AM stereo receiver.



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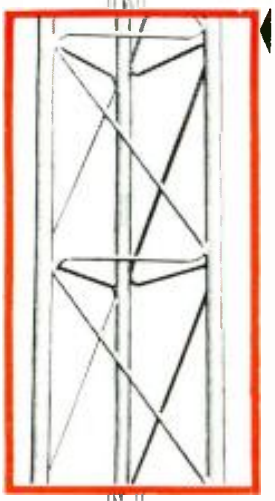
for ALL TV installation needs!

LOOK TO THE FOREMOST NAME IN THE COMPLETE LINE OF HOME TV, AMATEUR AND COMMUNICATION TOWERS, PLUS A COMPLETE LINE OF INSTALLATION NEEDS. You'll find that the ROHN line is *complete*. It gives you *better* products at a *better* price. Practically all ROHN products are available in the finest of finishes . . . *hot-dipped galvanizing!* Rely on the *dependable* name for ALL your needs —ROHN . . . today one of the largest manufacturers of a *complete* line of this type equipment.

TOWERS



No. 25 The ROHN No. 25 tower is one of the finest ever designed . . . a full 33⅓% stronger and more durable than "similar sized" towers. This is achieved by amazing zig-zag cross bracing design combined with highest grade steel and heavy-duty steel side-rail tubing. This superior strength means that this tower can ordinarily be installed self-supporting to 50 feet or guyed to 200! It is truly the *finest* tower of its kind for home television reception.

No. 6 This ROHN tower features the well-known "magic triangle", the cross-bracing construction that is unequalled in strength and durability. Also available self-supporting, or guyed to about 150 feet.

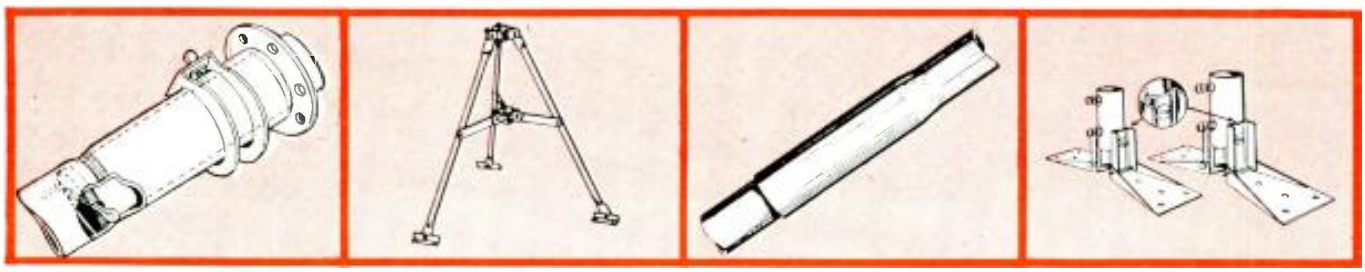
Fold-over The No. 25, as well as heavy-duty No. 40 communication tower, can be converted into "fold-over" towers for amateur use . . . the only tower of its kind. They let you work "on the ground!"

Communications

FIVE complete lines of communication towers are available to fulfill *practically* any need, including a 130 foot true heavy-duty communication tower that is completely self-supporting and guyed models up to 600 feet!

Complete communications catalog sent on request!

PLUS ALL THESE ROHN DESIGNED ITEMS



Telescoping masts—Unexcelled in design, structure and strength, with several exclusive features! All popular sizes, heights and weights available.

Roof towers—Available in 10, 5 and 3 foot heights. Most of them are collapsible for easy shipping. Ideal in use—a ROHN "big-seller".

Tubing—Just what you want: 6" expanded end with ½" taper to form a solid locking joint! High carbon steel. Available 5, 10 foot lengths, 1¼", 1½" diameter, 16 and 18 gauge.

Bases—Wide variety of roof mount bases. Special locking feature. Also available is cast aluminum roof mounts and many other types.

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Hi-Fi-Audio Product Review

FISHER REMOTE CONTROL

Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. has just released a new remote control unit which permits stereo speaker levels to be adjusted from anywhere in the listening area.

The Model RK-1 is designed to be used with the company's 400-C Master

Audio Control and consists of a control assembly, 30 feet of connecting cable, and an adapter plug for connection to the main unit. The adapter plug is color-coded to simplify connections.

The control assembly may be held in one hand and its two control knobs rotated with the thumb or index finger. In operating position, the knob on the left regulates the level in the speaker to the left of the listener and the right knob controls the volume of the speaker on the right. Each control has a range of from zero level to full volume as set on the 400-C, permitting the RK-1 control to be used to cut off the volume completely on either channel.

The control is housed in an ivory plastic case measuring 4" x 2⅛" x 1¼".

AIR-CORE INDUCTORS

C & M Coils, 3016 Holmes Avenue, N. W., Huntsville, Alabama has announced the availability of a new line

of air-core inductors for crossover networks which is being offered in 80 values in #17 wire and 52 values in #16 wire.

All of the inductors are oven baked, calibrated, and spaghetti applied to the 7" tinned leads. The units are then cotton wrapped, dipped in varnish, baked, and rechecked. Inductors are supplied with ± 10% tolerance.

The inductors available in No. 17 Formvar copper wire range in value from .05 mhy. to 12 mhy. The No. 16 Formvar copper wire units have inductances ranging from 5 to 20 mhy.

The company will forward a copy of its brochure on request. Complete electrical and physical specs are provided on each inductor.

UNITED AUDIO'S CHANGER

United Audio Products, 2024 E. 19th Street, New York 3, N. Y. has entered the changer field with a combination professional 4-speed turntable and deluxe record changer.

The Dual-1006 will track and operate the automatic cycling mechanism with as low as 2 grams stylus pressure. The unit includes a built-in direct-

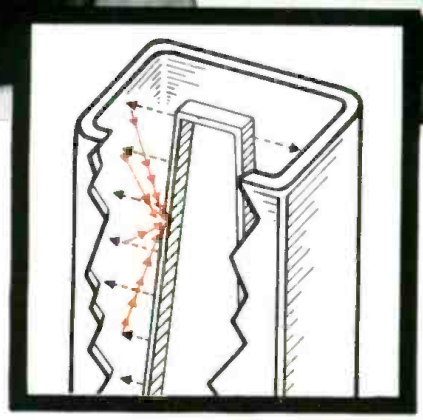
reading pressure gauge to insure optimum cartridge operation and long record life.

The 5¼-pound turntable is laminated and concentrically girded to retain dynamic balance and plano surface. The powerful motor enables the turntable to reach full speed within ½ second from dead start. The motor uses a new rigid equipoise suspension principle which eliminates vertical rumble.

A one-piece tonearm, employing a lock-key snap-in cartridge holder and double set of direct acting ball bearings for both vertical and horizontal axes, avoids multiple arm resonance and minimizes cartridge vertical amplitude distortion. The new design of the arm achieves perfect vertical and lateral tracking at all times by maintaining a constant 90-degree relationship between arm pivot axis and cartridge axis, according to the company.

The "stereo-mono" switch includes a phase-cancelling feedback circuit which removes vertical noise signals that result when monophonic records are played with stereo cartridges.

The changer mechanism will operate with any diameter record from 5" to 12" and intermixes ten records in any



Back emission

MAJOR CAUSE OF POWER RECTIFIER FAILURES

eliminated in 5U4GB

HERE'S HOW IT HAPPENS. Back emission from overheated plate to filament brings about most rectifier failures. The reverse current mounts . . . filament coating is stripped . . . filament becomes overheated . . . soon burns out.

HERE'S HOW IT IS ELIMINATED. Recognizing the vulnerability of rectifiers to premature failures, CBS-Hytron instituted a continuing program to get rid of them. As a result, the 5U4GB, for example, has a new larger-diameter plate that runs cooler. And the plate material is non-emissive. A taller bulb also operates at lower temperatures; permits depositing the getter inside cooler dome for improved getter action. Additional features include: a firmly anchored filament of purer tungsten . . . a ruggeder stem . . . and improved high-vacuum techniques.

Results? Dynamic "blast" tests brutally cycle the CBS-Hytron 5U4GB between 6.8 and 4 volts with 800 volts plate potential. Yet back emission is less than one microampere.

HERE'S WHAT IT MEANS TO YOU. Virtually eliminated callbacks for the 5U4GB put more money into your pocket. Prove it. Demand the CBS-Hytron 5U4GB. Insist on the premium quality at regular prices that is yours in all CBS-Hytron tubes.

THE CBS FAMILY • CBS-HYTRON • CBS INTERNATIONAL • CBS LABORATORIES
CBS NEWS • CBS RADIO • CBS TELEVISION NETWORK • CBS TELEVISION STATIONS • COLUMBIA RECORDS • LEADERS IN ELECTRONIC COMMUNICATIONS

CBS® tubes

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

sequence. In addition, an "elevator action" changer spindle design preserves record centers and grooves by separating the bottom-most record from the stack to an interim position before its travel to the turntable.

Detailed literature on the "Dual-1006" is available on request. Address your letters to Desk 6 at the previously mentioned address.

STEREOPHONES

Koss Incorporated, 2227 North 31st St., Milwaukee 8, Wis. has just released its Model SP-3 "Stereophones"—a specially constructed headset which permits the reception of two-channel sound with complete privacy.

The headset covers the full frequency range of 30 to 15,000 cps by means of 3½-inch dynamic reproducers

incorporated in each earphone. Since the "Stereophones" have an impedance of 4 ohms they can be connected directly across the amplifier's output or speaker's voice coil and thus no extra wiring within the amplifier is required.

Adapters are also available for 600- and 10,000-ohm impedances, permitting the units to be used for monitoring purposes. The units come complete with 8 feet of cable and a plug. Local high-fidelity equipment dealers and electronic parts jobbers are handling this new item.

ERIE CERAMIC CARTRIDGE

Erie Technical Ceramic Division, State College, Penn. has just released a single-ceramic-element stereo cartridge which is the product of several years of development.

The new unit offers a dynamically balanced single ceramic element in

which both channel outputs are developed—making them inherently equal. Freedom from resonance peaks is obtained through oil damping.

Marketed under the tradename "ST-ERIE-O," the new cartridge is available for immediate delivery. The Model 1304 cartridge has .7 mil diamond and 3 mil sapphire styli while the Model 1303 has dual sapphires. These models are supplied in kit form, including a 2-foot length of shielded cable and necessary hardware for conversion.

Separation is 20 db over the full audio frequency range. Response is 20 to 16,000 cps with output voltage .5 volt r.m.s. at 1000 cps, each channel. Compliance is 3×10^{-6} cm/dyne, vertical and lateral. Recommended load is 2 megohms and recommended tracking pressure is 5-6 grams. The unit is completely compatible. Mounting dimensions are EIA standard $^{7}/_{16}$" and $^{1}/_{2}$" centers.

Further details on these new cartridges are available from the firm's authorized distributors.

EICO 14-WATT AMPLIFIER

Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. has announced the availability of a 14-watt high-fidelity power amplifier which has been designated as the HF-14.

The new unit has a Williamson-type circuit and a push-pull EL84 output stage. A standard octal socket is provided for powering the HF65A and HF61A preamps.

The unit is rated at 14 watts continuous, 28 watts peak. Frequency response is 15 to 100,000 cps ±.5 db at 1

watt and ±1.5 db from 15 to 125,000 cps. At 14 watts the response is 25 to 25,000 cps ±.5 db and ±1.5 db from 20 to 60,000 cps.

Speaker connections are provided for 4-, 8-, or 16-ohm voice-coils. The unit draws 65 watts at 117 volts a.c. The entire amplifier measures $3^{3}/_{4}$" x 12" x 4". It is available both in kit and factory wired versions. An enclosure (E-6) is available at extra cost.

TAPE DECK HOUSINGS

Viking of Minneapolis, Inc., 9600 Aldrich Avenue South, Minneapolis 20, Minn. has recently released two furniture cabinets for housing its 75 and 85 Series tape decks and related tape system components.

The W3SX cabinet will accommodate either a 75 or 85 tape deck, together with a single recording amplifier or two playback preamps. Designed for table or shelf mounting, the enclosure can serve as a tape center for the music system.

For the stereo system, the W4SX cabinet will house a 75 or 85 tape deck and two vertically mounted recording amplifiers. A bottom panel (below the

tape deck) is removable for custom installation of a power amplifier or mixer controls.

Full details on these new units are included in the firm's accessory catalogue, Form 692, which is available from the manufacturer on request.

G-E SPEAKER ENCLOSURE

General Electric Company, West Genesee St., Auburn, N. Y. has announced the release of a new 5-cubic-foot "distributed port" 12-inch speaker enclosure, the "Stereo Classic" EN-50.

The enclosure is proportioned for minimum width and its height is compatible with the firm's EQ-1-series equipment cabinet. It has a recessed matching wood base and is available in mahogany, blonde oak, cherry, and walnut genuine wood veneer finishes.

With a high-quality 12" coaxial or biaxial speaker, the EN-50 series has more than double the low-frequency power output capability (up to 4 db) of closed type enclosures, according to the company. Its response is clean down to 35 cycles.

The enclosure features an optional front panel tweeter mount opening, with removable cover plate, for tweeters of 4-inches o.d. or less. The larger front panel opening accommodates all makes of 12" speakers. The seven "distributed port" openings are in the rear panel.

Further information on this new series of enclosures is available from the company on request.

MULTIPLE SPEAKER SWITCH

Olson Radio Warehouse, 260 S. Forge St., Akron, Ohio has added the SW-130 multiple-speaker selector switch to its line of audio accessories.

The new unit enables the user to connect and control up to six remote speakers without affecting impedance match at the sound source. The switch is designed for use with either 4- or 8-ohm speakers.

The device features simplified slide-type switches with six 4-ohm, 2-watt resistors and six 8-ohm, 2-watt resistors and easy-to-follow wiring instructions. The switches are mounted on a brushed brass panel suitable for custom mounting on hi-fi or p.a. control panels. The panel size is 3⅜"x2½".

"CROWN" STANDARDS UPPED

International Radio & Electronics Corporation, Elkhart, Ind. has announced that guaranteed standards have been raised on its 1959 "Crown Stereo X" tape recorder.

The new unit has two-track or four-track heads, is of all-aluminum construction, offers three speeds (15, 7½, 3¾ ips) has three motors and provides

(*Continued on page* 94)

build this great new knight-kit®

A PRODUCT OF ALLIED RADIO

never before such performance...such styling at so low a price...

tremendous value at only

$44.50

only $4.45 down

SAVE UP TO 50%...COMPARABLE IN EVERY WAY TO WIRED AMPLIFIERS COSTING TWICE AS MUCH

Includes two built-in preamplifiers for magnetic cartridges...

Single selector switch for instant choice of desired operation...

Separate bass and treble controls with boost and attenuation...

Concentric volume control adjusts balance on each channel— plus overall volume...

DC on all preamp filaments for hum-free operation...

Dual push-pull output circuitry for smooth, clear high-fidelity output...

knight-kit 20-watt stereo hi-fi amplifier

Newest complete stereo high-fidelity amplifier at an amazing low $44.50—the most sensational value ever offered in a stereo amplifier kit. It's a pleasure to assemble. It's a truly fine instrument—the worthy heart of the finest stereo hi-fi music system. Ideal for use with newest stereo records or stereo radio broadcasts. Delivers 10 watts per channel into each of two speaker systems for 20 watts of stereo—or 20 watts into one or more speakers for monaural use. Includes two fully integrated built-in preamps to accommodate magnetic cartridges. Single switch selects phono, tuner or auxiliary stereo inputs, plus stereo reverse on each; also switches monaural input to both amplifier channels. Has separate bass and treble controls with both boost and attenuation for complete control of tonal color. Special clutch-type concentric volume control permits individual channel balance adjustment, plus overall volume control. RIAA equalized for stereo discs. Has four pairs of stereo inputs: magnetic cartridge, ceramic cartridge, tuner and auxiliary. With switched AC accessory outlet for added convenience. Response is 20-20,000 cps, ± 1.5 db. Hum and noise, better than 85 db below full output. Distortion less than 1½%. Simple point-to-point wiring for easy assembly—even without previous electronic experience. Custom cabinet attractively finished in French gray; aluminum front panel with ebony trim; 4¼ x 13¼ x 9". With case, tubes, all parts, wires, solder and instructions. Shpg. wt., 27 lbs.

Model Y-773. Knight-Kit 20-Watt Stereo Hi-Fi Amplifier Kit. Net only . . . **$44.50**

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stereo hi-fi amplifier

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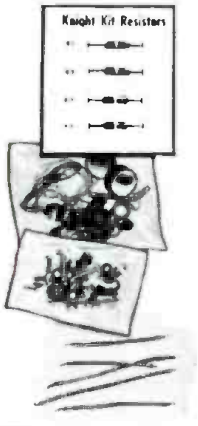
KNIGHT-KITS are an exclusive product of Allied Radio. Every KNIGHT-KIT meets or exceeds published specifications, or we refund your money in full.

BUY ANY KNIGHT-KIT! BUILD IT! IT MUST PERFORM EXACTLY AS CLAIMED— OR WE REFUND YOUR MONEY!

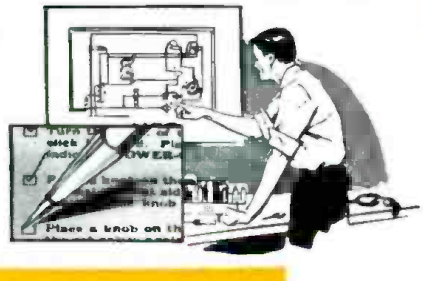
only ***knight-kits*** have

"CONVENIENCE ENGINEERING"

for easiest building...no previous electronic experience needed



Exclusive in all Knight-Kits, "convenience engineering" means special attention to every detail: resistors are carded and numbered for ease of selection...all parts and hardware are packaged in clear plastic bags for easy identification...wire is precut, stripped and color-coded to save time. Finally, Knight-Kits are world-famous for their step-by-step instructions and wall-sized picture diagrams —assembly is a marvel of simplicity. Your final reward is proud enjoyment of the superior performance designed into your Knight-Kit.



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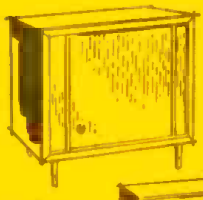
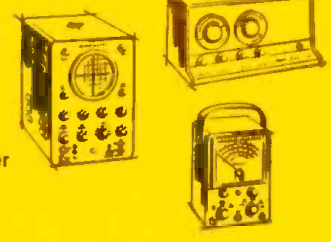
Stereo Deluxe Preamp
60-Watt Stereo Amplifier
Stereo Control
30-Watt Amplifier
25-Watt Basic Amplifier
18-Watt Amplifier
12-Watt Amplifier
FM-AM Tuner
FM Tuner
Hi-Fi Preamp
Speaker Systems, etc.



HOBBY KITS

"Span-Master" 4-Band Receiver
"Space-Spanner" Receiver
"Ranger" Radio
Clock-Radio
Radio-Intercom
"Ocean Hopper" Radio
5-Transistor Portable
2-Transistor Pocket Radio
1-Transistor Radio
Electronic Lab Kits
Photoelectronic System, and many others



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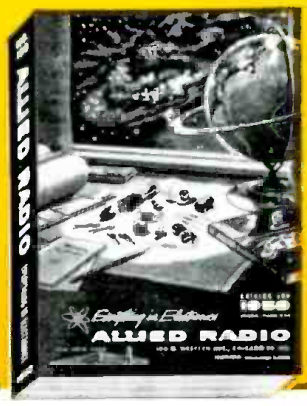
VOM's
Tube Checkers
Oscilloscopes
RF Signal Generator
Signal Tracer
Audio Generator
Sweep Generator
Capacity Checker
R/C Tester
Transistor Checker
Flyback Checker
Battery Eliminator
Sub Boxes, etc.

AMATEUR KITS

Communications Receiver
50-Watt Transmitter
Self-Powered VFO
100 kc Crystal Calibrator
RF "Q" Bridge
Code Practice Oscillator



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☐ Ship me Model Y-773 20-Watt Stereo Hi-Fi Amplifier.
$_____enclosed

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four mike inputs. At 15 ips, frequency response is 30 to 30,000 cps ±2db with flutter and wow .06% and noise ratio 57 db; at 7.5 ips the figures are 20-20,000 cps ±2 db, .08% and 54 db; while at 3.75 ips response is from 20 to 11,000 cps ±3 db, .8%, and 51 db.

Write the manufacturer direct for complete specifications on this stereo recorder.

AUDIO CATALOGUES

TUNER MEASUREMENTS

The Institute of High Fidelity Manufacturers, 125 E. 23rd Street, New York, N. Y. has just released copies of its "Standard Methods of Measurement for Tuners" which is described as the first in a comprehensive program of measurement standards for component hi-fi equipment.

Prepared by the Institute's Standard Committee in booklet form, the standard defines FM and AM terms, operating conditions, requirements and characteristics of testing apparatus, FM and AM test procedures, and test procedures for AM-FM tuners.

The Subcommittee on Tuners was chairmanned by Daniel von Recklinghausen of *H. H. Scott, Inc.*

Copies of the standard are available from the Institute at a $1.00 a copy.

"STEREO SIMPLIFIED"

The high-fidelity stereophonic reproduction of music in the home is clearly explained in the new booklet "Stereo Simplified" just released by *Sonotone Corporation* of Elmsford, N. Y.

The booklet explains, in layman's language, the entire process of stereo recording and reproduction. It is designed to help those who are interested in purchasing new stereo equipment as well as music lovers planning to convert present monophonic sets.

The company's hi-fi dealers will supply copies of this booklet without charge upon request.

"STEREO AND YOU"

Pilot Radio Corporation, 37-50 36th Street, Long Island City 1, N. Y. has just published a new booklet entitled "Stereo and You" which is available for the asking.

In this publication the company has endeavored to answer the questions that dealers and the public have been confronted with since the introduction of stereophonic sound.

BROCHURE ON STEREO

The Consumer Products Division of *Hoffman Electronic Corporation*, 3761 S. Hill St., Los Angeles 7, Calif. is offering a four-page, illustrated brochure on stereophonic hi-fi.

The two-color booklet also offers cabinet design and technical information on the firm's 1959 line of stereo consoles and companion stereo speaker/amplifiers.

Those wishing a copy of this new booklet, "Stereo-Fi," should address their requests to Dept. K of the company. —30—

SOUND ON TAPE

By BERT WHYTE

TAPE news from the West Coast Hi-Fi Shows is pretty much along the lines of the previews I gave you last month. Most of the items I listed made their appearance, with one notable exception . . . and this could be said to have more or less sounded the keynote of the shows as far as tape was concerned. In other words, the 3¾ ips, 4-channel cartridge machines and tapes in this format were, for all practical purposes, out of the picture. The anatomy of this debacle is very complicated and, to be quite candid, very "political" and I cannot go into it at this time. Suffice it to say that unless there are some drastic revisions in the thinking of certain companies, the cartridge concept is a long way from commercial realization. It will ultimately come about and undoubtedly it will have its place in the market, but I question whether it will ever loom very large as an item for the genuine quality conscious tape enthusiast.

As a long range prediction, I would say that with the application of new materials and techniques, the 3¾ ips cartridge concept might be competitive in quality with the stereo disc and might fill the needs of a large segment of the tape market. For the "all-out" hi-fi quality tape boys, the ultimate goal will be the practical development of true 3-channel stereo. As even now the two-channel stereo tape and disc market is leading engineers into new avenues of experiment with the need for miniaturization of high-quality playback equipment, this will eventually furnish the background for three-channel stereo systems of reasonable size and cost. Such systems are not in the cards for the immediate future.

But in the long interim (and it may take years) before this tape Nirvana is achieved, there must be a reasonable and practical system of high-quality tape reproduction. Obviously to achieve widespread commercial success this system must be demonstrably superior to stereo disc and, of course, must be reasonably competitive in cost. To my thinking this means something on the order of reel-type 7½ ips, 4-channel stereo tape.

As reported to you last month there have been some stirrings of interest in this concept and if enough people get behind this idea, the tape industry may have found its "Operation Bootstrap." Whether this or some other practical alternative is advanced, I think I can safely say that by the time the Fall hi-fi shows arrive, the tape business will have finally drifted out of the disc

doldrums and will be scudding smartly before the "trade winds."

BRAHMS
DOUBLE CONCERTO FOR VIOLIN AND CELLO
David Oistrakh, violinist and Pierre Fournier, cellist with Philharmonic Orchestra conducted by Alceo Galliera. Angel Stereo ST6001. Price $14.95.

Well, I managed to scrounge an *Angel* tape and I can tell those of you who may be interested in *Angel* tapes that the amount brought into this country is quite limited and you have to hunt in the shops of tape specialists or check with some of the mail-order houses to find them.

I have found the quality of the *Angel* tapes I have heard so far to be quite variable. As you probably know they utilize the "M/S" stereo recording technique (I have explained it in these pages before) and I have come to the conclusion that the results to be had from it depend to a great extent on the type of music that is recorded. As a general observation, these tapes exhibit far less directionality and more "middle fill" than tapes made to our 3-channel specification. Accordingly, in works of large dimensions and large orchestrations, the M/S works out fairly well. In scores with leaner orchestration where instrumental separation and directionality is important to the proper delineation of the music, it seems to miss its mark.

This "Double Concerto" of Brahms is a case in point . . . the superb cello playing of Fournier can be fairly well positioned in the right channel and the fabulous Oistrakh violin occupies the "middle" channel, but both are subject to "wandering," especially the violin which pops up in the left channel occasionally. Beyond this, the over-all sound is extremely diffuse, with an apparent lack of energy in the left channel. In other words, directionality in this tape is definitely limited and I don't think this will appeal to American tastes.

The tape was unusually quiet, but I am afraid that this was accomplished at the expense of the top end as it seems to be lacking in any appreciable high frequencies. Nor do bass frequencies extend very far down. Add to this a recording perspective well away from the orchestra which, with the reverberent acoustics, adds to the "formlessness" of the sound. Its very lack of solid contours lends an unobtrusiveness which may appeal to some, but hardly endear it to the sound enthusiast. It is really a shame for here is a much-needed addition to the stereo tape repertoire and the performances of Oistrakh and Fournier are breathtakingly beautiful.

RACHMANINOFF
PIANO CONCERTO #1
Byron Janis, pianist with Chicago Symphony Orchestra conducted by Fritz Reiner. Victor CCS65. Price $10.95.

This was one of the last *Victor* tape releases before the drought set in and somehow it got tucked away on my shelves where I just the other day found it! Janis is making something of a name for himself as an interpreter of Rachmaninoff and in this recording he gives a very good account of his talents in a reading that compares favorably with Rachmaninoff's own.

The sound has all of the stereo virtues and the plus of Chicago's Orchestra Hall acoustics for fine depth perspective. A good recording, but I wouldn't say one of the very best from *Victor*. But evidently the company thinks otherwise, as this was one of the tapes with which it did a great deal of the early experimenting with the stereo discs and many copies of it were given to people as a demonstration of the potentialities of the stereo discs. I might add that on subsequent comparison, the disc ran a very poor second to the tape. Perhaps the disc has been recut now in the light of more recent experience and fares a good deal better, but being admittedly prejudiced, I'd still place my dough on the tape!

BEETHOVEN
PIANO CONCERTO NO. 5 ("EMPEROR")
Jacob Lateiner, pianist with Vienna State Opera Orchestra conducted by Armando Aliberti. Westminster Stereo SWB9010. Price $14.95.

Here is a stereo tape that should enjoy a brisk sale. This is excellently done on all counts. Lateiner may not have quite the refinement of Rubenstein in his version, but this is first-rate playing with a very lovely tone production.

Soundwise this is a dandy, with fine balance between piano and orchestra. The piano is in "ghost" middle . . . and stays put, and the orchestra is well distributed left, middle, and right with excellent directivity making for good instrumental separation. Over-all sound is very clean and spacious. Highly recommended. —30—

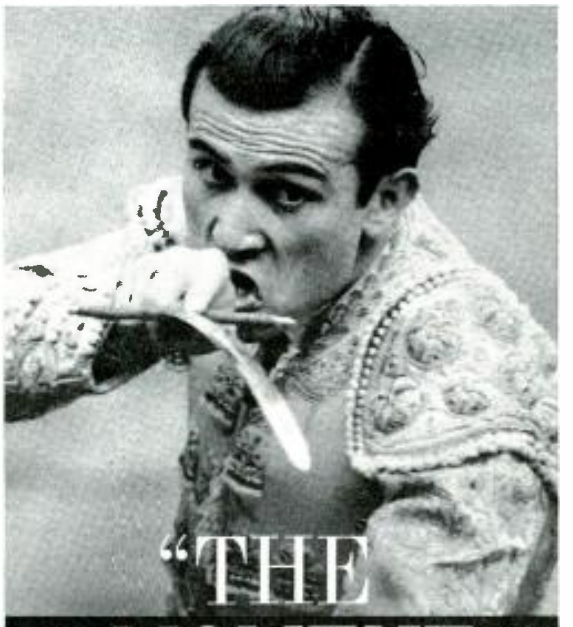
NOVICE COURSE POPULAR

ALLIED RADIO'S "Novice Code and Theory Course" for beginning radio hams has drawn a record enrollment in its just-completed Winter session.

A total of 110 students registered for the 14-week Winter course—an increase of 50 over the Fall class. According to the company, this is believed to be the largest Novice course enrollment in the country.

Classes are held in the company's cafeteria Monday evenings from 7 to 9. The course is offered free and the firm supplies telegraph keys, headphones, and paper. Tapes and records are used to broadcast the code and students having difficulty can avail themselves of personalized instruction. At the end of the 14-week course most students have a receiving speed of 8 wpm—3 wpm faster than required for the Novice license exam.

Basic radio theory is given, covering the questions on the Novice exam. George Bercos, W9WOV, and Joe Huffman, W9BHD, both of Allied are the instructors. The class shows an amazing record of 66% successful FCC exams on the first try. —30—



Juan Montero, matador.
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"THE MOMENT OF TRUTH"

. . . for the matador — it comes when he can no longer play at the game of bravery, but must at last face up to the supreme test of his courage and greatness — when he must conquer or be conquered.

. . . for the turntable or changer — it comes when the stylus deseends to the groove of a stereo record, to track as never before required . . . vertically as well as laterally, with lighter pressure, greater accuracy, less distortion and far more sensitivity—when the operation must be silent, smooth and flawless to permit the music to emerge with clarity, purity and distinetion.

Shorn of pretension and mere paper claims, every brand, every product of old must now face up to the *new* challenge wrought by stereophonic sound. Regardless of past laurels, it is *today's* performance that counts.

The United Audio DUAL-1006 . . . totally new, significantly different . . . is the *only* combination professional turntable and deluxe changer created for uncompromised stereo and monophonic reproduction.

We invite you to visit your authorized United Audio dealer . . . to submit the DUAL-1006 to the most demanding of tests . . . to see and hear it in *its* "moment of truth."

The DUAL-1006

combination professional turntable / deluxe changer for uncompromised stereo and mono reproduction

Actually tracks and operates automatically or manually with only 2 grams stylus pressure.

Choice of heavy, large diameter turntables* — new laminated concentrically-girded design retains dynamic balance and plano surface.

Rigid equipoise motor suspension principle eliminates vertical rumble.

Built-in direct reading stylus pressure/tracking force gauge.

Totally new design one-piece tonearm — provides perfect vertical and lateral tracking — no multiple arm resonance or cartridge vertical amplitude distortion.

Truly freefloating tonearm — unique clutch disengagement for complete freedom.

Multiple transmission motor drive uses individual gears for each speed — automatic disengagement makes "flat spot thumping" impossible.

Stereo-mono switch has phase-cancelling feedback circuit to remove vertical noise signal from mono records played with stereo cartridge.

Obsolescence-proof intermix for present or future record sizes.

Elevator action changer spindle safeguards record grooves and centers.

True manual (or automatic) single play — permits setting tonearm on rotating or motionless turntable.

**3½ lb. standard; 5¼ lb. optional at small extra cost.*

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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!

• Uses new improved SICO printed circuitry. • Employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability • Meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers.

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 value 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 steamlined carrying case. Operates on 110-120 volt 60 cycle. Only.. **$42.50**

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
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This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

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R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

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**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

THE ONLY 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES ALL THE FOLLOWING FEATURES:

- 6 INCH FULL-VIEW METER provides large easy-to-read calibrations No squinting or guessing when you use Model 80.
- MIRRORED SCALE permits fine accurate measurements where fractional readings are important.
- CAPACITY RANGES permit you to accurately measure all condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- HANDSOME SADDLE-STITCHED CARRYING CASE included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES
(At a sensitivity of 20,000 Ohms per Volt)
0 to 15/75/150/300/750/1500/7500 Volts.

6 A.C. VOLTAGE RANGES:
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.

3 RESISTANCE RANGES:
0 to 2,000/200,000 Ohms. 0-20 Megohms.

2 CAPACITY RANGES:
.00025 Mfd. to .3 Mfd.. .05 Mfd. to 30 Mfd.

5 D.C. CURRENT RANGES
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES:
— 6 db to + 18 db. + 14 db to + 38 db + 34 db to + 58 db

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

FEATURES:

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only **$42.50**

SUPERIOR'S NEW MODEL 76

ALL PURPOSE BRIDGE

For the first time ever: ONE TESTER PROVIDES ALL THESE SERVICES!

IT'S A **CONDENSER BRIDGE** with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A **RESISTANCE BRIDGE** with a range of 100 ohms to 5 megohms

IT'S A **SIGNAL TRACER** which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A **TV ANTENNA TESTER** The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

SPECIFICATIONS:

CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

SIGNAL TRACER SECTION
With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes: Test Leads and operating instructions. Nothing else to buy. Only **$26.95**

INDICATES RADIOACTIVITY IN 3 WAYS!

1—BY NEON
2—BY PHONE
3—BY METER

RCA RADIATION COUNTER

MADE TO SELL FOR $160°°—OFFERED FOR ONLY $47.50 NET

(Much less than cost of Manufacture.)

SPECIFICATIONS

Employs the extra sensitive 6306 Bismuth Type Geiger Counter Tube. Sensitivity is .015 Roentgens per hour (1 MR/HR=6600 counts per minute. • Three counting ranges: 0-200/2,000/20,000 counts per minute. • Handy reset button. • Ideal for survey work because the complete unit weighs only 5½ lbs. • Sight and sound indications by neon flashes and headphone. Then when an indication is obtained you switch to meter reading for exact measurements. • Decontamination easy with damp cloth applied to the weatherproofed aluminum case. • A radioactive specimen is included for instrument checking and experiments. • Included at no extra charge — U. S. Atomic Energy Commission booklet titled "Prospecting with a Counter." • R.C.A. Model WF-11AWB comes complete with self-contained batteries which provide over 200 hours of intermittent operation.

Endless experiments and discoveries in the new exciting field of nuclear energy are made possible when you acquire this finely built and engineered device. In the past, a rugged counter which was suitable for the prospecting of radio-active ores such as uranium, thorium and radium, was unsuitable for laboratory work due to the inability of combining accuracy with ruggedness. Conversely a laboratory counter, while being extremely sensitive, could not withstand use in the field where it would be subjected to abuse and abnormally hard knocks.

In the laboratory where determination of intensity (counts) of a reading are necessary, the WF-11AWB provides sensitivity for surpassing many laboratory counters.

Comes with complete set of batteries, carrying strap, headphone, radioactive specimen and A.E.C. booklet. Only ... **$47.50**

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL 82A — Multi-Socket Type

TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
  Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

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

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only **$36.50**

SUPERIOR'S NEW MODEL TD-55 — EMISSION TYPE

TUBE TESTER

FOR { THE EXPERIMENTER or PART-TIME SERVICEMAN, who has delayed purchasing a higher priced Tube Tester.
THE PROFESSIONAL SERVICEMAN, who needs an extra Tube Tester for outside calls.
THE TV SERVICE ORGANIZATION, which needs extra Tube Testers for its field men.

Speedy, yet efficient operation is accomplished by:

1. Simplification of all switching and controls.
2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

YOU CAN'T INSERT A TUBE IN WRONG SOCKET
It is impossible to insert the tube in wrong socket when using the new Model TD-55 Separate sockets are used, one for each type of tube base. If the tube fits in the socket it can be tested.

CHECKS FOR SHORTS AND LEAKAGES BETWEEN ALL ELEMENTS — The Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

"FREE-POINT" ELEMENT SWITCHING SYSTEM — The Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap."

ELEMENTAL SWITCHES ARE NUMBERED IN STRICT ACCORDANCE WITH R.M.A. SPECIFICATION — One of the most important improvements, we believe, is the fact that the 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

The Model TD-55 comes complete with operating instructions and charts. Housed in rugged steel cabinet. Use it on the bench—use it for field calls. A streamlined carrying case, included at no extra charge, accommodates the tester and book of instructions. **$26.95**

SUPERIOR'S NEW MODEL TV-12

TRANS-CONDUCTANCE

TUBE TESTER

TESTING TUBES

- Employs improved TRANS-CONDUCTANCE circuit. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- NEW LINE VOLTAGE ADJUSTING SYSTEM. A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

ALSO TESTS TRANSISTORS!

- SAFETY BUTTON—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
- NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY. Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit

TESTING TRANSISTORS

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors including NPN's, PNP's, Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Model TV-12 comes housed in handsome rugged portable cabinet and sells for only... **$72.50**

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.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only . . . **$38.50**

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

Try 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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Dept. D-598, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligations.

Name .....

Address .....

City .....Zone....State.....

All prices net, F.O.B., N. Y. C.

- ☐ Model 77 Total Price $42.50 — $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model TV-50A Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 80...Total Price $42.50 — $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 76 Total Price $26.95 — $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ RCA Radiation Counter Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82A. Total Price $36.50 — $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model TD-55...Total Price $26.95 — $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TV-12 Total Price $72.50 — $22.50 within 10 days. Balance $10.00 monthly for 5 months.
- ☐ Model 83 Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.

Tiny Vacuum Tube Rivals Transistor

High-efficiency, thimble-sized electron tubes are made possible by new RCA "Nuvistor" design.

A NEW development in vacuum-tube construction techniques that will serve to make the tube more competitive with the transistor was demonstrated recently by *RCA*. In moderate to high power uses and especially at higher frequencies, tubes made with the technique are expected to far outshine their transistor counterparts. What is more, the new construction is well suited to mass production and the finished tubes are far more rugged, reliable, and efficient than ordinary tubes. Many notions about tube construction were abandoned and the construction of the new tubes was based on a fresh design approach, both from the mechanical and electrical points of view.

Called "Nuvistors," the new tubes may find wide use in television receivers, communications receivers, and computers, as well as in more compact and efficient electronic equipment for defense and industry. Prototypes of the new tubes are now in advanced development at *RCA's* Electron Tube Division in Harrison, N. J. Developmental samples of the "new look" tubes are now being furnished to the electronics industry. A small-signal triode and a small-signal tetrode are offered at first and these will be followed later by a beam-power tube. According to present plans, limited commercial production will be started in 1960.

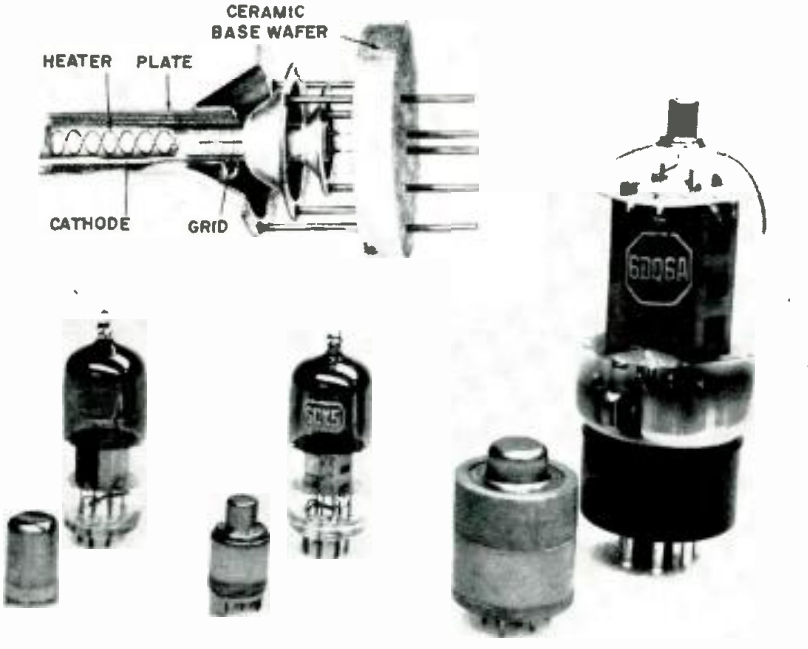
At the press demonstrations, a completely "nuvistorized" tuner unit of a television set was shown in operation. The tuner required only a fraction of the plate voltage needed by conventional tuners. This experimental tuner, believed to be among the smallest ever designed for TV receivers, reduces the over-all volume of conventional tube TV tuner units by approximately one-third.

The ruggedness of the new design was displayed in several torture and endurance tests. The tiny tube continued to function normally in an electronic circuit when placed alternately in the heating coils of a special furnace (at 660 degrees F) and in liquid nitrogen (at −320 degrees F). In another demonstration, the new tubes were shown operating continuously in both the special furnace and in liquid nitrogen. Operation of the tubes was also not disturbed as the tubes were dropped repeatedly onto a metal block from a height of several feet. A cathode-ray tube curve tracer connected to the tube being dropped showed absolutely no change in operation and performance when the tube bounced on the block. The demonstrations clearly showed the high temperature capabilities of the "Nuvistors" as well as their reliable performance under conditions of severe shock and continuous vibration.

Although life testing has not as yet been completed, it was said that tubes of this new design should have useful lives of tens or even hundreds of thousands of hours of normal operation.

—30—

Three of the new tubes, now under development, are shown below along with their larger present-day counterparts. Inset shows inside construction of the triode. The outer shell, or envelope, of the new tube is metal or metal and a ceramic.



The new dualette™ by SYLVANIA

√ MORE THAN A PORTABLE √ MORE THAN A TABLE MODEL

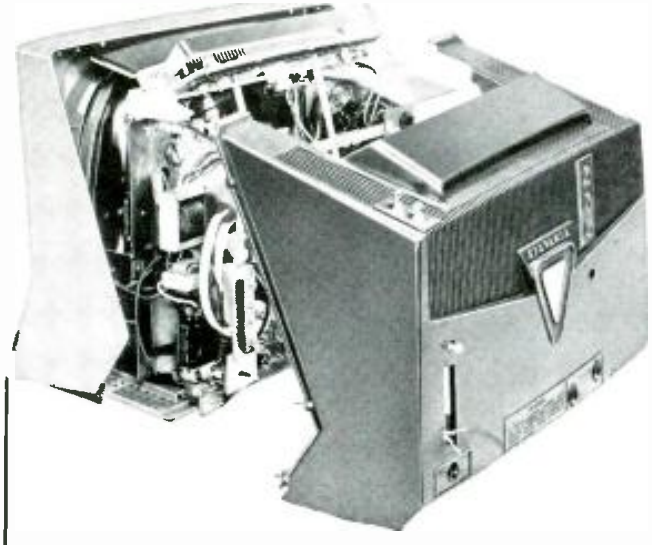
The set a serviceman can recommend to his best friend

- powerful fringe area performance
- long-life GERMANIUM OR SILICON RECTIFIERS
- exclusive "LIFETIME ENGRAVED CIRCUIT"
- shockproof, HIGH IMPACT STYRENE CABINET

for years of dependable reception

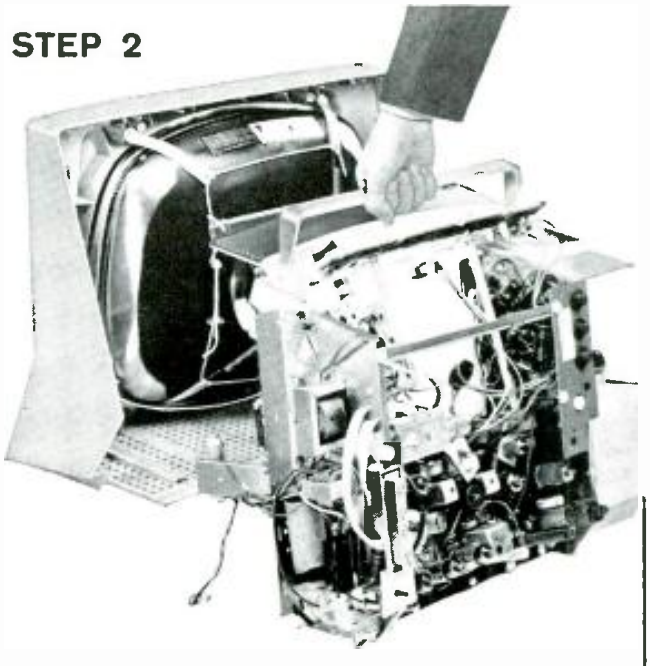
And, if service is ever necessary
TWO QUICK STEPS OPEN THE DOOR FOR ALL SERVICE JOBS

STEP 1



Take out only 8 screws to remove the back cover! All check points and tubes are accessible. A burned-out tube can be located in seconds! 90% of all service jobs and adjustments can be made without even removing the chassis!

STEP 2



Just two more screws remove the entire chassis! If it ever becomes necessary to pull the chassis, simply remove two more screws and lift it out. The dualette carrying handle becomes a carrying handle for the chassis!

Recommend SYLVANIA TV
—every set has a "LIFETIME ENGRAVED CIRCUIT"

Service Association of the Month

EMPIRE STATE FEDERATION OF ELECTRONIC TECHNICIANS ASSOCIATIONS

LAST YEAR, in an atmosphere of public resentment against the service industry, the Attorney General of the State of New York promulgated some rules that citizens could use to protect themselves against unethical service. One recommendation was to prohibit removal of their TV sets to the shop. Disturbed at the difficulties thus created for legitimate technicians when they find bench work necessary, ESFETA President Robert Larsen brought the service industry's side of the story directly to the Attorney General. After an exchange of views, more things began to develop than can be fully covered here.

ESFETA is a living example of the fact, cherished in democratic societies, that tightly centralized, arbitrary leadership is not an absolute necessity for effective organizational action. The 13 affiliates in this true federation have often gone separate ways. For instance, some are in NATESA and some are not. Furthermore, there are no plans for state action on national affiliation although the incumbent president happens to favor it. Membership qualifications also reflect wide latitude and local autonomy. Any group with at least five technician members is eligible if its code of ethics, constitution, and bylaws are compatible with those of the parent body.

Aside from being a forum for exchanging ideas, then, what good does the state machinery do? It has made united action on state and other levels pay off in ways not otherwise possible. When the industry used to get bad breaks in the past from lawmakers, manufacturers, the press, or the public, small-voiced, unorganized objections went unheard or ignored. The strong united voice, as in the case with the Attorney General, can now produce tangible results.

All ESFETA affiliates have grievance committees for handling consumer complaints, whether member shops or others are involved. The statewide grievance machinery now has the prestige of operating with the recognition of the Attorney General (just one result of conferences held with him) and thus has more teeth to bite with.

Talks with the Attorney General, the state's consumer council, and lawmakers have produced many proposals now before the legislature. They involve such matters as itemization of repair bills, identification of parts replaced as new or reconditioned, and a program for voluntary certification of technicians instead of mandatory licensing. If the latter experiment is tried and succeeds, full licensing may eventuate.

No longer ignored by set manufacturers, the state group has held mutually rewarding conferences with these. Some results—special plans for getting service data from manufacturers, probable future inclusion of a schematic on every set (from *RCA*), and greater emphasis on associations in training programs and advertising—will benefit the industry nationally.

Although locals are well scattered, 11-year old ESFETA (19 W. Cowden Pl., Jamestown, N. Y.) manages to get together five times a year. Its articulate incumbent president is supported by Irving J. Toner, vice-pres.; George Carlson, secy.; Dan Hurley, treas.; and Frank Kurowski, sgt.-at-arms. Its official organ, "ESFETAN," is a relatively new monthly. Like many other associations, it is thinking of setting up a ladies auxiliary. If its efforts to woo the only two remaining groups in the state not now members succeed, it will bring total membership strength to about 1000. —30—

Would you like us to feature your association here? Send in the coupon!

Service Editor
ELECTRONICS WORLD
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New York 16, New York

We want to tell you more about our association. Please send us your questionnaire.

Name of Association.....

Mailing Address.....

.....

Name of President or Corresponding Sec'y.....

Mac's Service Shop

(*Continued from page 68*)

arrange his light so that he can view what goes on beneath the turntable. Then he revolves the turntable slowly with his finger while he watches carefully to see if each of the actions described in the change-cycle actually takes place in the proper manner and sequence. When something fails to happen, or when it happens at the wrong time, with any luck he has found the trouble."

"You sure have to turn the thing by hand," Barney remarked. "Trying to spot trouble while the motor is doing the turning is like trying to watch all three rings of a three-ring circus on speeded-up film."

"Once in a great while, though, something will show up when the motor is doing the turning that will not be there when the turntable is rotated by hand. I had a case of that last week. The customer admitted that the changer had operated perfectly until he decided to 'give it a good cleaning and oiling.' In the process he carefully cleaned off the heavy grease from around a small pawl on the rim of the main drive gear that had to be pushed outward to start the change cycle. This grease was put there intentionally to keep the pawl from moving out under vibration and centrifugal force as the drive gear made its revolution. With the damping grease gone, the pawl did just that and kept the changer cycling. It would not move out when the turntable was revolved by hand. Very fortunately, in the list of possible difficulties given in the changer manual, the lack of this grease was mentioned as a likely cause of continual cycling."

"That 'Trouble Chart' in the service data is my favorite reading," Barney confided. "I love the way they list first the 'symptom;' then the 'possible causes'; and finally the 'remedy.' Nine times out of ten you'll find the cause and cure for any particular fault listed in these charts, no matter if it's turntable wow, recycling, failure to cycle, improper set-down point of the needle, dropping two records at a time, improper turntable speed, or what have you. When you have a specific complaint to go on, that's the place to look."

A broad grin spread across Mac's wrinkled face. "Sure is funny," he commented, "how, when we have all this good help, we still both hate to work on changers and will work on practically anything else in the shop first."

"It *is* queer," Barney agreed. "But I kind of think part of it is that we unconsciously consider working on record changers sort of *infra dig*, or beneath our dignity, as my Latin teacher used to put it. Changer work is 'mechanical work'; and we are proud and haughty 'electronic technicians!'"

—30—

Radio Sextant Tracks Moon

New precision instrument aboard Navy experimental navigation ship has ten times the accuracy of present marine compasses.

Control console aboard navigation ship.

FOR the first time in history, the moon has been tracked continuously by radio through the use of a new precision radio sextant designed and constructed by *Collins Radio Company*. The new radio sextant has been delivered and installed aboard the Navy's experimental navigation ship, the USS "Compass Island," where it is used in navigation research. The unit is also used to track the sun and such tracking is possible even under foul weather conditions. In addition, the sextant functions as a precise compass, furnishing the direction of north with more than ten times the accuracy of present marine compasses.

The instrument utilizes a 5-foot parabolic antenna connected to an extremely sensitive radio receiver that measures the thermal radiation in the short microwave region. Operation is at a wavelength of 1.8 centimeters (about 16,500 mc.). A new tracking system involving advanced servo techniques is used. A special remote angle read-out system, which can punch its data directly on cards with great precision, is part of the installation. It is also possible to control and check all phases of operation from a remote-control console. From a mechanical standpoint, machining processes with tolerances as small as 25 millionths of an inch were required, and new procedures for optical alignment were worked out. In order to provide the necessary mechanical precision, an air-conditioning and heating system is used to maintain the equipment at a constant temperature at all times.

Aboard the USS "Compass Island," radio sextant observational data is coupled with the vessel's precision time standard and presented directly to a navigational computer. This then combines celestial and intertial data to determine the ship's location and true north.

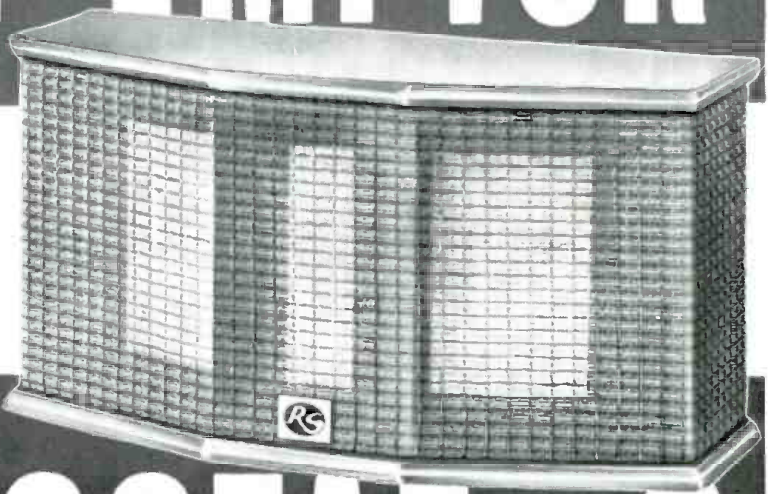
The sextant operates by picking up radiation from the moon or sun. Such radiation fluctuates in the same fashion as the Johnson noise from a resistor, making detection of the weak signal difficult. In this instrument, the antenna scans a circle around the sun or moon's rim. If the antenna is pointed directly at the sun or moon, the received signal will show no modulation at the scanning frequency, but if the antenna is displaced slightly, the moon or sun signal will be modulated. Phase-sensitive detectors derive error voltages which are used to make the radio sextant's antenna track the sun or moon.

The use of other heavenly bodies, such as radio stars, is presently very difficult with practical size receiving equipment. These stars produce extremely weak radiation in a much longer wavelength portion of the microwave region so that high resolving power is difficult to achieve with reasonably compact equipment of the type described above. —30—

Antenna system of the AN/SRN-4 radio sextant installed on the USS "Compass Island."

CAVEAT EMPTOR*

*LET THE BUYER BEWARE



IMPORTANT NOTICE:

NO OTHER COMPANY has been authorized by Radio Shack or The Factory to sell or advertise the famous Electrostat-3, and no company other than Radio Shack has delivered **or can deliver** this unit!

REALISTIC ELECTROSTAT-3

THE MOST PUBLICIZED — MOST WANTED — TWEETER IN ALL HI-FI HISTORY!

3 ELECTROSTATIC ELEMENTS FOR 120° SOUND DISPERSION

BUILT-IN AC POWER SUPPLY TO PROVIDE EXACT VOLTAGE

This is the unique electrostatic tweeter—*the only tweeter*—that has been getting RAVE NOTICES from the hi-fi test laboratories. This is the tweeter that makes any speaker system a better speaker system by its addition. ONLY RADIO SHACK—in all the world—*sells it, delivers it!* When used with any good high compliance speaker system, Electrostat-3 adds a smooth and silky response from 5,000 cycles to 25,000 cycles—beyond the range of human hearing. And its wide dispersion angle carries its new world of acoustic brilliance to all corners of the room. Compact size: 11⅞" wide x 5⅞" high x 4½" deep. In mahogany, blond or walnut finish. ORDER TODAY and hear the "highs" that have brought the whole audio world to our door!

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Includes coils, condensers and L pad, complete with simplified assembly instructions. Available for either 8 ohms or 16 ohms.....4.95

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	16-ohm X-over	2 lbs.	91L505	4.95
	15-watt Amp	15 lbs.	90LX000Y	49.95
	16" Stereo Arm	3 lbs.	91L050	15.90
	FM-3 Tuner	11 lbs.	90LX040	44.50
	SOLO Speaker	12 lbs.	90LX250	15.95

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Foreign Tube Substitution Data

Foreign tubes that are hard to replace are listed by Sylvania, with possible domestic substitutions.

EUR. TYPE	AMER. TYPE	CODE*	EUR. TYPE	AMER. TYPE	CODE*	EUR. TYPE	AMER. TYPE	CODE*
1C1	1R5	NR	DL95	3Q4	ER	HF93	12BA6	NR
1D13	1A3	ER	DL98	3B4	NR	HF94	12AU6	NR
1F2	1L4	NR	DP61	6AK5	ER	HK90	12BE6	NR
1F3	1T4	ER	DY30	1B3GT	ER	HL90	19AQ5	ER
1FD9	1S5	ER	DY80	1X2A	NR	HL92	50C5	ER
1P10	3S4	ER	EAA91	6AL5	NR	HMO4	6BE6	ER
1P11	3V4	NR	EABC80	6T8	ER	HY90	35W4	ER
6D2	6AL5	NR	EB34	6H6G	NR	KT32	25L6GT	ER
6E8	6A8	NR	EB91	6AL5	NR	KT63	6F6G	ER
6H8G	6B8	NR	EBC33	1639	NR	KT66	6L6, 5881	NR
6M1	6U5G	ER	EBC90	6AT6	NR	KTW63	6K7G	ER
63ME	6U5G	ER	EBC91	6AV6	NR	L63	6J5GT	NR
108C1	OB2	NR	EC90	6C4	ER	L77	6C4	ER
150C2	OA2	NR	EC92	6AB4	ER	N14	1C5GT	NR
B36	12SN7GT	ER	ECC33	6SN7	NR	N17	3S4	NR
B65	6SN7	ER	ECC35	6SL7GT	NR	N18	3Q4	ER
B152	12AT7	ER	ECC40	6N7	NR	N19	3V4	NR
B309	12AT7	ER	ECC81	12AT7	ER	N77	6AL5	ER
B329	12AU7	NR	ECC82	12AU7	NR	N148	7C5	NR
B339	12AX7	ER	ECC83	12AX7	ER	N709	6BQ5	NR
BPMO4	6AQ5	ER	ECC84	6BQ7A	NR	N727	6AQ5	ER
D63	6H6G	ER	ECC91	6J6	NR	PCF82	9U8A	ER
D77	6AL5	ER	ECF80	6A8GT	NR	PL21	2L21	ER
D152	6AL5	ER	ECF82	6U8	ER	PMO4	6BA6	NR
DA90	1A3	ER	ECH81	6BA7	NR	PMO5	6AK5	NR
DAC32	1H5GT	NR	ED2	6AL5	ER	QEO6/50	807	NR
DAF91	1S5	NR	EF93	6BA6	NR	QVO5/25	807	NR
DAF92	1U5	ER	EF94	6AU6	NR	U50	5Y3G/GT	ER
DCC90	3A5	ER	EF95	6AK5	NR	U52	5U4G/GB	ER
DD6	6AL5	ER	EF96	6AG5	ER	U70	6X5GT	NR
DF33	1N5GT	ER	EH90	6CS6	ER	U78	6X4	NR
DF62	1AD4	ER	EK90	6BE6	ER	U147	6X5GT	NR
DF651	CK549	ER	EL37	6L6/6L6GB	ER	U149	7Y4	NR
DF91	1T4	NR	EL84	6BQ5	ER	UF41	12AC5	ER
DF92	1L4	NR	EL90	6AQ5	ER	V2M70	6X4	NR
DF96	1AF4	ER	EL91	6AK6	NR	W17	1T4	NR
DF904	1U4	ER	EM35	6U5G	ER	W63	6K7G	NR
DH63 (M)	6Q7G/GT	NR	EY81	6V3A	NR	W149	7Y4	NR
DH77	6AT6	NR	EZ35	6X5/GT	NR	X14	1A7GT	NR
DH149	7C6	ER	EZ81	6BW4	NR	X17	1R5	NR
DK32	1A7GT	NR	EZ90	6X4	NR	X63 (M)	6A8G	NR
DK91	1R5	NR	GZ30	5Z4	ER	X81	7S7	NR
DL33	3Q5GT	ER	GZ32	5V4G	ER	X148	7S7	NR
DL35	1C5GT	NR	GZ34	5U4G/GB	NR	X727	6BE6	ER
DL36	1Q5GT	ER	H63	6F5/G	ER	Y61	6U5G	ER
DL651	CK546	ER	HABC80	19T8	NR	Y63	6U5G	ER
DL91	1S4	NR	HBC90	12AT6	NR	Z14	1N5GT	ER
DL92	3S4	NR	HBC91	12AV6	NR	Z63	6J7G	NR
DL93	3A4	NR	HD14	1H5GT	NR	Z300T	OA4	NR
DL94	3V4	ER	HD30	3B4	ER	ZD17	1S5	NR

Code*: ER denotes exact replacement. NR denotes nearest replacement. Socket and/or wiring changes may be involved here, or slightly different electrical characteristics and ratings may have to be considered in some circuits.

NOTE: The increasing sale of imported receivers and audio equipment has resulted in the problem of obtaining replacements for some of the unfamiliar tubes used. This list, reprinted through the courtesy of Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., is believed to be accurate. However, neither Sylvania nor ELECTRONICS WORLD assumes responsibility in case of error. The complete Sylvania list also includes foreign-made replacements, available in this country, for other foreign-made tubes that are not generally marketed here. These additional listings will appear in a forthcoming issue.

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Your present customers and prospects for intercom installations and sound systems are first-rate prospects for the new SCRIBE magnetic tape dictation systems.

SCRIBE records the voice with greater fidelity than any other dictation equipment now on the market. Electronic controls, a powerful motor giving instantaneous start and stop for re-recording of even single-word errors, plus both fast forward and fast rewind speeds permit completely error-free dictation—cuts dictating and transcribing time, eliminates misunderstood words. SCRIBEPAK preloaded tape magazine holds 30 or 60 minutes of Mylar tape . . . user never has to touch the tape.

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DEALERSHIPS FOR THE NEW 1959 line of SCRIBE machines and network systems are available in many cities, offering unusual opportunities for immediate profits with modest capital investment. Adequate sales and service facilities are required.

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The CORMAG® mechanism assures magnetic shielding . . . the spring-backed jewels, shock and vibration resistance . . . the meter housing, electrostatic shielding . . . the case, impact resistance. And the ohm ranges are fuse protected.

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IN-CIRCUIT CONDENSER TESTER

Model CT-1

AN ABSOLUTE 'MUST' FOR EVERY SERVICEMAN!

Here is an in-circuit condenser tester that does the whole job. The CT-1 actually steps in and takes over where all other in-circuit condenser testers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation. . . .

in-circuit checks:

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

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

SIZE: W–6" H–7" D–3¼"

out-of-circuit checks:

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

SPECIFICATIONS

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

MINI-CHECK TUBE TESTER

Model MC-1

A Real ECONOMY MULTIPLE SOCKET TUBE TESTER without sacrifice in ACCURACY, SPEED or VERSATILITY

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

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

SIZE: W–9" H–8½" D–2¾"

SPECIFICATIONS

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

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

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

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.

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

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

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

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

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

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

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

TRANSISTOR TESTER Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.

SPECIFICATIONS

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

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

SIZE: W–6" H–7" D–3¼"

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

EASY TO BUY IF SATISFIED

see order form on facing page

FOR 10 DAY FREE TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * Patent Pending

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

1 DC Probe **2 AC Probe** **3 Lo-Cap Probe** **4 RF Probe**

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize 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 do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

SIZE:
W-7⅜"
H-9"
D-4¼"

FUNCTIONS

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.

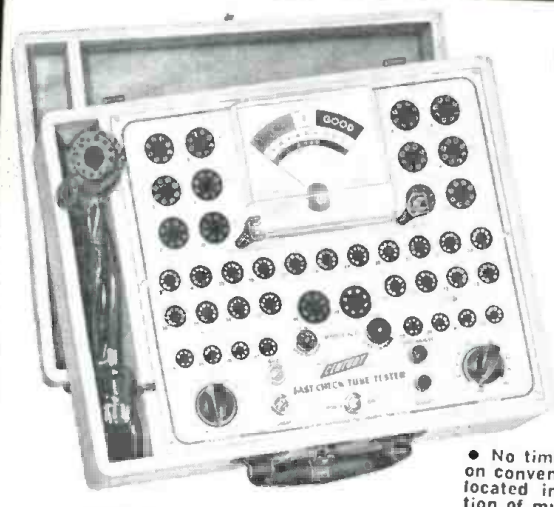
OUTSTANDING FEATURES

• Completely portable — self powered with long life batteries — permits use everywhere • New advanced pentode amplifier circuit assures amazingly low battery drain • Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s • Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC • Simplified multi-color easy-to-read 4-scale meter • No heat operation assures rigid stability and accuracy • Immune to power line fluctuations • Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments • Meter completely isolated — practically burn-out proof • Hand-crafted circuitry eliminates the service headaches of printed circuitry • 1% resistors used for permanent accuracy • Separate RF ground return for low-loss RF measurement • Microphone type co-axial connector • Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- 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 — 0 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
- Decibels — from —10 Db to +10/22/36/50/62 based on the Dbm unit: 0Db-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 VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE and thorough instruction manual covering all the applications in detail. **$58.50 Net**



SIZE: W—14⅝" H—11¼" D—4⅜"

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

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 700 tubes 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

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

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

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

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

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CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CT-1 In-Circuit Condenser Tester $34.50
  $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model MC-1 Mini-Check Tube Tester $39.50
  $9.50 within 10 days. Balance $6 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester $29.50
  $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester $24.50
  $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter $58.50
  $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester $69.50
  $14.50 within 10 days. Balance $11 monthly for 5 months.

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

111 Roosevelt Avenue, Dept. 205, Mineola, New York

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

Name .....
Please print clearly

Address .....

City ..... State .....

Ultra-stable Amplifier

(*Continued from page* 72)

distortion and the instrument used was a *Measurements* Model 31 IM analyzer. See Fig. 6.

Transient response: This can best he evaluated with a square-wave signal. See Fig. 5. These photographs were taken with a *Tektronix* Model 514 oscilloscope. The output load was a 16-ohm resistor. Note the absence of tilt on the 20-cycle square wave and the complete absence of ringing on the 20,000-cycle square wave. Few output-transformer-coupled amplifiers can duplicate this response.

Power output: This varies with the impedance of the loudspeaker. See Fig. 7. It is recommended that a 15-ohm or higher impedance loudspeaker system be used. With a 16-ohm loudspeaker the peak power is 38 watts. At frequencies where the impedance of the loudspeaker rises, the peak power is correspondingly increased. Figs. 8 and 9 show the impedance curves of two loudspeaker systems owned by the author; an *RCA* LC-1A mounted in a ten-cubic-foot infinite baffle and a *KLH* Model 4. It is interesting to calculate the power output capabilities of this OTL amplifier at various frequencies when using these loudspeaker systems.

Listeners who have visited the author's home (average size living room) have agreed that there is more than adequate power available, even when reproducing heavy orchestral passages. This was so even on the *KLH* Model 4. Careful monitoring of selected program material, using an oscilloscope, has shown a moderate amount of clipping at signal peaks, but the extremely fast overload recovery of the OTL amplifier has not made them discernible to the ear.

Gain: The gain of the amplifier is 8.5; that is, 1 volt of signal into the amplifier will produce 8.5 volts across the output. For maximum output using a 16-ohm load slightly over 2 volts is required. This is available from most preamplifiers.

Feedback: This amplifier uses 35 db of over-all negative feedback. The complete stability of the OTL amplifier can be dramatically demonstrated by connecting a 3000-ohm control in parallel with the feedback resistor R_{25}. The normal gain of the amplifier is 8.5; with the total resistance of the control in the circuit the gain is approximately 8 and the feedback 36 db. When the control shorts out R_{25}, there is 100% negative feedback (54 db) and the gain of the amplifier is reduced to unity. Even under these conditions there is no evidence of instability. Again, no output-transformer-coupled amplifier can duplicate this stability. (If there is need for a remote gain control, such as in a stereo setup, then this control is ideally suited as it is in a very low impedance circuit.)

Damping factor: Referred to 16 ohms, the damping factor is 80. This figure was arrived at as follows. A signal at 400 cycles from the *Precision* E300 signal generator was fed to the input of the amplifier. The meter section of the *Hewlett-Packard* 330B distortion analyzer was connected to the output of the amplifier and the signal level adjusted to read full-scale on the .3 volt range of the meter. This was with no load connected to the output. A *General Radio* 1432F decade box was then connected to the output and the resistance reduced until the meter reading was .15 volt. This occurred at a load resistance of .2 ohm, the damping factor being the ratio of the internal impedance of the amplifier (.2 ohm) and the output load.

Miscellaneous additional specifications of interest include: Hum and noise—50 dbm. Power consumption at a 117-volt line, when reproducing program material at average room volume, is 110 watts.

At this point it might be well to consider that this amplifier is designed to reproduce program material only; that is, music and speech. It is not intended for sine-wave signals and prolonged testing, at high outputs, with this type of signal will shorten the otherwise long life of the 12B4A output tubes. It should be appreciated that in the amplification of the complex signals that make up music and speech, the instantaneous power requirements are very many times the power averaged over a period of time. What we desired is an amplifier which, in the absence of signal input, uses a minimum amount of current from its power supplies and a minimum amount of plate dissipation and, when called upon to do so, can deliver a large amount of undistorted power within the average plate dissipation of its power tubes. This we have accomplished in what we believe is a novel and economical manner in the amplifier described here.

Enough of specifications! How does the amplifier sound? We honestly believe that it is the closest thing to perfection yet developed in an audio power amplifier. Given associated components of first-class quality and good program material, it recreates thrilling sound.

—30—

"OK, Joe. That's perfect, tighten her up!"

Generating Crystal Signals

(*Continued from page 67*)

The possibility of extreme error just discussed will not usually arise and can be easily avoided. A more typical case, for example, would be the pairing of units rated at 8010 kc. and 4500 kc. to produce a difference of 3510 kc. Since these are not too close together, the least favorable combination of errors (assuming the rated tolerance of .01% for each) would result in an approximate error of .036% at 3510 kc. This is probably less than could be detected by reading the dial of a conventional signal generator.

Sum heterodynes, of course, allow far less possibility of error. Here the deviation in the output will be greatest when the individual crystals err in the *same* direction. Even in this case, however, accuracy will be no worse than that of the individual crystals.

Additional Uses

The twin-crystal heterodyne oscillator circuit may be used to compare the frequencies of two crystals having the same nominal frequency, as a check on accuracy. To perform this task, simply connect sensitive headphones with good low-frequency response (or an amplifier-speaker combination good in the lows) to the output of the circuit in Fig. 1 or 2. The difference frequency, if greater than about 40 cps, will be audible. This output can be compared with that of a calibrated audio generator.

Another valuable application is the determination of actual frequency for crystals that are unmarked (or incorrectly marked). Place the unknown unit in one socket of the oscillator and another crystal of known frequency in the other socket. The difference output they produce (the available output signal that is lowest in frequency) can, in turn, be zero-beat against the already calibrated variable signal generator, using the arrangement shown in Fig. 3.

This method still leaves two possible values for the unknown, but doubt can be resolved easily. For example, suppose an unknown crystal has been paired with another whose frequency is known to be 3105 kc. The difference output is found at 970 kc. To produce this difference, the unknown may be beating either above or below the frequency of the known unit. Frequency of the unknown may therefore be either 4075 kc. or 2135 kc.

To determine which value is correct, simply repeat the test using another crystal of known frequency. For example, the unknown is next paired with one rated at 3550 kc. and the beat is found at 525 kc. The results of this test alone would indicate the frequency of the unknown to be either 3025 or 4075 kc. Comparing both test results obviously establishes the value of the unknown at 4075 kc. —30—

By **WILLIAM C. CALDWELL**

Rational troubleshooting based on clear-cut rules can end the futility of hit-and-miss procedures.

Save Time on Transistor Radios

GET OUT your meter, put on your thinking cap, and let's see how we can put those increasingly popular transistor portables back into your customers' pockets almost before they miss them. It is possible to do this if a few simple rules and transistor principles are observed:

Rule 1. Always keep a voltmeter handy and don't be afraid to use it. A 20,000-ohms-per-volt instrument is perfectly satisfactory in most cases. In fact, since it requires no periodic zero adjustments, it can prevent errors and save time when reading small voltages and biases.

Rule 2. Use miniaturized tools for miniaturized components—small screwdrivers, pliers, and a small (20 to 40 watt) soldering iron. Nothing like the right tool for the job.

Rule 3. Use a system; never just "hunt or poke" around.

"But what sort of system shall I use?" you ask. Simply follow the rules already mentioned, along with some other common electronic principles that will be pointed out here, and you're in business. Before stating these principles, let's review some working facts about transistors:

1. There are two basic transistor types commonly used in portable radios, *n-p-n* and *p-n-p*. Of these two, the *n-p-n* may be more closely compared to a vacuum tube: one element emits electrons that are influenced (biased) by the base as they are attracted toward a collector that has a positive potential on it.

2. The *p-n-p* transistor differs from the *n-p-n* primarily in the direction that electrons flow through it. They move from collector to emitter, but this flow is still influenced by the potential (bias) between base and emitter. With this reversed internal operation, externally applied voltages are also turned around: the most positive potential is applied to the emitter.

3. In terms of their use in the radio, transistors may also be divided into three general categories. *Low-power* types are generaly used in such stages as r.f., local oscillator, converter, i.f., a.g.c. amplifiers, and small audio amplifiers (under 50 milliwatts) like those found in hearing aids. *Medium-power* transistors may be used as audio drivers (50 milliwatts or more) or in audio-output stages of small portables. *High-power* (or simply "power") types are used in the audio-output stages of car radios or larger portables that are capable of one watt of output or more.

Troubleshooting Procedure

Now we are ready to take a typical portable and apply some of the principles involved. The first step always is to check battery voltage under load (radio on). This reading should be within 10 per-cent of rated voltage if standard zinc-carbon batteries are used or within 5 per-cent of rated voltage if mercury batteries are involved. Bad batteries can cause any number of conditions: weak, dead, or distorted sound, or even instability and oscillation.

While at the batteries, it is a very simple matter to find out how much current the radio is drawing without unsoldering any leads if the batteries are mounted in clips. Simply insert a piece of paper as an insulator between one end of a battery and its clip. Switch the meter to the appropriate milliampere range and measure across the open battery connection, with no signal and minimum volume on the receiver. If more than 25 per-cent over the normal drain is indicated you should be looking for a short somewhere, not an open condition. If several times the normal value of drain is noted, you probably have an "A" line short, such as in an electrolytic capacitor.

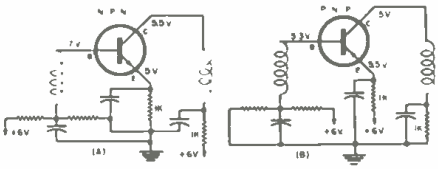


Fig. 1. Typical transistor stages.

Fig. 2. Open condition in base circuit.

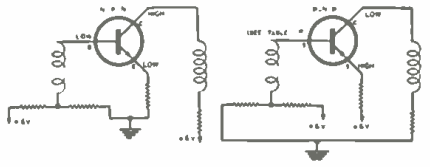


Fig. 3. Open condition in collector.

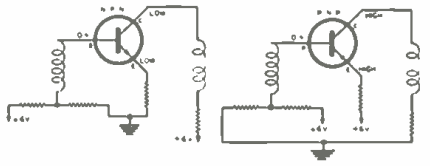
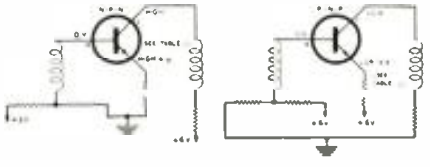


Fig. 4. Open condition in the emitter.



Next, if any sign of instability is present—oscillation, motorboating, whistles, or howl on stations—substitute good electrolytics across the ones in the circuit. If not, isolate the trouble to a stage or section of the radio.

Some manufacturers give a step-by-step procedure for stage isolation in their service literature. A good example is the *Delco Radio Division* of *General Motors*. This company describes both a "click" test and a signal-generator approach for auto-radio portables. The "click" test (touching a 10,000-ohm protection resistor from certain transistor elements to ground while listening for a slight noise as this is done) is usually the fastest procedure for a completely dead radio. The signal-generator approach is often best for a set that is merely weak. A resistor installed in a test lead, with clips on both ends, has proved very

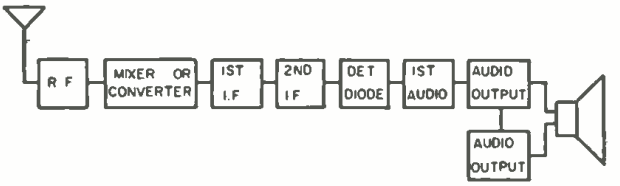


Fig. 5. Block diagram for deluxe transistor portables.

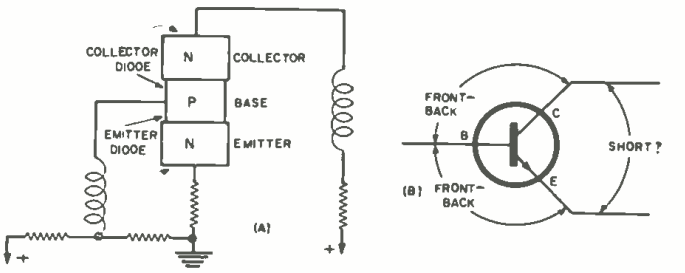


Fig. 6. Internal elements (A) in an "n-p-n" transistor. (B) Points for checking individual transistor "diodes."

helpful in troubleshooting dead portables. The resistor prevents damage to transistors and i.f. transformers.

For example, in the block diagram of Fig. 5, a click should be heard at the base of the first audio transistor unless the trouble is present in one of the audio stages. Then, moving toward the front end, a click should be heard at the collector element of the mixer stage. If not, one of the i.f. stages is at fault.

In some radios, clicks may be heard within the i.f. stages, but in others the gain is not sufficient. The general rule is that, if two i.f. stages are present, a click at the first i.f. collector or base may be heard but, if the radio uses only one i.f. stage, the collector of the mixer stage is the first click test point after the first audio stage. Then, moving to the r.f. stage, a click should be heard at the base element and at the "hot" end of the loop antenna when it is touched with a screwdriver that is "grounded" by the grip of your hand.

Since radios vary in their ability to pass these test signals, it is advisable to try clicks and signal-generator injections at various points in order to get the feel of normal responses and to gain self-confidence. The volume control should be set at maximum in these tests. One important point: when using a signal generator, always start with a low r.f. gain setting and increase gradually to prevent blocking the stages with excessive signal. The amount of signal required, of course, should decrease as one moves toward the front end.

In-Stage Isolation

After stage or section isolation, the next step is to pinpoint quickly the defective part, connection, or circuit point. This is where that voltmeter and those previously mentioned transistor principles come in handy. Voltages should be measured carefully in the suspected stage or stages. Assuming that the battery voltage is normal, stage voltages are usually accurate to ± 10 per-cent for voltages above one volt. Accuracy of voltages below one volt is usually .1 volt. If battery voltage is not quite at rated value, allowances would have to be made in measuring the stage voltages. This is another good reason for always measuring source voltage first.

Fig. 1A shows a typical *n-p-n* amplifier stage and Fig. 1B shows the same circuit revised for *p-n-p* operation. The voltages are "normal" ones, taken with respect to ground. (In this article, the negative pole of the battery is at ground potential. If a positive ground is used in a circuit being checked, the direction of change in voltage with each defect, would be reversed from that shown here.)

Before launching into a discussion of defects and their symptoms, one point is worth clarifying. Reference is made in what follows to "open" transformers and resistors. Actually these conditions are seldom found in transistor radios except in the output stages of auto radios where the emitter resistor also serves as a fuse. In actual practice, apparently open conditions of this kind would end up as poor connections, usually repaired by heating solder joints slightly, rather than as true internal opens. However, the assumption of open transformers and resistors is useful for the purpose of explanation and clarification. Now for principles:

Principle 1. With an open transformer in the base circuit, voltages around the transistor elements will change in the directions indicated in Fig. 2. Note that voltages for an *n-p-n* transistor tend to go in the same direction that a tube's voltages would go under similar circumstances. The *p-n-p* voltages change in the opposite direction. In either case, the floating base tends to assume the emitter voltage; thus there will be no difference in potential between emitter and base.

Principle 2. With an open transformer in the collector circuit, transistor voltages will change in the direction shown in Fig. 3. In this case, the emitter measures the same as its source potential (ground or battery voltage, as a rule), indicating that no collector current is flowing through the emitter resistor. The collector assumes the same voltage, making this condition easy to detect.

Principle 3. With an open stabilizing resistor in the emitter circuit (or an open in the printed wiring of the emitter circuit), transistor voltages will alter in the direction shown in Fig. 4. The emitter assumes the voltage of the adjacent element (in terms of internal construction), and again there is no potential difference between base and emitter.

Principle 4. When the lead to the transistor base is internally open, voltages will change in the direction shown in Fig. 7.

Principle 5. With an internal short or high leakage between emitter and collector, voltages will change in the direction shown in Fig. 8.

Note that the transistor that has become leaky or shorted in this way can cause the emitter-to-base voltage relationship to be reversed from normal. That is, if the emitter voltage is supposed to be higher than the base voltage, it will become lower, or *vice versa* in this instance.

Based on the typical arrangements shown in Fig. 1 for the two types of transistors, and the defects illustrated in Figs. 2 through 8, a summary of defect indications is given in Table 1. Until the symptoms described are memorized, it might be useful to keep a copy of this table handy for ready

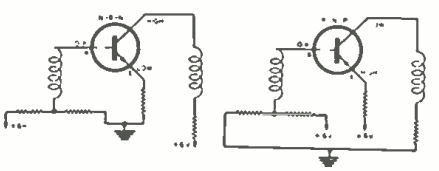


Fig. 7. Open lead in transistor base.

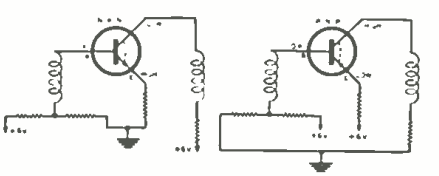


Fig. 8. Emitter-to-collector leakage.

Table 1. A summary of typical defect indications in transistor circuits.

DEFECT	N-P-N			P-N-P		
	Collector	Emitter	Base	Collector	Emitter	Base
Open Base Transformer	High	Low	Low	Low	High	*
Open Collector Coil	Low	Low	OK	High	High	OK
Open Emitter Resistor	High	High**	OK	Low	Low**	OK
Open Base (internal)	High	Low	OK	Low	High	OK
Emitter-Collector Leak	Low	High	OK	High	Low	OK

NOTES:
All indications will be opposite to those listed if a positive ground is used.
*Reading depends on resistance of meter.
**Small change only. Emitter assumes voltage on base.

reference when defective transistor radios come along.

Circuit components, component connections, and printed-circuit wiring are the first items checked in a suspected stage, of course. Only after these have been examined should the transistor itself be checked.

Transistor Tests

Certain facts about a transistor can best be determined by leaving that transistor mounted in its circuit. This is a blessing in troubleshooting, especially where the transistor leads are soldered into the circuit. In Fig. 6A some facts about the internal construction of an *n-p-n* transistor are highlighted. Note that it may be regarded as two diodes back-to-back—an *n-p* emitter-to-base diode and an *n-p* collector-to-base diode. It is common to refer to these as simply the collector diode and the emitter diode.

To test for individual diode action, simply check for a front-to-back resistance ratio on each diode, using an ohmmeter. The best scale to use is easily found by experience and is determined by the transistor type and resistance values in the external circuit. The general rule is to start on the R x 100 scale and never use the R x 1 or R x 10,000 scale for low-power transistors (r.f., converter, i.f., etc.). Most ohmmeters are capable of drawing up to 100 ma. current on the R x 1 scale with a 1.5-volt internal battery and have 15 ohms of series resistance internally (I = 1.5/15 = .100 ampere). This is too much for some of the small transistors. In addition, the v.o.m. type meters sometimes switch in a 22.5-volt battery on the R x 10,000 range, making that scale undesirable for this application since the voltage rating of the transistor may be exceeded.

In-Circuit Test Example: Turn radio off, set meter on R x 100 range, and place it between base and collector elements. See Fig. 6B. Note resistance. Then reverse the ohmmeter leads and again check base-to-collector resistance. The reading should change.

If, however, this is an audio stage (medium-power transistor) and the reading is near the low end of the scale during both checks, switch to the next lowest range (R x 10 or R x 1) and try again. This is permissible with most audio transistors, since they are not likely to be damaged, and the lower circuit resistances in audio stages make it necessary to use the lowest ranges in some cases.

The next step is to check the emitter-to-base diode in the same manner, as shown in Fig. 6. If no change in resistance takes place as the leads are reversed in each case, one of the leads in the transistor may be open. However, before the transistor is discarded, a final check is always made with the transistor removed from the circuit.

Another check is to make certain that the transistor is not shorted between emitter and collector. See Fig. 6B. Start on the R x 100 scale and work down in range until a short is

ruled out. This will not damage even the low-power transistors. When removed from the circuit, most low-power transistors read over 5000 ohms on this test, medium-power transistors over 500 ohms, and power transistors over 50 ohms. The readings will be lower in the circuit, but should not show a complete short.

Power transistors, although not used in most portables, should be checked according to manufacturers' recommendations. They usually have to be removed from the circuit due to the low circuit resistances involved.

Unlike tubes, transistors rarely fail and should not be suspected first. Because of close proximity of connections in most transistor radios, more circuit shorts and loose connections are found than defective transistors. Also, due to the miniaturized i.f.'s and capacitors, a greater percentage of these parts are found defective in portables.

Summary

1. Check the batteries under load.
2. If signs of instability are noted—oscillation, whistles, motorboating, or slight howl on stations—substitute good capacitors across the miniature electrolytics.
3. Isolate trouble to a section or stage.
4. Take voltage readings in the stage or stages suspected and compare with schematic for the radio.
5. When voltage irregularities are found, check other components in the circuit and look for poor connections.
6. Check the transistor itself.

The main thing is to approach the radio with confidence. Use reasonable care but do not become paralyzed by the fear of damaging components. If one does become damaged by excessive heat or voltage, it will be so rare an occurrence that it probably will have paid for itself many times in the knowledge and self-confidence gained prior to the mishap.

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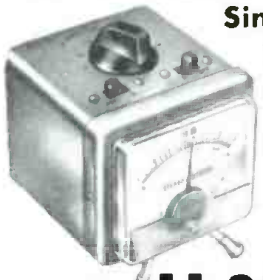

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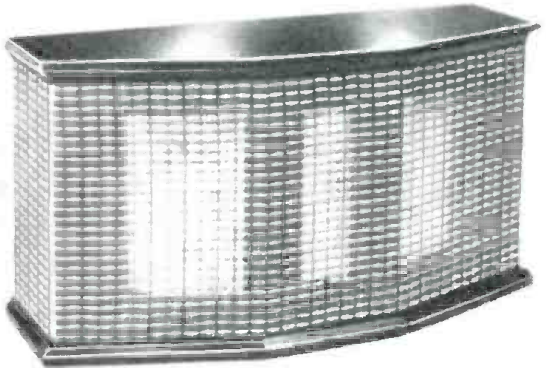

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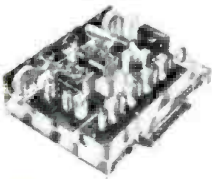

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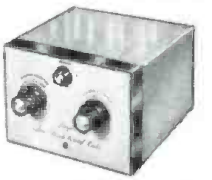

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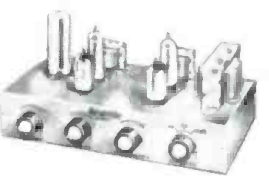

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Electrical Shock

(*Continued from page* 41)

a wasting away of muscle—a slow, progressive disturbance that may not become evident for weeks or even months. Other delayed effects may produce personality changes, amnesia, mental inertia, blood-vessel diseases, cataracts, destruction of the pancreatic tissues, and heart conditions.

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The first step is to break the connection between the victim and the power source. If possible, do this by turning off the power. The next best thing is to remove the victim from the voltage source—without endangering yourself. Use a wood board or other non-conducting object. As soon as you can touch the victim safely, apply artificial respiration.

Speed is essential. Any delay at all greatly reduces the chances of recovery. Of some 600 cases studied, over 70 per-cent of those receiving artificial respiration within three minutes recovered. Just one more minute of delay dropped the figure to 58 per-cent. If there is no heart or respiratory action and treatment is delayed five minutes, death is virtually certain.

If you are alone, do not take time to go for help. Start artificial respiration *immediately*. If the person can be saved, you can do it as well as anyone. And don't stop even if the victim appears dead. Eight hours have elapsed, in some cases, before the victim responded. The only sure sign of death is *rigor mortis*—and only a physician should judge whether that condition exists.

Above all, don't let the victim be you.

—30—

ITV ON AM

By WILLIAM R. SHIPPEE

THE INTERFERENCE caused by TV receivers to nearby radios is much easier to cope with than is often believed. The whistles and other noises that occur on the AM radios are the result of harmonics of the horizontal-sweep signal. The latter are being radiated from the high-voltage section of the TV set, principally from certain leads that act as transmitting antennas. These include the insulated lead to the cap of the horizontal-output tube, the lead from the flyback transformer to the high-voltage rectifier, and the second-anode lead from the rectifier to the picture tube.

The procedure for suppressing this radiation involves winding a few turns of insulated hookup wire around the offending lead and connecting one end of the hookup wire to a nearby chassis ground point. Satisfactory results can usually be achieved with ten turns around the insulated lead to the horizontal-output tube. —30—

Electron Tube Crossword

By JOHN A. COMSTOCK

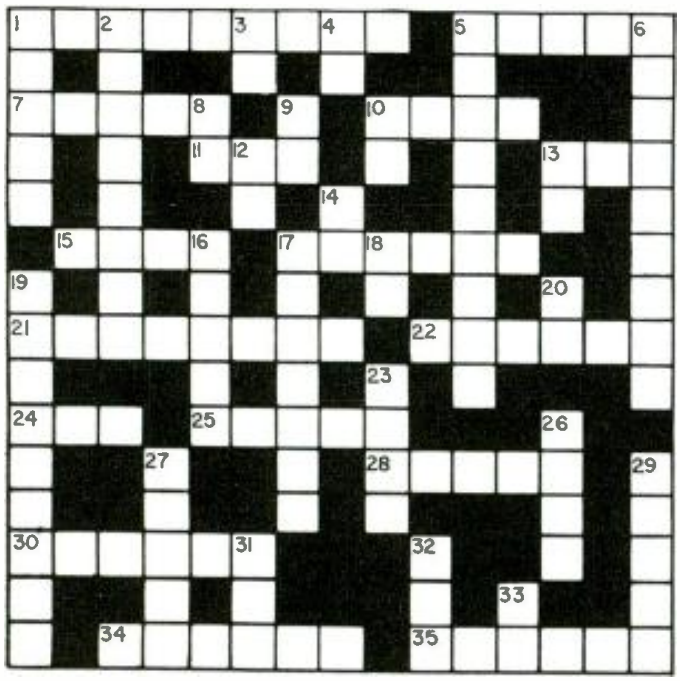
THOSE of our readers used to working with tubes will have no difficulty with this crossword puzzle that is based on tube applications and terminology. Have a try and if things get too difficult, turn to page 153 for the answer.

ACROSS

1. Five-grid tube used in superhets.
5. In a beam ——— tube the electrons are focused to achieve greater amplification.
7. Used in gaseous electron tubes.
10. Negative potential applied to tube's control grid.
11. Every TV and scope has one (Abbr.).
13. ——— off is bias voltage at which plate current ceases to flow.
15. Male connectors attached to a tube's base.
17. Resonator associated with magnetron circuits.
21. Electrodes of a tube.
22. ———-triode (tube having two triodes housed in a single envelope).
24. British "treble."
25. Type of light-sensitive cathode.
28. Tube's plate.
30. Extended cut-off vacuum tube.
34. Tube element.
35. Three-element tube.

DOWN

1. Tube's collector.
2. Grid bias voltage's polarity.
3. Transconductance (symbol).
4. Plate current (symbol).
5. An 866-A is one.
6. Tube capable of converting a.c. to d.c.
8. Letters sometimes found on a tube basing diagram.
9. Not a metal tube (Abbr.).
10. Potential and polarity applied to tube's plate and screen grid.
12. Plate resistance (symbol).
13. Letter and sign used to designate point in circuit where the positive terminal of the grid bias source is connected.
14. Unit of measurement in vacuum-tube current flow.
16. Tube in TV set which moves CRT beam from side to side or up and down.
17. It emits electrons in a tube.
18. Non-gaseous tube (Abbr.).
19. Five-electrode tube with two plates.
20. Class of amplification.
23. Found in output circuit of an electron tube.
26. Concentrated stream of electrons passing from cathode to plate in a power tube.
27. Tube with two electrodes.
29. Charge resulting from gathering of electrons near the cathode of a tube.
31. ———inction is the plate potential at which plate current will not flow in a gaseous tube.
32. ———uration is condition existing in tube when electron flow within tube is maximum obtainable by increasing plate voltage or cathode heat.
33. Input power to tube (Abbr.).



By
BERT WHYTE

CERTIFIED RECORD REVUE

AS ANYONE who attended the West Coast Hi-Fi shows can attest, the stereo disc has literally taken over the record industry. Not only was stereo disc the central theme of things, but it was obvious that it had already reached a point of refinement where it was challenging all but the best of stereo tape. Naturally, this did not escape the attention of the tape boys and I can assure you that loins are being girded and midnight oil is burning in the tape industry in a new and all out effort to stem the rising stereo disc tide.

As I have said before, those of you who think stereo disc is for the birds, should hear some recent releases played on top-quality equipment which is properly set up! Sure, there is a lot of junk around. There are some pretty miserable excuses for stereo disc being produced and there are plenty of stereo disc machines, mostly of the packaged variety, which are so unbelievably bad they are tantamount to a fraud! In fact the "fast buck" boys have produced allegedly stereo phonographs which are even more execrable than the junk they used to label "hi-fi"!

Be that as it may, the stereo disc is inexorably continuing its march at a faster pace than anyone could have dreamed. Almost monthly estimates have had to be revised upwards toward the day when stereo disc production supersedes monophonic output. Despite many admonishments to the public not to play stereo discs with monophonic cartridges, this practice is becoming more widespread and, in fact, a few manufacturers have contended that this is perfectly OK. The truth of the matter is that with many cheap packaged units, their owners can't tell stereo from mono anyway, so great is the inherent distortion. The trouble with all this frantic stereo disc activity is, of course, that there is already very grave danger of the public being "oversold." There are already plenty of folks who have been "conned" into junk stereo phonos and who are even now thoroughly disenchanted with this whole stereo business.

You know, the best advertising is "word of mouth" and one unhappy stereo "pigeon" can convince 10 or 20 of his pals that stereo is all bunk and these 20 guys can each tell five of their friends, etc., etc. In a country of 170 million people even this snowballing of discontent takes time to make itself felt, and it is this "grace" period that is keeping the stereo ball rolling. And quite obviously, the other side of the coin is that even with some of the lesser quality stereo phonos, there are thousands who are happy with their rigs and think stereo is the cats whiskers. But the warning in the situation is implicit . . . the legitimate hi-fi stereo manufacturers are a small handful compared to the number of "johnny-come-latelies" who are trying to cash in on the stereo boom . . . it is easier for the smaller hi-fi companies to retain the quality market they have always had . . . but even they would have a hard time riding out the storm should the stereo boom go bust! At very least it would seriously arrest the normal growth patterns of those companies.

Now I'm no crepe-hanger . . . as long-time readers of this column know, I have always been an enthusiastic pioneer in many developments which have led to better sound and the greater enjoyment of music. I'm all for stereo disc and equally for stereo tape. I think the two can live in peaceful co-existence and I really believe that given a stable, confident market to encourage research and development, the next few years will bring audio into full flower and we will have systems capable of reproducing sound with quality and realism beyond our wildest imaginings! But make no mistake . . . the threat posed by these "fast buck" boys is very real and not at all exaggerated. Unless something is done to curb their fantastic claims and impose restrictions on how they label, represent, and advertise their products, the public will continue to be bilked and this can only lead to chaos. Surely the Federal Trade Commission, which is an effective agency for enforcing honest labeling and fair practices in so many other industries, can be made cognizant of the situation and impressed with the need for action. This, plus a hard-hitting intelligent program of consumer education by the IHFM, should weed out the phonies and ensure the continued growth of stereo.

LISZT

PIANO CONCERTOS #1 AND #2
Julius Katchen, pianist with London Philharmonic Orchestra conducted by Ataulfo Argenta. London Stereo CS6033. Price $5.95.

This is a real humdinger of a stereo disc and for devotees of piano concertos I can recommend it to you unreservedly. This is wild and woolly piano in the grand Lisztian manner. Katchen has tremendous drive here and plays with such a spirited and ebullient manner that one feels he is really enjoying his work. The late Argenta, who might appear to some to be an odd choice for this kind of repertoire, shows that his talents were not confined to the Iberian idiom exclusively. His accompaniment is entirely sympathetic, and in the excellent balance which is maintained between piano and orchestra, his rapport with Katchen is obvious.

The sound is quite thrilling and is that magical *London* blend which combines crisp sparkling close-up detail with its contours

The opinions expressed in this column are those of the reviewer and do not necessarily reflect the views or opinions of the editors or the publishers of this magazine.

softened with spacious acoustics which lend a fine sense of depth. The over-all volume level is very high for a stereo disc and this combined with the inherently quiet surfaces makes for a completely unobtrusive background. Directivity was quite pronounced, with the piano nicely filling the middle ghost channel, although disposed a little more left than dead center. Over-all sound was bright but smooth with very clean piano transients.

MUSIC OF LEROY ANDERSON VOL. 2

Eastman Rochester Pops Orchestra conducted by Frederick Fennell. Mercury Stereo SR90043. Price $5.95.

No doubt this record will be greeted with loud huzzahs from the thousands of people who were charmed by Fred Fennell's first excursion into the music of LeRoy Anderson on *Mercury* SR90009. With a generous serving of 12 numbers including such Anderson hits as "The Waltzing Cat," "Fiddle-Faddle," and "Blue Tango," the disc is a triumph of light entertainment. Fennell's performances are as ingratiating, and infectious as his previous effort, which is high praise indeed!

Fennell fares just as well in the sound department too, as this is stereo of rare high order. All is crisply clean, superbly balanced, with easily discernible directivity, full middle "fill," and the whole clothed in spacious acoustics which heighten the illusion of depth and add the final fillip of realism.

MENDELSSOHN VIOLIN CONCERTO IN E MINOR *BRUCH* VIOLIN CONCERTO #1

Ruggiere Ricci, violinist with London Symphony Orchestra conducted by Pierieno Gamba. London Stereo CS6010. Price $5.95.

London continues its stereo march through the standard repertoire. These were excellent performances in their monophonic format and with the enobling robes of stereo this opinion is merely emphasized. The ordinarily fairly lean tone of Ricci takes on a glowing richness and fullness that adds immeasurably to the enjoyment of these oft-played warhorses. Ricci's violin appears just slightly left of center and is recorded moderately close-up. Acoustic perspective is such, however, that the solo violin is nicely balanced against the orchestra and is always smooth.

TCHAIKOVSKY SYMPHONY #6 ("PATHETIQUE")

Vienna Philharmonic Orchestra conducted by Jean Martinon. London Stereo CS6052. Price $5.95.

Quite naturally, every recording company wants to trot out stereo versions of the tried and true warhorses and *London* is no exception. Jean Martinon might seem an odd choice for this work and, in fact, his performance is somewhat erratic and would hardly qualify as definitive. But I can tell you he makes this a very high tension affair, with positively the most exciting rendition of the scherzo I have ever heard. It is beautifully balanced, but at the same time is a headlong impetuous orchestral *tour de force* which blazes with color.

This alone is worth the price of the record, but more than that, this is a tremendous feat of stereo recording. Every sonic attribute is there in plus degree . . . it is absolutely clean, the articulation of each instrument is matched by the wonderful acoustic balance which affords one of the best depth perspectives yet encountered. The over-all volume levels equal any of *London's* best monophonic efforts, hass response has been scrupulously preserved and the wide dynamics allow *fortes* of huge impact along with *pianissimo* sections

whose delicate tracery is unmarred by surface noise. This is stereo disc at its best and monophonic diehards are urged to listen and be convinced!

MARCHING ALONG
Eastman Symphonic Wind Ensemble conducted by Frederick Fennell. Mercury Stereo SR90105. Price $5.95.

Here is the other side of Fred Fennell and the one with which we are most familiar . . . as the band maestro extraordinary. His pulse-stirring highly supercharged readings of famous marches, recorded with some of *Mercury's* most spectacular sound, have been widely used for demonstration in hi-fi salons. Now with the added blandishments of stereo, this will likely continue to be used for the same purpose. Over-all volume level here is great, yet this has been accomplished without drastically cutting bass response or dynamic range. The big bass drum still has a mighty wallop, the cymbals sizzle with high frequencies, and the brass is brazenly bright and weighty, but with the rounded spaciousness of the stereo, the sound is more homogeneous and has a natural fullness that is ultra-realistic. The Sousa pieces are, as usual, the favorite crowd pleasers but also in strong contention now is the "Colonel Bogey March" made famous in the movie "The Bridge on the River Kwai."

SCHUBERT
QUINTET IN A MAJOR ("TROUT")
Denis Matthews, pianist with members of Vienna Konzerthaus Quartet. Vanguard Stereo VSD2019. Price $5.95.

Here is a mighty smart and knowledgeable recording job. Chamber music, especially string quartets are supposed to be the one type of music that gains very little from stereo. Not so . . . if an intelligent approach is used, as it was here, the result can be a more true-to-life sound in your living room than with almost any other type of music. For one thing the spread of the quintet here is strictly limited, about the amount of room you would expect to occupy at one end of a moderately spacious living room.

The piano appears to the left and the strings to the middle and right. For another thing, the acoustic approach here is nearly ideal. Most chamber music recordings are given monstrously bloated reverb which makes them sound as if they were recorded in a cave. Here there is just a tinge of reverb to lend liveness and with the amount of damping in most living rooms will reproduce with an intimate, close-up type of sound, about as identical to having the actual quartet in your room as possible. Believe me, with the nice clean over-all sound and the excellent treatment, you can impress your really musical friends more with this than with many a more spectacular, larger orchestrated disc. The performance here is good, but not outstanding but the stereo effect and its attendant "presence" makes this highly desirable.

BARTOK
DIVERTIMENTO FOR STRING ORCHESTRA
WEINER
SUITE OPUS 18 (HUNGARIAN FOLK DANCES)
Philharmonia Hungarica conducted by Antal Dorati. Epic Mono LC3513. Price $3.98.

Lesser-played Bartok and an interesting but not particularly distinguished suite of folk dances is the fare here. The Bartok is a genuine masterpiece in spite of the infrequent exposure of it and, in this repertoire, Dorati is in his element. His performance is striking, a brilliant job that probes to the core of the music. His performance of the Weiner piece impresses this reviewer as authoritative.

The Philharmonia Hungarica is reportedly composed, in the main, of refugee Hungarian musicians. In this idiomatic repertoire they give forth with some splendid playing and with many touches of individual brilliance. The sound is generally good, well balanced, just a bit short in dynamics and in high frequencies, but nothing serious and all-in-all, easy on the ears. A stereo of this, if such exists, should make this doubly attractive.

BEETHOVEN
OVERTURES (LEONORA #3, EGMONT, FIDELIO, CORIOLAN)
Vienna Philharmonic Orchestra conducted by Karl Munchinger. London Stereo CS6053. Price $5.95.

Fine idiomatic performances of these familiar Beethoven overtures are turned in by Munchinger and the playing he elicits from the Philharmonic is truly wondrous for its precise sonorities. Very smooth, clean string sound, with marvelously rich contrabassi. The stereo effects here are easily evident but not overdone. With the splendid acoustics, this is a big stereo sound of notable richness. A good basic addition to any stereo library.

DVORAK
SYMPHONY NO. 4
Cleveland Orchestra conducted by George Szell. Epic Mono LC3532. Price $3.98.

This is the sort of repertoire that Szell excels in and this reading of the lyrical Dvorak 4th Symphony must be reckoned as among the best on records today. He might be a shade too slow in tempi for some, but this gives the music a broad, expansive and almost "casual" feeling. Certainly he treats it expositionally and the expressiveness and warmth are all there. This is big, full blown sound, might be a bit too bass heavy for some tastes, but everything is nice and clean and the acoustics of newly rebuilt Severance Hall have just the right amount of reverb to lend roundness and spaciousness without swamping detail. For those who haven't "gone" stereo yet, a first class item.

THE QUEEN'S BIRTHDAY SALUTE
Herald Trumpeters and Band of the Royal Regiment of Artillery conducted by Major S. V. Hays. Vanguard Stereo VSD-2011. Price $5.95.

Blimey blokes, if this disc ain't a ruddy smasher! My enterprising friend Seymour Solomon of *Vanguard Records*, has come up with a most thrilling disc, a real coup and an unqualified stereo success. Every year in London the Official Birthday of Queen Elizabeth is celebrated with appropriate pomp and pageantry. The date is June 13th and has nothing to do with the Queen's actual birthday which is April 21st. At any rate, hundreds of thousands of Britons converge on Hyde Park on this occasion to watch the spectacle of colorfully uniformed cavalrymen galloping up and down the parade grounds on their superbly matched steeds, watch the horse-drawn artillery wheel and rumble up and down the field in intricate maneuvers, watch the scarlet-tuniced and bearskin-shakoed foot soldiers in precise drills, and above all listen to the ancient heraldic trumpets and the magnificent Band of the Royal Regiment of Artillery and the earthshaking thunder of a 21-gun salute.

Vanguard, utilizing some of the finest outdoor stereo recording I have ever heard, captures most effectively the thrilling spirit of the ceremony. For those who may not be aware of it, stereo recording outdoors is an extremely difficult feat. Because there is no confining hall with reflective walls, ceiling,

etc., which normally is responsible for a large proportion of the stereo effect, the over-all sound is usually too diffuse. I'm not certain, but I rather suspect that *Vanguard* used a modification of a parabolic mike pickup, which in this recording affords a very big, full, rich, and utterly spacious sound.

As to stereo directivity . . . believe me, if you own a big speaker system and king-sized amplifiers, the clattering roar of the horses hooves will sweep across your listening room with almost terrifying realism. This is a really severe test for the transient capabilities of any system, as are the myriad clinks, clanks, and thuds of the artillery caissons.

When we get to the 21-gun salute, if you have the proper equipment, the effect will make you jump! Those of you who have reveled in the boom of the Napoleonic cannon used in *Mercury Records'* "1812 Overture" will find a different breed here. These are fairly modern fieldpieces . . . 75's I would judge . . . and their sound is quite unlike the cannon of olden times. At first there is a very sharp crack, which is followed by a huge booming reverberation with a surprisingly long period. During this period if your system is capable of really low-frequency response, you will hear some tremendous shuddery sounds. Even considering *Vanguard's* usually excellent engineering, I would have thought such very-low-frequencies were beyond the reach of most stereo cutterheads, but they are very audibly in evidence!

The second side of the disc is devoted mainly to the Band playing a potpourri of familiar British tunes, and ends with a "Fanfare for a Jubilant Occasion" by the Master of the Queen's Musick, Sir Arthur Bliss. Quite obviously this disc will enjoy a brisk sale to hi-fi afficionados and Anglophiles alike!

SCHUBERT
SYMPHONY NO. 9 IN C MAJOR ("THE GREAT")
London Symphony Orchestra conducted by Josef Krips. London Stereo CS6061. Price $5.95.

The second Schubert 9th to appear on stereo disc and without question the better. This is as close to a definitive performance as has appeared on stereo disc of any symphony. It has a very model of a performance from Krips . . . richly expressive, with tempi "by the book," strictly no nonsense. His handling of orchestral textures is masterful and, above all, the reading is never flaccid, but surges with vitality and the finale is indeed as close to "heaven storming" as any since Toscanini's.

Of course, the impression is heightened by the splendid hugely resonant stereo sound. This is a *big* sound for a big performance. The sonority of the cellos and contrabassi is magnificent and the brass is full and mellow, the woodwind exceptional in their purity. The stereo virtues are in evidence everywhere . . . directionality and instrumental separation are nigh perfect, the ghost center is well filled, the feeling of depth most cleverly realized. A real winner and recommended without reservation.

BRAHMS
CONCERTO NO. 1 FOR PIANO AND ORCHESTRA
Leon Fleisher, pianist with Cleveland Orchestra conducted by George Szell. Epic Mono LC3484. Price $3.98.

Another choice monophonic item is this rousing, headstrong reading of the Brahms first piano concerto by Leon Fleisher. This is perhaps the most vital, taut, and exciting performance of this work since the Rubenstein effort of 4 or 5 years ago. Fleisher has technique to burn and a very firm, robust tone, yet where expressiveness is demanded he is

most eloquent. Szell evidently was caught up in the spirit of the occasion and his accompaniment is entirely sympathetic.

The sound wins plaudits too. The piano is quite forward, recorded closely as is the orchestra, but there is never any harshness or transient distortion problems. A very sensible balance between piano and orchestra is maintained and the acoustic perspective is such that it lends liveness without destroying detail or brilliance in the piano tone. I hope this was recorded stereophonically as it is so well done in mono that it should be a real winner in its stereo format.

SHAKESPEARE
AGES OF MAN
Sir John Gielgud. Columbia Mono OL5390. Price $3.98.

It is very rarely that I ever review so-called "spoken words" discs, but this one is so outstanding it deserves your attention. Sir John Gielgud is, of course, one of the most distinguished Shakespeareans of our time and has that compelling, rich resonance of voice, flawless diction, and commanding stage presence which are the attributes of a great thespian. This album derives from his "one-man show" which has lately been touring this country and is, in essence, scenes from various plays and sonnets of Shakespeare divided into sections depicting Youth, Manhood, and Old Age.

If you like Shakespeare, then with this album you will sit, listening spellbound to Shakespeare's incredible play on words, delivered in their every shade and nuance by Sir John. This is really the highest art of the theater and I, for one, am grateful to Sir John for a most memorable experience.

WE COULD HAVE DANCED ALL NIGHT
Griff Williams and his Orchestra. Mercury Stereo SR60021. Price $5.95.

This album was, I am told, the largest selling stereo tape in the *Mercury* catalogue. As I remember the tape it was indeed first class material of the "society band" type and recorded with extraordinary presence. Here in the stereo disc version, it is perhaps one of the loudest discs over-all I have heard, but I feel there is a penalty for this, because a little shrillness crops up now and then that definitely wasn't on the tape.

The sound, in general, is very crisp and bright but I don't think it can meet the measure of the tape. —30—

COMPONENT SERIES STEREO RECORDS

AUDIO Fidelity Inc. has just announced its "First Component Series" of stereo records. The first group consists of six different selections: "Marches from Operas"; Tchaikovsky "Symphony #6"; "Russian Composer Masterpieces"; Ravel "Bolero"; Bizet "Carmen Suite"; "Strauss Waltzes"; and a stereo test record.

From a technical point of view these recordings are equal to the best that we have heard to date. All masters were made on a Scully record lathe mounting a Westrex cutter and, according to the firm's literature, the frequency response is from 16 to 25,000 cps. We doubt that this extreme frequency range, if it is actually on the final pressings, will hold up too long in playing. But even if the records do cover a range of 30 to 15,000 cps they can be classed among the tops in the record field.

We were particularly pleased with the tremendous dynamic range that was attained and the lack of static and surface noise which is so annoying on many of the records available today. All six of these discs are literally noise-free.

A word of appreciation to the company regarding the policy that they have established. All of the promotion literature specifically states that these records are to be used only with the best component hi-fi systems available. This is admirable in the sense that they are not after the mass market but are making an attempt to produce nothing but the finest for those who are willing to spend a little extra ($6.95) for a stereophonic record. —Editor

NEW STEREO DEMO DISC

CONCERTAPES, Inc., P. O. Box 88, Wilmette, Ill. has just released copies of its "Concert-Disc Stereo Demo" record which incorporates an exclusive "bouncing ball" balance control signal in addition to a lush sampling of excerpts from the recording firm's stereo library.

Catalogued as the CSD-2 and priced at $6.95, the new disc carries complete instructions for using the balancing band (the first on the record) to ready the stereo system to receive the rest of the material on the disc.

There are fourteen selections from twelve of the company's stereo albums. The program content ranges from jazz, sound effects, polkas, show tunes, to Bach preludes and semi-classical numbers by Tchaikovsky, Strauss, et al. —30—

RIDER CODE RECORDS

JOHN F. Rider Publisher, Inc. of New York City recently demonstrated its new "Sound-N-Sight" system for learning the Morse code to the press.

The system comprises long-playing records of code signals and instructor's voice, along with flash identification cards, and instruction book.

The new system of learning the code "painlessly" and in minimum time is being offered in three different versions: The complete course covers all licenses up to commercial (0 to 20 wpm) and consists of six 10" LP records, 47 flash cards, and instruction book. The Novice course (0-8 wpm) comprises three 10" LP records, 47 flash cards, and instruction book while the Advanced course for General, Amateur Extra, or Commercial license exams (9-20 wpm) includes three 10" records and an instruction book.

The series involves the "re-inforced learning techniques" which have proven so successful in pedagogical experiments and military "cram" training courses.

Full details on these new series of code instruction records can be obtained by writing the publisher at 116 West 14th St., New York 11, N. Y. —30—

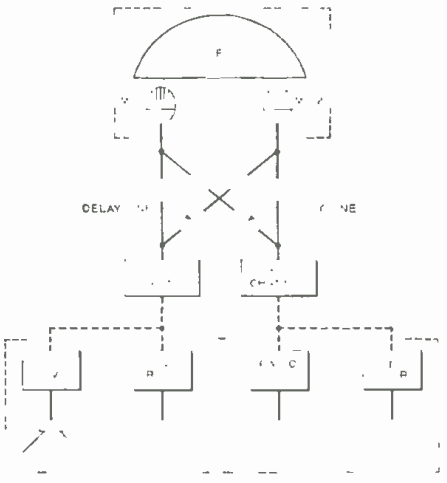
Compatible Stereo Broadcasts

New Bell Labs system uses a time-delay effect for stereo.

MUCH present stereo broadcasting is not compatible in that the listener to one channel does not receive the entire program information. Now this single-channel problem may be eliminated without affecting the stereo listener, through the use of a new "compatibility" circuit which has been developed by F. K. Becker of *Bell Telephone Laboratories*. The circuit depends for success on a psycho-acoustic phenomenon known as the "precedence effect." This effect operates in such a manner that when a single sound is reproduced through two separate loudspeakers, but is delayed several milliseconds in one, the listener will hear the sound as if it came only from the speaker from which he heard it first. He will judge the second loudspeaker to be silent.

In the new development, circuits are cross-coupled (see diagram below) through two 10-millisecond delay lines, each with its own amplifier. Signals from the left mike are sent directly to the left speaker, while the same signal is delayed 10 msec. before reaching the right-hand speaker. The stereo listener will hear the sound as if it came only from the left speaker because of the precedence effect. Also, sound from the right mike goes direct to the right speaker but is delayed before reaching the left speaker, and is therefore unheard. The stereo listener thus localizes the sound in such a way that a full stereo effect is produced. However, monophonic reception is completely compatible with this, since a listener to each single channel hears the total sound from both mikes in a balanced reproduction. The slight delay produces no echo and does not affect reception at all, according to subjective tests. —30—

Basic setup employed in compatible system.



Loudspeakers for Stereo

(*Continued from page 44*)

respondingly different proportions of sound from the two units will be "located" somewhere between, although that "somewhere" may differ with different seating positions relative to the speakers.

A directional loudspeaker is a useful adjunct for improving coverage, especially where provision is made for aiming it, independent of its location, as provided by the *Jensen* "Director" assembly both in separate units and the unitized variety, or by *Goodmans* in its "Stereosphere" (which can be used as part of an installation similar to the "Stercodot").

Directivity of the "stereo" units can be used either to improve the stereo effect in one's favorite listening seat, although the speaker symmetry is not ideal (due to room shape, for example), or to cover a "long shot" position to improve uniformity throughout an area.

One good way of getting a loudspeaker *truly* omnidirectional in the horizontal plane is to "point" it upwards. The *Hegeman*-designed unit put out by *EICO* is an example of this design approach. If the *Goodmans* "Stereosfere" is aimed straight up this does the same. But to give smooth omnidirectional radiation, such units should be close against a wall to avoid undesirable reflection effects from producing effective "double image." This way the reflected radiation merges completely with the direct radiation.

A unit designed to have a highly dispersed radiation from its front only may actually be more uniform in its radiation in some situations—especially if the room arrangement prevents its being close to the wall—due to a radiator or window, for example.

Another factor, besides shape of the area to be covered, is the furnishings although this can cut both ways in different circumstances. In a recreation-type room, with all hard surfaces, a directional pattern that spreads horizontally but restricts vertically is an asset. The *JBL* "Koustical" lens, with its appropriate driver and horn, provides one way of doing this. A less expensive way is to use a vertically aligned row of small direct-radiator units, connected in-phase as shown in Fig. 12. Otherwise, an essentially omnidirectional or diffuse radiation is best for this kind of room.

Rooms with heavy drapes, wall-to-wall carpeting, and heavily upholstered furniture come at the other extreme. Generally speaking, these are more tolerant of loudspeaker types as regards radiation pattern, so concentrate on getting the smoothest response. But sometimes the room shape will tend to produce "dead spots" where the sound gets lost. By "beaming" the sound into these spots with a director system, more complete coverage can be obtained.

That's the story with the well-established and by now familiar *dynamic* speakers, but this year several new names have appeared in the *electrostatic* (I prefer the term "electric"—there's nothing "static" about sound radiation) speaker field. Most of these, thus far, are tweeters or mid-range and tweeter, but at least two claim full-range with electric units only.

Electrostatic Speakers

One objection to electric units has been their directional property — a small, flat unit will send out a narrow-angle beam that gets narrower as the frequency gets higher. But this assumes a flat—or near flat—shaping. Actually there seems to be a good reason why this form should be more pliable in making a desired shaping than the more familiar dynamic. Even now, *Electrocoustic* claims a unit that has adjustable directivity by hinging both the radiator and the reflector. The firm says it includes the possibility of omnidirectional radiation. This does provide considerable variation which is a nice feature. In addition, *Wright St. George* is featuring a number of variations including an adaptable "modular" scheme.

A question arises here about the size needed for adequate bass response. This depends on how far the diaphragm can move. Large movement will produce corresponding bass response from a smaller surface area but larger movement requires wider spacing between the fixed and moving elements, a higher impedance amplifier output (which can be provided in a transformer which comes with the speaker), and a very much higher polarizing voltage. This gets into insulation problems which, until recently, have seemed insurmountable. But at last it looks as if a break-through is being made.

When the electrostatic speaker was thought of as essentially a small-movement device, the only way full-range response, including bass, could be visualized was by making at least one whole wall of your room a speaker—which is hardly practical for most of us. That got into a sound radiation concept that was quite the opposite of the conventional dynamic which uses a relatively small cone with large movement. Now the development looks as if it will be quite feasible for electric transducers of the future to optimize on the size question. This may well make them very adaptable units.

Conclusion

In this article I have departed from my usual rule of not mentioning specific names. I could not say what I had to say without being specific. But in mentioning these names, no endorsement or censure is intended. Some whose names I have not mentioned, but which appear in the table, represent as much work and achievement as many others.

Now let's gather the pieces to see how to go about buying what you want. First, do you want a system to just sit

back and listen to good stereo for some time to come or are you an experimental "bug"? Second, what kind of room do you have: size, shape, and furnishings? And, third, how much do you want to spend?

If you don't want to play around, changing your system, and trying out different arrangements, get one that does a good job in your room and is as simple as possible. For the smaller rooms, a single-cabinet job, for the larger ones two separate cabinets of a size that "looks right" in the room; using types of unit that suit your room's acoustics.

If you want to play around, experimenting with different arrangements, get one of the flexible systems, of which there is quite a variety, preferably to suit your room size. And about your budget, you don't need me to tell you. Stereo has produced a wider price range in speakers than monophonic hi-fi ever did! —30—

LOW-DISTORTION SINE-WAVE GENERATOR

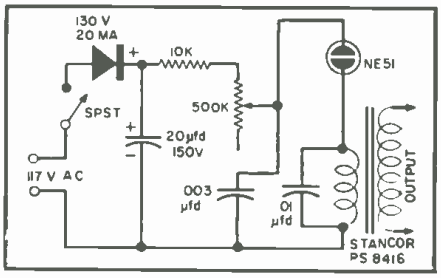
By HERBERT COHEN
General Transistor Corp.

THE author has been considering the problem of extracting the fundamental frequency from a conventional neon-tube saw-tooth generator. The slow charge time and the extremely rapid discharge time produces a saw-tooth waveform whose usefulness is limited but which contains the fundamental and many harmonics.

However, by parallel tuning the capacitor discharge circuit, a low-distortion sine wave can be obtained. The primary of a Stancor PS8416 power transformer, paralleled by a .01 μfd. capacitor, is used as a high-"Q" tank circuit. The tuned circuit appears as an exceedingly high impedance to the fundamental frequency but practically a short circuit to its harmonics.

With an oscilloscope across the transformer primary, the pot is adjusted to set the oscillator at the LC frequency of transformer and capacitor. As the fundamental approaches the tuned LC frequency, the waveform becomes more and more sinusoidal with an increasing amplitude on approaching resonance.

At resonance, the waveform shows less than 3% harmonic distortion as measured with a distortion analyzer. The secondary of the transformer supplies many outputs for low- or high-impedance matching. One problem in this construction is that ground is also a.c. ground. An isolation transformer can be used to eliminate this problem. The stability of this unit is basically determined by the stability of the a.c. line. A 1000-cycle oscillator, constructed by the author and shown in the diagram below, puts out a waveform comparable to the Hartley type. —30—



Experiments in Stereo for P.A. Systems

By **JACK THORNTON**

RECENT comparison tests with stereophonic music systems suggested a re-investigation of a two-channel technique in public-address system work. The results were quite interesting and the idea seems worthy of further experiment by those working with auditorium amplifier setups. Such a system uses two separate sound channels set up in a "left" and "right" relationship which is essentially the same as that used in stereo music recording and playback.

Auditorium public-address systems usually use a loudspeaker enclosure at either side of the stage. The two sound sources obviously give better sound distribution and coverage. But the system remains monophonic because both speakers are fed by a common microphone and amplifier.

Consider a person speaking from a stage *without* a sound system. The audience experiences the normal acoustical effect, that is, when the speaker turns slightly to his left, the audience in that direction hears the voice projected a little more toward them. The audience the other way hears the voice diminish slightly. Even though this effect may not be too pronounced, natural sound does depend upon it.

When the same person uses the ordinary single-channel sound system, the loudspeakers override his actual voice so that listeners hear only what comes over the p.a. Now when he turns slightly, his voice fades in *both* directions as he goes "off mike" and the sound diminishes in both speakers. The sense of movement and liveness is impaired. Of course there is the visual sense of direction because the audience can see the person and his movements. But they still hear the sound through a monophonic system. A dual-channel sound system seems to offer one method of improvement. This holds true even though the source of sound moves very little.

First tests of p.a. stereo were run in adjoining radio studios with a window between them. A curtain could be drawn for comparison between impressions when the observers could or could not see the speaker. Matched microphones fed companion amplifiers in studio A. Matched speakers were placed eight feet apart in studio B. A switching arrangement allowed single- or dual-channel operation, with both speakers operating either way. Observers had no difficulty identifying the "stereo" setup, even with the curtains drawn. The person talking was twelve inches from the mikes. Mike separation varied from two inches to two feet. The larger separations gave exaggerated effects. About ten inches seemed the most natural in that particular studio.

More checks were run in an auditorium. Microphones were *Shure* 556 cardioids to allow somewhat greater mike-to-subject distance without audio feedback. The systems were balanced by having an observer at the center of the auditorium indicate when the sound seemed to come from the middle of the stage.

With speech as the program material, trial and error finally placed the microphones on the speaker's rostrum twelve inches from the voice, separated from each other ten inches, and angled in slightly toward the sound source. The closer the mikes are to the voice, the closer they must be to each other if a "ping-pong" situation is to be avoided. (It's quite an effect to have the speaker turn his head slightly and seem to jump thirty feet to the other side of the stage!)

If the microphones are too close to the voice, most of the stereo effect is lost since any movement will put the speaker off both mikes and you'll be back to a monophonic system. Unless the speaker has a weak voice or the room is a bad one for feedback, the greater mike distance will give better sound anyway.

When music is the program material, both the volume of sound and the size of the group producing it must be considered. A vocal or instrumental solo usually allows greater mike distance: two or three feet. Mike separation is accordingly greater. As the musical group becomes larger so must microphone distances become greater. Large orchestras or choirs seldom need amplification and if a sound system is used with these, it's usually for a soloist and the solo settings can be used.

Operators who wish to duplicate and expand these experiments could use this guide: microphones, amplifiers, and loudspeakers should be as identical as possible. Identical models may not be matched; one unit may be new, the other a veteran of rough service. Tone controls are set the same for both units, although some compensation for unmatched units can be obtained by tone setting variations. With mikes about twelve inches from a voice and separated about ten inches, balance the two channels by having an observer indicate when the sound seems to come from the speaker. Then vary the mike distance and separation for best effect with the program material to be used.

Such a setup is an interesting sidelight on the stereo boom and, although it won't hide poor p.a. systems or practice, it offers a worthwhile improvement in the naturalness of sound reproduction. —30—

Hi-Fi Crossovers

(Continued from page 55)

while at 20,000 cps this figure was 50 watts. This comes very close to expectations in that, at the crossover point, the power should be 3 db down from maximum.

As indicated in Fig. 9A, the actual measured crossover point for these two electrolytics in series turned out to be 700 cps low (from 5000 cps) which would indicate that the electrolytic combination was about 13% off from rated value.

What is of major importance is the fact that a full 50 watts could be delivered through such a back-to-back configuration of polarized electrolytics. Just to be contrary, the back-to-back direction was reversed so that where in the first case, the positive terminals were tied together, in the second case the negative terminals were connected. There was no change in performance. There is apparently no reason why non-polarized electrolytics cannot be used in crossover networks.

But, now, how about the polarized type? With the same test setup as described previously, a test run was made on only one of the 8 μfd. units of the previous test. Again during the run the amplifier was adjusted to give the maximum undistorted waveform at the load resistor. The results were exactly the same as in the case of the non-polarized combination. There was no waveform distortion at a full 50 watts input to the load resistor and at the crossover point (in this case 2500 cps for 8 μfd. for 8 ohms) there was a clean 25 watts which was the expected 3 db down.

To tie the matter down even more firmly, a test was made on three different 50 μfd. polarized electrolytics rated at 150, 50, and 25 volts respectively. No differences in performance could be observed as far as waveform at maximum output was concerned (50 watts). They were all clean, as observed on a scope.

The last question that was to be resolved was the matter of the rising impedance of a large value of electrolytic at the higher frequencies, which would have the effect of reducing the voltage at the tweeter terminals. Fig. 9B is the curve of maximum undistorted waveform voltage at the load resistor from which it will be seen that for this 50 μfd. capacity, there is a drooping voltage characteristic at the load. When, however, this capacity was shunted by a small paper capacitor, the voltage characteristic was respectably evened out.

Looking prejudice squarely in the eye, there would seem to be no reason as yet for not using electrolytics, polarized or non-polarized, for network construction. This, along with Chart 1 should make the matter of collecting the necessary components for a home-built network a fairly simple and straightforward operation.

Improving the A.C.-D.C. Radio

By **A. H. FRY**

Simple, inexpensive modifications that will improve the sound and give you some bass from the little set.

THAT rascally little mantlepiece a.c.-d.c. set—the common garden variety of $9.95 radio "screech box"—can be made to sound quite good by means of two simple and inexpensive improvements. The procedures involve getting rid of some of the set's inherent distortion and improving the bass response.

A lot of the shrillness in these sets stems from violent peaks and transients in that part of the audio spectrum where the ear is most sensitive. This shrillness is due, in part, to an unbalance between treble and bass—both electrically and acoustically. Both of these "unpleasantnesses" may be alleviated by the simple expedient of: (1) running a little selective feedback around the output tube and (2) by "operating" on the loudspeaker and baffling it properly.

First obtain a 100,000-ohm pot and a .015-μfd. paper capacitor—the junk box should include a serviceable old volume control and a discarded capacitor—if not, buy the parts.

Next take the chassis out of its cabinet and turn it upside down. Be sure the set is not connected to the wall outlet. Locate the plate pin and the control-grid pin on the socket of the output tube (usually of the 25L6 variety). Arrange the potentiometer and capacitor in series between the two points shown in Fig. 1. This arrangement tends to flatten out the audio peaks and suppresses the screechy treble to the enhancement of the bass. Use insulated wire for making these connections and drape the "feedback works" in any convenient position behind the chassis.

Second remove the loudspeaker from the chassis, cutting the wires and carefully noting which wires go where. Most speaker leads are color-coded.

The third step is to obtain a large piece of stiff corrugated cardboard or panel of plywood—about 3 feet by 4 feet at a minimum. This is the "baffle." Cut a hole the same size as the speaker diaphragm somewhere near but not exactly at the center. Bolt the loudspeaker to the baffle board and with extension or zip cord, reconnect the speaker wires to the speaker leads on the chassis. A length of five or six feet will not adversely affect the performance. Place the speaker baffle in a corner and the receiver conveniently nearby. Put the chassis back in its cabinet.

The fourth step involves treating the speaker as shown in Fig. 2. The "equipment" required consists of a sharp paring knife or razor blade, thin shellac, and castor oil (or any other plasticizer—such as Di-Butyl Phalate). Observe the order of operations carefully. The shellac serves to keep the oil from "creeping" or bleeding to the main portion of the cone. The oil softens the area and renders the cone free for piston-like movements. It can now make its back-and-forth excursions more easily. The slits further free the cone.

Finally, replace the wall plug, turn on the set, tune in a station, and adjust the potentiometer for most pleasing acoustic effect. You will need to turn the volume up slightly higher than normal.

You and your family will be pleasantly surprised at the set's new performance. The rig will sound "rich-throated" and you will now hear bass on a $9.95 set! —30—

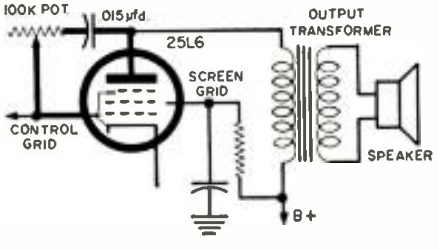


Fig. 1. (above) Simple circuit modifications suggested by the author.

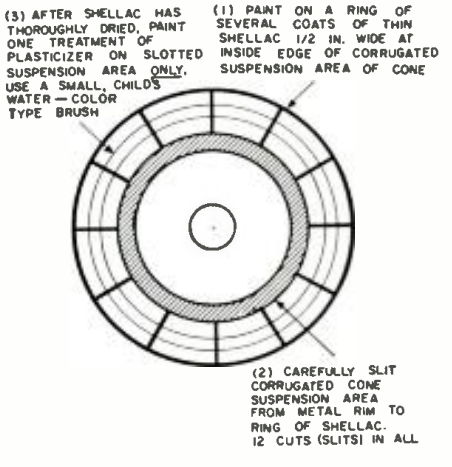


Fig. 2. (right) Drawing illustrating the treatment that is applied to the small loudspeaker in the a.c.-d.c. set.

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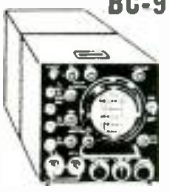

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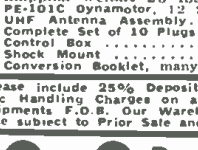

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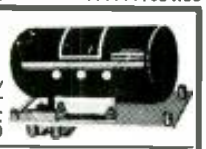

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another day in the shop

By **BOB ELDRIDGE**

Students Jack and John make headway on their own, but learn more from Tommy's experience.

EDITOR'S NOTE: *High on the list of articles readers told us they liked last year was Eldridge's "A Day in the Shop." It involved a couple of student technicians who, in return for some miscellaneous chores, were permitted to nose about an established service shop to pick up what they could from experienced trouble-shooters. Into this story was woven much practical bench know-how. Using the same cast of characters, the same author matches his first performance here.*

EVERY once in a while Jack and John, a pair of up-and-coming student technicians, come in to help out in our shop. They do a useful job in routine cleaning and checking chassis that are ready for servicing, meanwhile keeping interested eyes on Tommy, our benchman. Tommy, for his part, takes time out once in a while to explain just what he is doing, and why, with the sets on the bench.

Tommy phoned in one morning recently to say he would be coming in to work half an hour late. Seizing the opportunity, John piled right in checking the tubes on an *Emerson* chassis from a model 720D.

He likes to have the set running while doing this, because he hates waiting for each tube to warm up from dead cold in the tester. He used to have troubles sometimes, when he pulled the tubes in the wrong order, but now he plays it safe and removes the rectifier tube *first*, leaving it out. As he says, "If there's no 'B+' in the set, you can do what you like with the tubes without harming any because you have unthinkingly pulled the one that drives it."

Anyway (to get back to the *Emerson*) when John started pulling tubes for testing, the first one attended to after the rectifier was the 6V6 audio-output tube. He noticed that it wasn't as blistering hot as he had expected and, being a methodical sort of fellow, he wrote on the check-out slip (which already bore the message, "No sound, not tubes," contributed by the outside technician) a note of his own: "6V6 checks normal but doesn't get hot in the set."

Now one of the useful chores the two boys do is to hunt out the schematic for each set awaiting service. A look at the audio-output circuit on the schematic made John feel that this one should be so easy that it wasn't worthy of Tommy's august attention.

John belongs to the "play-it-safe, static-test-first" school of servicing, so he set to work with the ohmmeter and in two minutes flat he came up with an open 470-ohm cathode resistor (see Fig. 4).

He soldered a new resistor in place just in time to hand over the set to the late-arriving Tommy for a routine check. Except for a minor adjustment to the phasing coil, the set performed dead on the ball. Thus the first job of the day was on the hot-run bench by 9:45 a.m.

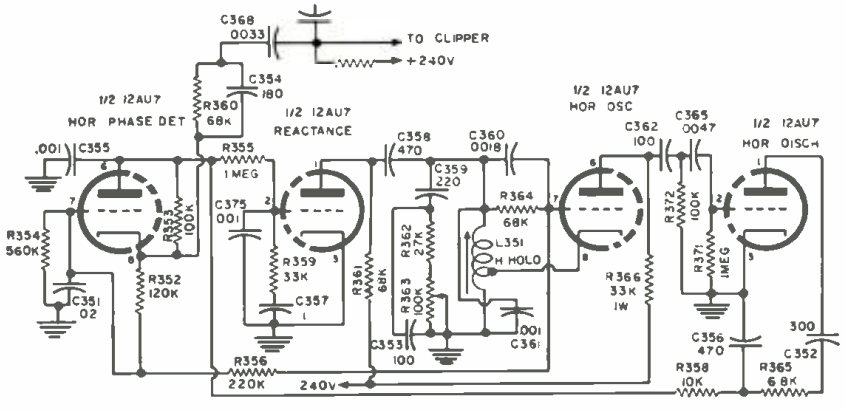
No Vertical Sync

Meanwhile Jack had been preparing a *Majestic* 110 chassis. The job sheet bore the legend "No vertical lock." The only tubes weeded out by Jack's efforts on the tester were a couple of 6AU6's. Have you noticed that the 6AU6 is often a candidate for replacement in sets where all other tubes are still going strong?

On the bench, the set performed just as noted. Everything was fine except that the picture would roll up or down without even hesitating as it went round for another turn.

"Well," said Tommy, "what can we see? The oscillator is capable of running at the correct speed and the sync separator must be popping out pips all right, or the horizontal would be haywire. There's not much in between the sync separator and the oscillator except the integrator network, so we may as well tack in a new one." (The cir-

Fig. 1. Two G-E receivers using this circuit exhibited similar symptoms.



cuit is shown in Fig. 2). This proved to be a bad guess and the fault remained unchanged with the replacement printed-circuit network in place.

"Whip it out," said Jack, "and I'll put it back in the drawer."

"Oh no we don't," reproved Tommy, "we leave it right there until the trouble is found! What if we should have *two* faults at the same time, one maybe caused by the other? We leave any substituted parts in the circuit, then take 'em out one at a time when the set is working properly. What is there left to check now?" he continued. "A couple of capacitors and the 33,000-ohm resistor. It's easier to measure the resistor, so let's start with that."

The ohmmeter registered the resistor as being about 35,000 ohms so the clipped end was soldered back in place and one end of the .0022-μfd. capacitor (input end of the integrator network) was disconnected.

"Check it with the ohmmeter," said Tommy. "It would have to be shorted or leaking badly to produce a fault like that. If it was open, the lock would be more or less normal." The capacitor showed a dead short. Jack was puzzled to see Tommy replacing the 33,000-ohm resistor, after soldering in a new .0022-μfd. capacitor and the original integrator network.

"Well," explained Tommy, "that's a matter of safety first, really. 'B+' current has been running to ground through that resistor and it may have been damaged in the process. You know how the boss feels about callbacks!"

John was scribbling on a piece of paper. "Look here," he queried, "doesn't 135 volts across 33,000 ohms only produce half a watt anyway?"

Tommy looked thoughtfully at the schematic. "Bet you a coffee break there's much more than that across it sometimes." He attached the probe of the v.t.v.m. to the "hot" end of the resistor, clipped the common lead to the chassis and switched on the set. Up and up swung the needle to read nearly 400 volts and then it eased slowly down to settle at 120 or so. "Let's go!" exulted Tommy (who seldom loses a bet). "What would you expect from a directly heated rectifier feeding a pile of indirectly heated tubes?"

John trailed along on the way to the coffee shop, looking in bewilderment at the schematic. When they were settled in the booth he could contain himself no longer. "I don't get it!" he blurted. "What's this midget relay thing for then?" (*RL*$_1$ in Fig. 2) Tommy took the schematic and studied it in silence. "That's a good question," he finally admitted. "We'll have another look when we get back to the shop. Let's forget it for ten minutes."

Back on the bench the mystery was speedily solved. The .0047-μfd. capacitor across the midget relay contacts was completely shorted. "That was a bit of luck," said Tommy, when a new component was in place and the set was on test. "I think probably that was the original fault, and the .0022 went down as a result. I don't think you should pay for the coffee after all, John—the boss should! We might have had a sticky callback on that one but for your curiosity!" As we said—Tommy seldom loses a bet!

Two With The Same Chassis

The boys had readied two *G-E* "Stratopower" chassis next for attention, each with more or less the same symptoms. The first one was way off horizontal frequency and could not be corrected by adjustment. The other one could just be brought to the correct horizontal speed, with the oscillator slug unusually deep in the coil, but sync was then very unstable.

"Let's tackle the totally wrong one first," said Tommy. Like most technicians, he prefers the definite failure to the marginal one. "There's a beautiful schematic for this model, with waveforms and voltage and resistance measurements all over the place. Make a check with the v.t.v.m. on those two 12AU7 bases. Don't forget to short the antenna terminals to keep the local signal *out* of the set while you are measuring."

John undertook the job and soon came up with a list of readings that showed the only serious discrepancies from the normal voltages were on the cathode, grid, and plate of the phase detector (Fig. 1). These points were all slightly positive, instead of being from 4 to 6 volts negative as called for in the manual. "What now?" asked Jack.

"Well, according to the circuit diagram," said Tommy, "there is nothing connected to these points that could produce positive potential. That resistor R_{356} goes away to the grid of the oscillator, which is bound to be negative: the grid current flowing in an oscillator tube produces negative voltage at the grid terminal. Change the 12AU7 first, just in case there's something wrong that didn't show up on the tube tester."

With a new tube in the socket and the fault still present, John was studying the schematic. "Maybe that 3300-μμfd. unit (C_{365}) from the sync section is lacking," he offered.

Tommy looked at the list of voltages on the bench. "I doubt it because, if it was, you would expect to find pin 8 more positive than pin 6. It's closer to the point of connection you see. But we can't be sure of that, so clip it and have a look."

"No change," reported John. "Maybe I can follow up this 'most-positive-point' idea. The most positive voltage is on pin 6. It can't be coming through the 100,000-ohm resistor (R_{363}) because pin 8 is on the other end of that. The other end of the 1-megohm job (R_{355}) is pin 2 of the other 12AU7, and that's reading negative. What about this 10,000-ohm fellow (R_{356})?

"Whoops!" He grinned happily. "Now I think I'm getting somewhere. This point *is* more positive, so I can follow along through the 6800-ohm resistor (R_{365}). Yep! That's even more

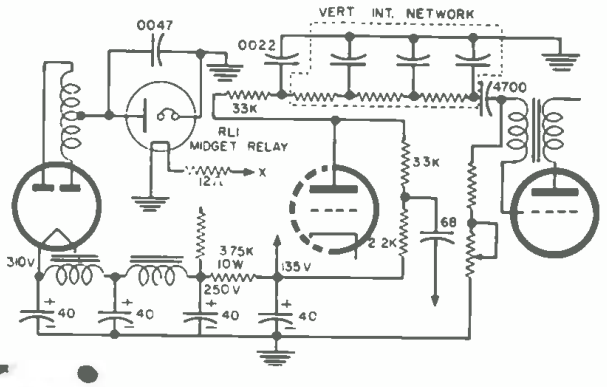


Fig. 2. The primary defect in this Majestic circuit was easily found and cured. However, an afterthought led to a recheck with interesting results. Another, hidden fault was found and cured!

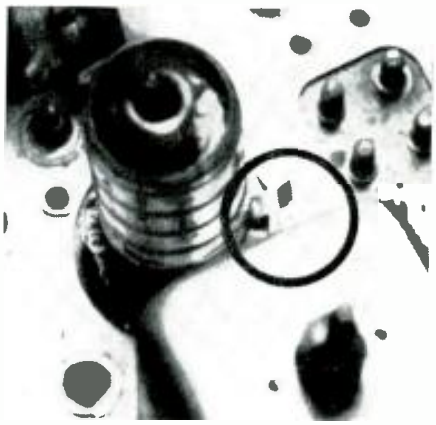


Fig. 3. The circled ground strip, outside the tube shield, may mean trouble.

Fig. 4. First job of the day, handled by John, involved this Emerson circuit.

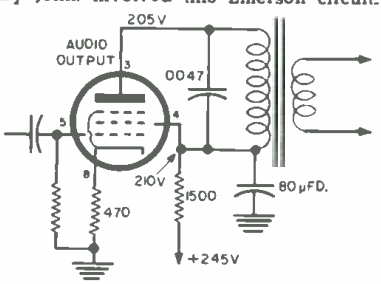
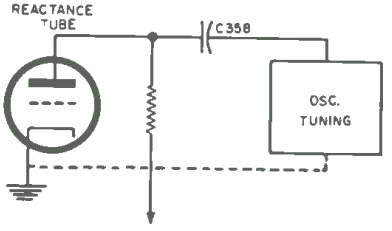


Fig. 5. The reactance tube is in shunt with the oscillator tank, through C_{358}.



positive! Now we come to what *ought* to be a dead end, a 300-$\mu\mu$fd. capacitor (C_{352}). The capacitor has the same voltage at both ends, so I guess he's the culprit."

"Dead on the ball," approved Tommy, "and that's the best way to approach a fault like that too. Put a decent capacitor in there, one of those 750-volt types. I'd better give the rest of the set a check over I guess. Hey!" he erupted a few minutes later, "Who checked these tubes."

"I did," admitted John, "what's wrong?"

"See those shields?" Tommy pointed to the i.f. strip. "You must tuck those little grounding strips *inside* the shield (Fig. 3) when you replace it, especially on this particular model. It has a tendency to take off into oscillation if those tubes aren't properly shielded."

The Second G-E Chassis

Jack had been quietly making a voltage check of the second chassis and now came up with a list that practically matched the figures on the schematic. "That doesn't get us far, does it?" he observed disappointedly. "I guess this one needs a different approach—and I was looking forward to playing Sherlock Holmes myself on this one."

"Don't worry," said Tommy, "there are other ways of bringing the fault to justice without tracking him everywhere he goes. Let's look for some more evidence." He picked up the low-capacitance probe and turned up the intensity control on the scope above the bench. "Let's have a look for the sync pips coming through from the clipper circuit." He attached the probe to pin 8 of the phase detector in Fig. 1.

"Note we have plenty of spike from the sync department which disappears when we tune off-channel. Always a good idea to remove the signal temporarily to make sure it is the sync pulse you are looking at, rather than some induced signal from the high-voltage section. And you can see the saw-tooth there from the horizontal-discharge tube. Better check along that line as John did with the other set. We'd look rather foolish if it was the same thing and we went batting off on some other tack." This was done, but it turned up nothing.

"Now look here," said Tommy, "I think the *best* way here would be to sift the evidence through, exhibit-by-exhibit in the routine, component-check method. Check each part in the grid circuit of the reactance tube and then those between the reactance tube and the oscillator grid. I'm going to nip out for an early lunch." When Tommy returned, the set was working merrily on the bench, its horizontal hold as stable as a rock.

"It was this 470-$\mu\mu$fd. capacitor, C_{355}," reported Jack. "It has no capacitance at all according to your checker."

"What does that capacitor do in the circuit anyway?" asked John. "I don't know much about this reactance-tube business."

"Well," explained Tommy, "you can regard the reactance tube as being in parallel with the oscillator tuned circuit, like this (see Fig. 5). Now the capacitor that went open was coupling the reactance tube to the circuit so, with it open, the reactance tube might as well not be there for all the good it does. Under such conditions, when the oscillator drifts off-frequency, the reactance tube is not able to change the phase of the circulating currents in the oscillator tuning network to compensate for the drift . . . what was that you said, John?"

"I just said, 'I pass,'" mumbled John. —30—

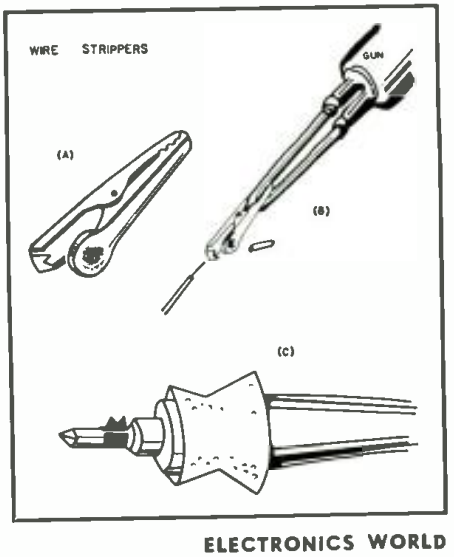
SOLDER GUN WIRE STRIPPER

By FRITZ C. HOFFMAN

WHEN INSULATION must be removed from wire, an irritating situation usually results, especially when the wire involved is in a cramped working space. A slender knife might work, but even the slight nicks that inevitably result weaken the wire and thus tend to invite breakage. The little device shown in parts (A) and (B) of the accompanying illustration, made from a miniature, copper alligator clip of the "Minigator" type, solves the problem neatly.

To make up the wire stripper, cut a "V" into the very tip of the clip, and then bend this tip over 90 degrees as shown in (A). The entire unit is then clipped onto the tip of the soldering gun, as shown in (B). Now all you have to do is press the trigger of the gun and rotate the adapted tip around the wire to be stripped. With the help of the applied heat, insulation comes off cleanly and quickly.

Where a considerable amount of stripping is to be done, as in wiring up kits, a stripping clip can be made up for use on a regular or pencil type iron. Shown in part (C), this adapter can be fashioned from copper and left permanently in place on the iron. While this version may not work quite as well as the gun adapter in close quarters, it is more practical for extensive work and is always at hand when needed. —30—



Hi-Fi Control Center

(Continued from page 65)

Treble Control: −16 db, +16.2 db at 15 kc.

Loudness Control: Designed to affect the low-frequency end only and is effective in its operation.

Channel Separation: 41 db at 1000 cps.

IM Distortion: Measurements were taken under two separate conditions and through the high-level stages only. For 1 volt in and 1 volt out, IM distortion was .12%. For .5 volt in and 2 volts out, IM distortion was .13%. These measurements were taken at 60 and 6000 cps mixed 4:1.

Harmonic Distortion: Tests were made under two separate conditions through the high level stages. For 1 volt in and 1 volt out, harmonic distortion was .11% at 30 cps, .1% at 1000 cps, and .07% at 15,000 cps. For .5 volt in and 2 volts out, it was .07% at 30 cps, .06% at 1000 cps, and .05% at 15 cps. If we were to subtract the residual distortion in the test equipment for both the IM and HD tests, one would have to report that distortion was entirely negligible. This unit should not add in any way any coloration to the sound reproduction.

Hum and Noise: −56 db on magnetic phono input with .006 volt input and level controls adjusted for 1 volt output.

One point worthy of mention is that both tone controls have a flat taper at their centers of rotation and this, coupled with the use of Baxandall tone control circuits, provides a fairly broad center adjustment for flat response.

The over-all design of the front panel and cabinet is neat and attractive although it is not as elaborate as many of the preamplifiers on the market today.

This unit is available in either assembled or kit form. The one we tested was a wired version and therefore we did not have the opportunity of actually constructing and checking it out as a kit. In going through the construction manual, however, we found no reason why anyone should have problems in assembling the kit. There is one point very much in the builder's favor and that is the use of printed circuit boards. This obviously minimizes possible errors and certainly simplifies the construction. —30—

COTTON-TIPPED TIP

DOUBLE-TIPPED cotton swabs, such as "Q-Tips," originally designed for the nursery, may be used for the maintenance of recording and other electronic equipment.

Dipped in carbon tet or other cleaning fluid, the cotton swabs are handy for cleaning recording, bias, and playback heads; wiping oil from driver wheels; and cleaning hard-to-reach contact points of all kinds.

They are also useful for applying talc to drive wheels to prevent slippage and for applying oil to switches and moving parts. —30—

Technical Books

"THE ALGEBRA OF ELECTRONICS"

by Chester H. Page. Published by *D. Van Nostrand Company, Inc.*, Princeton, N. J. 253 pages. Price $8.75.

This excellent, specialized text will be of inestimable value to electronic and radio-TV technicians whose practical "know-how" exceeds their theoretical understanding of their field. Those with a working knowledge of high-school algebra and simple differential calculus will have no difficulty with this text—even on a "do-it-yourself" basis.

The text material is clear and arranged in logical progression. Over 100 problems have been included for self-checking or for student practice. Answers are given in the book.

The author starts his treatment with a discussion of direct current and general direct-current networks then continues with simultaneous equations, general network properties, capacitance, inductance, series-tuned circuits, complex numbers, alternating-current networks, specific a.c. networks, impedance matching, diodes, amplifiers, and noise, concluding with a chapter on modulation, demodulation, and distortion.

* * *

"JUNCTION TRANSISTOR ELECTRONICS"

by Richard B. Hurley. Published by *John Wiley & Sons, Inc.*, New York. 461 pages. Price $12.50.

The material included in this volume is based on the author's class notes developed during his tenure as lecturer in electrical engineering at the University of California. Although the college course was presented to practicing engineers and graduate students, the author has "tempered" the treatment so that readers with less impressive backgrounds can benefit from this material.

Chapters on low-level semiconductor physics, low-level diode and triode analysis, gain and impedance formulas, audio-frequency amplifiers, transistor biasing, noise in transistors, degenerative feedback, high-level physical considerations, power amplifiers, direct-current amplifiers, direct-current regulators, high-frequency equivalent circuits, internal feedback compensation, video amplifiers, frequency selective amplifiers, gain control, sinusoidal oscillators, modulation, switching theory, non-regenerative switching circuits, regenerative switching circuits, and transistor-saturable reactor circuits indicate the scope of this volume.

Those without an adequate mathematical background may experience some difficulty in handling the text material but those used to working with figures and formulas will find this exposition especially enlightening. A bibliography accompanies each chapter for additional investigation on the part of the reader.

* * *

"WORLD RADIO HANDBOOK"

edited by O. Lund Johansen. Available in U. S. from *Gilfer Associates*, P. O. Box 239, Grand Central Station. New York 17, N. Y. Price $2.50. Paper bound. Thirteenth Edition.

There is good news for the SWL and DX fan in the announcement of the 1959 edition of the dial-twirler's "bible."

Revised and considerably enlarged, this new edition includes a wealth of information: data on sunspot activity; medium-wave reception throughout 1959; the most suitable short-wave bands to use, DX programs of all stations; radio and TV receivers in use in all countries; frequency allocations; operating schedules for broadcast stations; addresses, frequencies, powers, languages, and slogans of all stations; interval signals including musical identification notes for all stations; a listing of long-, medium-, and short-wave stations; world time chart; call signs, etc.

In addition to this current material, the same publisher issues a summer supplement (70 cents) which will update the information in the "Handbook" for the fall and winter broadcasting season and serve until the 1960 issue is ready for distribution.

* * *

"BASIC PULSES"

by Irving Gottlieb. Published by *John F. Rider Publisher, Inc.*, New York. 170 pages. Price $3.50. Soft cover.

This book is directed to service technicians, hams, and engineers since all of them in the course of their work or pursuit of their hobby deal with pulses.

The author has made his presentation with an absolute minimum of mathematics. The treatment is based on descriptive narration with the pulse phenomena being explained by analogy, through cause and effect relationship, and by means of qualitative rather than quantitative analysis.

The text covers pulses used in electronic equipment, measurement of irregular waveforms, types of pulse wavetrains, additional pulse characteristics, Fourier analysis of pulse constituents, the d.c. component in pulse trains, factors determining waveshapes, wave symmetry in waveform analysis, single-pulse concepts, pulses in *LCR* circuits, frequency response of *RC* networks, *RC* filters in radio and test probes, energy-storage viewpoint,

time-constants in *RC* and *LR* networks, shunt resistance, waveshaping by special circuits, waveform differentiation and integration, speech waveforms, d.c. restoration principle, the saw-tooth generator, vacuum tubes as pulse generators, the blocking oscillator, multivibrator-produced pulse trains, and relaxation switching circuits.

A glossary of terms and a series of test questions make this book entirely suitable as a classroom or home-study text.

* * *

"TELEVISION SERVICING" by Walter H. Buchshaum. Published by *Prentice-Hall, Inc.*, New York. 380 pages. Price $6.75. Third Edition.

It has been four years since the Second Edition of this volume reached the public and in that time many new and important developments have been made in TV circuitry and in the ways and means of coping with service faults. This volume has been completely revised and brought up-to-date to reflect the most recent developments in design and servicing.

The text material is divided into three parts covering general television theory, alignment and installation, and troubleshooting. The student can work straight through the volume while the practicing technician may wish to scan the first two parts and use the text as a source-book for troubleshooting sets on the workbench. Emphasis has been placed on practicality and there is an absolute minimum of mathematics and pure theory.

The book is lavishly illustrated with block diagrams, photographs of commercial units, line drawings, schematics, scope patterns, graphs, and tables. The troubleshooting section is especially well served with a number of picture-tube photographs with actual service faults shown on the screen.

Readers of this magazine are thoroughly familiar with the author's style and approach and will welcome this reference text from the same pen.

* * *

"TRANSISTORS, THEORY & PRACTICE" by Rufus P. Turner. Published by *Gernsback Library, Inc.*, New York. 156 pages. Price $2.95. Paper bound. Second Edition.

The author's first edition, published in 1954, was an immediate success but since so many new developments have been made in the interim, the appearance of a second and up-to-date version was called for.

Each of the original chapters has been expanded to include the latest information and, in addition, material on thyristors, four-layer diodes, spacistors, double-based diodes, and photo-transistors has been included to keep the reader abreast of this fast-moving field.

Eleven chapters are devoted to semiconductor theory, transistor characteristics, equivalent circuits, transistor amplifiers, transistor oscillators, duality in transistor circuit design, triggers and switches, practical transistor circuitry, tests and measurements, related devices, and the care and handling of transistors.

The treatment is simple enough for the beginner and this volume would be entirely suitable for classroom instruction as well as home study. Lists of recommended reading material are appended to each chapter allowing the user to pursue any particular topic more deeply. The text is well illustrated and the copious use of schematics will be of considerable help to the reader.

—30—

Missile Measurement Ship

"Floating Laboratory" of electronic gear aids in tracking missiles from South Atlantic post.

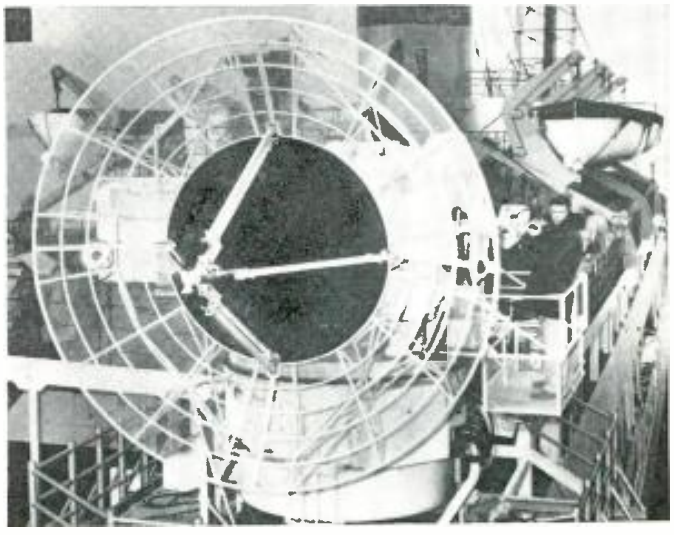
A REFURBISHED cargo vessel, fitted out with electronic equipment so elaborate as to make it a veritable floating laboratory, has taken its post in the South Atlantic to aid in tracking the experimental missiles fired by the U. S. and in recording data on their performance. The vessel is the S. S. "American Mariner," which has been refitted from stem to stern with the latest electronic and optical instruments to provide the most precise data yet collected at sea on missile flights. *Radio Corp. of America* is the systems management contractor and *Barnes Engineering Co.* is in charge of the non-radar projects.

The information the ship collects—by radar, telemetry, and optical apparatus—will supplement the data already being recorded on the missile range by ground stations and picket ships operated by the Air Force. The range extends from Cape Canaveral, Fla., more than 5000 miles southeast across the Atlantic to the vicinity of Ascension Island, half way between Brazil and the African Coast.

The new missile measurement ship is a project sponsored jointly by the Advanced Research Projects Agency, Dept. of Defense, and the Army Ordnance Missile Command. Fifty-two civilian scientists, engineers, and technicians, in addition to the ship's crew, will make up the vessel's complement for each tracking mission that is embarked upon.

Some of the most advanced electronic equipment in existence has been incorporated into the elaborate system aboard the ship, including tracking radars described as the most accurate in the world. The system even includes a videotape recorder similar to that used by broadcasting networks for recording and rebroadcasting television programs.

The scientific staff will make precision observations and collect data on the characteristics of a missile's performance from its ascent to remote altitudes in space, through all levels of the earth's atmosphere, to the final plunge into the sea. The data obtained will be shared by all branches of the Armed Forces. The Navy provided computing equipment to compensate for the ship's roll, thus making possible accurate radar measurements at sea. The Air Force, in turn, will contribute valuable information on missile firings from its missile test center at Patrick Air Force Base, Florida. —30—



This huge dish, largest tracking radar antenna afloat, will assist in tracking missiles and recording their performance on the Atlantic Missile Range. The radar, two of which have been installed on the S.S. "American Mariner," is sufficiently powerful to "see" missiles at distances of hundreds of miles away.

Engineers are shown manning the operations plotting and recording equipment aboard the S.S. "American Mariner," the new missile measurement tracking ship.

HAIL to the fair sex! The ladies' auxiliaries of the service industry's far-flung associations have been playing an increasingly important role in the forward march of organizations striving to improve the status and stability of the service business. Witness, for example, the San Antonio group featured as the "Association of the Month" in the March 1959 issue (page 90). The activities of other such auxiliaries receive some attention here this month. The officers of distaff groups that would like to tell us about their work are invited to do so. Address reports to this column in care of ELECTRONICS WORLD.

In reporting the names of the newly elected officers for the Ladies' Auxiliary of the Radio-TV Technicians Guild, the "RTTG News" of Florida handed the ladies some very nice verbal orchids when it said:

"The Ladies' Auxiliary voted some time back to hold their elections and installation of officers at the same time and in conjunction with the Guild so that one installation be held instead of two separate ones. The money thus saved could be used to have a better and more elaborate installation at one of the finer hotels.

"The ladies have always previously outshone the men in the installation affairs, finding better accommodations and better food; so it was decided that, since they are so good at this sort of thing, they be appointed a committee to select and arrange for the location, the food, and the entertainment of the combined installation of new officers for the coming year."

Officers elected to guide the RTTG Ladies' Auxiliary are: Mrs. Everett Atherton, president; Mrs. Roger Misleh, vice-president; Mrs. Nancy Azar, treasurer; and Mrs. Carol Seymour, secretary. Mrs. Harriet Kessler and Mrs. Sybil Tittle were elected to serve on the board of directors along with Mrs. Clyde Lawrence, who is a two-year-term member of the board.

The Guild members chose A. Edward Stevens of *Eagle Radio & Television*, 165 Aragon Ave., Coral Gables, president for the coming year. Dan Prowler of *Prowler's TV Service*, 2283 N. W. 36th St., Miami, was elected vice-president. The second vice-presidential post went to Roger Misleh, *City-Wide TV* 626 N. W. 27th Ave., Miami. Sam Kessler of *Kessler Radio & TV*, 4895 S. W. 8th St., Miami, was re-elected recording secretary and Max Reiser of *Radio Center Music, Inc.*, 2922 N. W. 54th St., Miami, was elected to the post of corresponding secretary. C. W. Minter of *Buena Vis-*

ta Radio, 86 N. W. 36th St., was unanimously elected treasurer.

The Guild's board of directors will be made up of Shan Desjardins, owner of *Shan the Radio Man, Inc.;* Joseph H. Rizzo of *T.V. Joe, Inc.;* Elmer V. Vohs of *ADCOF;* George Peroni of *Best Television;* Mack Tittle of *Keene Radio & Television, Inc.;* and Julio W. Sera of *Sera's TV*.

In Texas, the wives of TEA members have formed a state-wide ladies' auxiliary that is probably the first of its kind in the industry. With chapters now active in San Antonio, Houston, Dallas, and Fort Worth, the TEA Auxiliary officers hope to expand their organization to include *all* of the affiliated cities.

The latest roster of associations affiliated with the Texas Electronics Association includes the following, all of which have adopted the name of "Texas Electronics Association" followed by a city or county designation:

Dallas: 430 Exchange Bank Bldg., Dallas 25; Fort Worth: 1513 West 7th St., Fort Worth; San Antonio: 810 East Commerce, San Antonio; Houston: P. O. Box 8725, Houston; Corpus Christi: Box 3013, Corpus Christi; Tyler: Box 3302, Station A, Tyler; Longview: 504 East Methvin, Longview; Conroe: P. O. Box 1204, Conroe; Midland: 700 S. Main, Midland; Big Spring: 609 Gregg St., Big Spring; Harrison County: % Fred Bohmer, 306 E. Austin, Marshall; Waco: 1712 Franklin, Waco; Erath County: 1400 Frey St., Stephenville; Oak Cliff: Wynnewood Professional Building, Dallas; Hale County: 508 Quincy St., Plainview.

The Spring convention of TESA of Ohio, the Buckeye State organization, was held at the Commodore Perry Hotel in Toledo early in April. Again the gals were involved—the ETAT Ladies' Auxiliary taking responsibility for the weekend entertainment. ETAT is the Electronic Technicians Association of Toledo.

The Associated Radio & Television Servicemen, 433 S. Wabash Ave., Chicago, Ill. has leased exhibit space at the International Trade Fair which is scheduled to be held at Navy Pier in Chicago from July 3rd to 18th. The committee named to handle the various details of the project includes Sam Bellavia, John Sotor, William Siegrist, Jr., Anthony Mallin, and Martin Nebojsic. The over-all supervision of the project will be handled by Joseph Ehlinger, vice-chairman of ARTS.

N.Y. Service Bill

In New York State, service technicians are divided on the plan to support a bill before the state legislature that provides for TV technician "certification" on a voluntary basis.

Robert Larsen, president of the Empire State Federation of Electronic Technicians Associations and also president of the local Radio & Television Technicians Guild of Long Island, has been urging affiliates of the State

Federation to support the self-licensing measure proposed by the state's Attorney General. Mr. Larsen feels that in any event, a bill to license technicians will be passed "with or without the aid of the service industry." If for no other reason than to forestall unfair treatment of service, then, the industry should have its say.

Mr. Larsen claims that the bill currently before the legislature will increase respect for people in TV service, will obtain a "little better deal for them on service rates and charges, and would raise the standards of the service industry as well as its income."

The principal objection of association members to the New York bill is that it lacks the *mandatory* requirement that a technician must have a license to do consumer service work in the Empire State.

Pennsylvania Crackdown

The Federation of Radio & Television Service Associations of Pennsylvania, at a recent meeting, initiated a campaign to plug loopholes in the present state sales-tax law. They will recommend stricter controls in wholesale-retail selling. Through its campaign, the Federation will endeavor to focus attention on three weaknesses in the administration of the present sales-tax law:

1. Wholesalers collecting sales tax from retail sales at the wholesale price level. 2. The failure of many operators to obtain the required sales-tax certificate. 3. Part-time operators who pay the sales tax at the wholesale level but collect the tax at retail prices.

The members of FRTSAP hope to prove that, by stricter enforcement of the present law, the state will gain thousands of dollars in additional revenue and thus eliminate the need for an increase in the state sales and use taxes now being proposed by some legislators.

Effects of Licensing

The editor of "TSA News" of Michigan, Hal Chase, recently reported on the results achieved in Detroit from their license law, Ordinance 110F. After two days of personal investigation, he said:

"The success of 110F has greatly raised the standards of service locally. Better Business Bureau records show a great drop in complaints of about 60% since the passage of 110F. Here are the BBB figures: 1160 complaints in 1956; 846 complaints in 1957 (enforcement of 110F started in mid-year); and 466 complaints in 1958.

"Further study of these figures will undoubtedly reveal that, if the worst offenders are refused 1959 licenses, the 1958 figure of 466 would be cut down to a figure too small to even consider. It is rumored that, in the case of one of these flagrant offenders, the BBB complaint file is so large they refuse to process any more complaints, regarding them useless." —30—

Service Notes

SYLVANIA: BETTER SYNC

Later production of receivers using TV chassis 1-537-5, (or, −6) and 1-539-3 (or −4) incorporate circuit revisions to improve sync stability. The receivers on which these changes have been incorporated begin with serial numbers 537501- and 537601-. To correct earlier schematics and to facilitate incorporation of the changes in earlier sets where improved stability is desired, the altered circuit is shown in Fig. 1. Changes are as follows:

R_{216} (1000 ohms) is changed to R_{216-1} (470 ohms, ½ watt). R_{215} (470 ohms) is changed to R_{215-1} (2200 ohms, ½ watt). R_{211} (39,000 ohms) is removed. C_{302} (.047 μfd.) is changed to C_{302-1} (.01 μfd. paper capacitor). The lead that formerly connected R_{211} to R_{215} and L_{205} is removed. C_{302-1} is now connected to the junction of R_{216-1} and R_{215-1}.

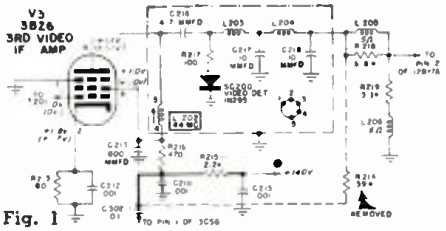


Fig. 1

Fig. 1 shows both the old and new circuit. A broken line indicates the original wiring and original component that are removed. Components that are changed in value and new circuit wiring are indicated by the heavier lines.

PHILCO RETRACE BLANKING

When performing service on the 9H25 TV receivers, avoid confusion by noting that a change in production has resulted in circuit changes with respect to the retrace suppression network and the CRT in many models. Since the blanking network, N_1, is no longer considered necessary, it has been removed. Its connections to lugs 5, 6, and 7 will then no longer be found on terminal board 1. Also, where this change exists, the connection of the green wire coming from the CRT cable will also be changed. Instead of going to lug 6 on terminal board 1, it goes to lug 7.

TRAV-LER: HORIZ. STABILITY

In some chassis using a 6CG7 tube as the horizontal oscillator, it may be desired to effect some improvement in sync stability. The chassis involved are some in the 740, 743, 744, and 775 series. An improvement in stability can be achieved with a relatively minor change. Simply add a .047-μfd., 600-

volt molded capacitor: one end of this new component goes to the junction of R_{82}, R_{83} (the hold control), and R_{84}. See Fig. 2. The other end goes to ground.

After this change, it will be necessary to realign the horizontal frequency and waveshaping coil assembly, L_{119A}, to obtain the improved performance now possible. This should be done in accordance with instructions in the service data, using an oscilloscope. If this data is not at hand, the oscilloscope is connected, through a 10-$\mu\mu$fd. capacitor, to the junction of C_{71} with

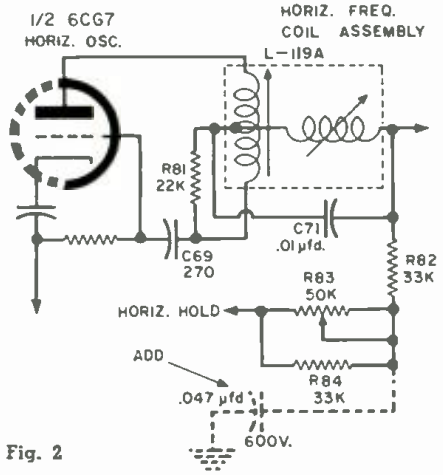


Fig. 2

R_{83}. With a picture properly tuned in, the horizontal-hold potentiometer control is set to the center of its range. Then L_{119A} is adjusted for correct frequency and waveshape, the latter being the typical waveform of pulse-width horizontal a.f.c. circuits. The top slug of L_{119A} is used to adjust for correct frequency. The bottom slug is used to achieve correct waveshape. After this is done the picture should hold sync over the entire range of the hold control.

EMERSON AM RADIO NOISE

Field reports indicate that, in certain areas where interference from electrical power lines is high, more effective line filtering is required on some *Emerson* AM radios. This can be obtained by placing a .047-μfd., 600-volt molded, *UL*-approved type of capacitor (such as *Emerson* part #922208) directly across the power line within the receiver. Before this capacitor is added, the existing power-line bypass capacitor in the set should be removed. Keep the pigtails of the replacement short and dress the unit down and away from the antenna loop.

MAGNAVOX HUM BAR

Some TV receivers in the 27 series may exhibit a tendency to develop hum bars noticeable in the raster. If you run into this symptom, the chances for a quick and easy cure are good. Simply shunt a .01-μfd., 500-volt ceramic capacitor across the power rectifier. This component has been incorporated in later models of the 27 series, after the hum bar came to notice. —30—

Low-Level Clamp Modulator

(*Continued from page 61*)

power of approximately 25% of the peak modulated value. Not only is the efficiency of the final stage higher with this adjustment, but also there is less detrimental effect to the operation of a.v.c. systems at the receiving end.

Transmitter Adjustments

Any transmitter incorporating the design provisions previously outlined can be adjusted for proper operation of the low-level clamp modulator by following the step sequence given below. In medium- and high-power transmitters, the customary provision should be made for reducing power input to the final during initial tuneup.

Other than a dummy antenna load for the transmitter output and the shack receiver or a crystal detector for checking audio quality, no special equipment is required to make the necessary tuning adjustments. As in the case of the antenna, the dummy load used for tuning should be capable of loading the transmitter to at least 75% full output for best depth of modulation.

1. With the dummy antenna connected and the clamp modulator switched out of the circuit (to c.w. position), peak up the tuning of all stages for maximum power output as for c.w. operation, making a note of the final amplifier plate current reading.

2. Switch the clamp modulator into the circuit and observe the final amplifier plate current reading (with no audio fed into the modulator). If this reading is approximately 25% of the maximum reading obtained in Step 1, no further r.f. adjustment should be necessary and the audio gain control should then be set so that sufficient audio is available to swing the final plate current to the maximum reading of Step 1. The audio gain control should then be backed off slightly and the transmitter is ready for operation.

3. If the plate current reading obtained in Step 2 is greater than 25%, detune the final grid circuit slightly to reduce the current to the desired value. This should require very little detuning. If, however, insufficient reduction in current is obtained by only slight detuning, then increase the resistance setting of the driver grid resistor (R_2) until the proper reading is obtained. If the reading is still too high, indications are that stray coupling exists between the exciter and final or that there is too great an excess of drive available to the buffer. This can be reduced by lowering screen voltages on the exciter stage or stages.

4. If the plate current reading obtained in Step 2 is zero, or much less than 25% of maximum plate current reading, carefully touch up the tuning controls to see if the desired value can be obtained. If the plate current is still far below the desired value, reduce the resistance setting of the driv-

er grid resistor [illegible] and necessary plate current is obtained. Failure to obtain the necessary plate current at this point indicates insufficient drive to the buffer and exciter voltages or interstage coupling should be increased accordingly.

Advantages of System

Aside from the prime advantage of economy in components and space, which is offered by the conventional clamp systems described in the past few years, the low-level clamping system dissipates negligible power even when used to modulate transmitters with outputs up to the maximum legal limit. Other clamp tube circuits are quite wasteful of power, especially when used to modulate high-power amplifiers.

An outstanding feature of this system is that despite its use as a low-level modulator, it is impossible to overmodulate the transmitter and cause sideband splatter. Another feature is that, since the plate current of the buffer and final amplifier stages averages about half the maximum value required for steady input modulation (due to the character of speech audio), it is practical to operate these two stages at plate inputs of 50% or more above manufacturers' ratings, without damage to the tubes. Thus, a kilowatt input can be achieved with smaller tubes than usual, an example of which is shown in Fig. 6. —30—

MARS SESSION FOR MAY

THE following sessions have been scheduled by MARS for the month of May. The First U.S. Army MARS SSB Technical Net, Wednesdays at 9 p.m. (EDT) on 4030 kc. upper sideband, has listed the following speakers:

May 6 — "American Antarctic Communications Adventures" by Amory H. Waite, Jr., Project Engineer, U.S. Army Research & Development Lab., Fort Monmouth, N. J.

May 13 — "Telemetering for Guided Missiles" by J. R. Popkin-Clurman, W2LNP, Telechrome Mfg. Corp.

May 20 — "The Megacoder" by Harry Kihn, Technical Staff, RCA Laboratories.

May 27 — "Novel Tuning Methods at UHF & Lower Microwave Frequencies" by Bernard D. Nadler, Lewyt Mfg. Corp.

The net will recess until September upon completion of the May series.

* * *

THE Air Force MARS Western Technical Net, Sundays from 2-4 p.m. (PST) on 7832.5 and 3295 kc. and 143.46 mc., has listed the following speakers for May.

May 3 — "Organization Facilities & Operation of a Modern Communication System" by P. C. Christensen, Mackay Radio, San Francisco.

May 10 — "Wide-band Microwave Telemetry" by Fred Barry, Equipment Development Div., Philco, Palo Alto.

May 17 — "High Impedance Modulation Systems for Klystrons" by Gene Tallmadge, Levinthal Electronics Products Inc., Palo Alto.

May 24 — "Electronics in Medicine" by Dr. J. Phillip Sampson.

May 31 — "Equipment Utilization and Conversion Information" by USAF MARS Western Technical Net Members.

—30—

"TELEVISION ANALYZING"

B&K Manufacturing Co., 3726 N. Southport Avenue, Chicago 13, Illinois, has released a book entitled "Television Analyzing Simplified" by Milton S. Kiver.

Priced at $1.00 and available at electronic parts distributors or direct from the company, the book compares television servicing methods. It illustrates and explains the latest point-to-point, signal injection, direct-viewing technique that makes it quick and easy for experienced or inexperienced service technicians to spot and correct the exact video or audio trouble in black-and-white and color television receivers, including intermittents, after tube changing has failed.

This new book helps show how to save time and work and make more servicing profit.

ELECTRONICS CATALOGUE

Philco Corporation's Accessory Division, Philadelphia 34, Penna., has issued a new, 400-page 1959 electronics catalogue designed to provide independent service technicians with a complete service library for radio, auto radio, television, and other electronic products. Copies may be obtained through any of the firm's distributors or by contacting Rayford E. Nugent, general manager of the division.

Each of the catalogue's five sections deals with a different group of parts and information, including electronic components and test equipment, outdoor and indoor parts and accessories, phonograph and audio parts and accessories, and electronic products parts information and quick-reference material. Information is categorized into more than 100 groupings ranging from antennas to transistors.

AUTO-RADIO CONTROLS

Centralab, a division of *Globe-Union Inc.*, 900 E. Keefe Ave., Milwaukee 1, Wisconsin, has just published a guide to its line of exact replacement auto-radio controls.

This guide is designed to enable the service technician to quickly determine the proper replacement. The auto manufacturers are listed in alphabetical order and each listing is broken down by model year. The guide, available without charge by writing directly to the firm, lists the original manufacturer of the radio, the model number and the original part number, as well as the replacement and its price.

NEW TUBING

Minnesota Mining and Manufacturing Co., Irvington Division, 900 Bush

Avenue, St. Paul 6, Minn., announces a new, three-color, four-page brochure containing prices, tolerances, sizes, and application information on PTFE (polytetrafluoroethylene) tubing. It may be obtained by writing to the manufacturer direct.

A gate-fold chart lists electrical, mechanical, chemical, and thermal properties of the high-temperature tubing, opposite a full page of purchasing information such as price, color packaging, and terms.

Cross-reference and dimensional tolerance charts are also included.

SHOCK MEASUREMENTS

Columbia Research Laboratories has prepared a 14-page booklet which fully describes and illustrates three commercially available shock and vibration measuring systems. Free copies may be obtained upon request to the company, Bullens Lane and McDade Blvd., Woodlyn, Pennsylvania.

The systems described are fully integrated both in instrumentation and packaging and are complete systems featuring automatic control, self-calibration, and requiring no additional equipment.

D.C. POWER SUPPLIES

Electro Products Laboratories, 4500 N. Ravenswood Avenue, Chicago 40, Ill., has announced a four-page folder covering the uses and specifications of its new dual-purpose filtered d.c. power supply. To obtain this folder, write to the company direct, attention of Mr. R. C. Crossley.

The illustrated brochure features tabulated information on percentage of ripple, continuous maximum current rating, and special features for transistor circuit servicing provided by the new Model PS-2 as well as other power supplies.

POWER SUPPLY BROCHURE

Lambda Electronics Corporation, 11-11 131 St., College Point 56, N. Y., has released a new, 36-page catalogue containing information and specifications on the company's line of transistor-regulated and tube-regulated power supplies. It is available direct from the firm.

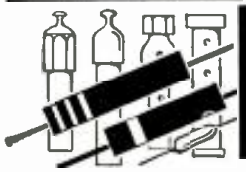
In addition, the brochure explains the background of the organization's "Five-Year Guarantee," gives detailed outline drawings of the equipment, and pictures various power supplies in use.

CABLE ASSEMBLIES

H. H. Buggie, Inc., Box 817, Toledo 1, Ohio, has released a new 12-page catalogue covering standard molded-type cable assemblies as well as field, special, and coaxial types. Copies of the brochure are available from the company upon request.

Thirty-four standard types are illustrated utilizing common connector ends and standard molded terminal ends. Also included are three pages of tabular reference data giving types, cable numbers, corona levels, and special remarks. —30—

What's New in Radio



REMOTE "ON-OFF" FOR TV

New Products Company, 5305 Chicago Ave., Minneapolis 17, Minn. is currently marketing an inexpensive "on-off" control unit which is designed to provide remote operation of any TV or radio receiver.

Tradenamed "Sound-Off," the new device is housed in a case made from *Eastman* Tenite Butyrate which will withstand years of use, and even abuse, without breaking. The 3-position remote switch allows tuning to full volume, half-volume, or no volume.

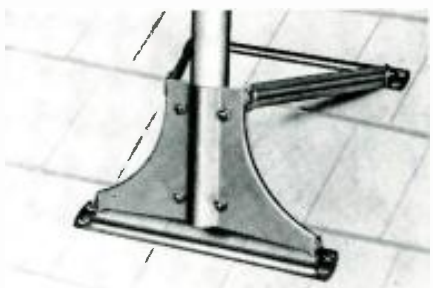
The unit comes with 25 feet of 3-conductor connecting wire plus alligator clips for the immediate installation of the device without tools or soldering. Each "Sound-Off" is packed in an individual carton with 12 units comprising a "master carton" lot.

Write the manufacturer for additional details and prices.

ANTENNA MOUNT

Vokar Products, Inc., 201 Catherine, Ann Arbor, Mich. is now offering a new, all-steel "Fast Mount" antenna holder which is claimed to cut installation time drastically.

According to the company, no special tools are required and one man can



handle the job. No guy wires are needed for standard antennas and the unit will mount anywhere on the roof, irrespective of pitch.

The mount, designed by a service technician for service technicians, is weather resistant and will not rust or stain shingles. For further information or a data sheet on this new TV accessory, write the manufacturer direct.

"GLOBE PATCHER"

Globe Electronics, Inc., 3417 W. Broadway, Council Bluffs, Iowa is now marketing a patching unit which is designed for use with DSB, SSB, or AM rigs.

The Model PH-1 "Globe Patcher" provides switchable selection of 500-, 8-, or 3.2-ohm speaker terminal connections without need for an additional transformer. The unit is easy to install and operate—requiring only 9" x 5⅜" x 1⅝" space for its neat steel cabinet. The device operates automatic voice control on sideband or push-to-talk on AM—thanks to the hybrid system design. There is manual control for compensation of line unbalance and stand-

by switch which permits placing the land-line call without energizing the transmitter.

There are separate gain controls for receiver and transmitter to permit proper adjustment and balance. Shielding and r.f. bypass elminates r.f. feedback. The unit is supplied with all of the necessary connectors for either sideband or AM.

Write the manufacturer direct for a data sheet on this patch unit.

AMATEUR BEAM ROTATOR

Moran Products Company, 2925 East 55th St., Cleveland 27, Ohio has announced a new low-cost rotator for amateur beam antennas which is being marketed as the HM 120 "Powerotor."

The HM 120 is offered as a complete package with control unit, rotator unit, and thrust bearing. The metal control cabinet is finished in grey and features a constant-indicating compass pointer which shows antenna direction when the control unit is switched on. The antenna is rotated by turning the center knob on the control unit either left or right. The rotator operates on 60-cycle, 117-volt a.c.

The rotator and thrust bearing can be tower or mast mounted. Total

weight of these two components is 12 pounds. These units may be mounted on any mast up to 1½" diameter and will hold any antenna mast up to 1½" diameter or 50 pounds weight. Steel worm gears keep the antenna locked in position so it cannot drift or coast.

Brand New!

Special to our readers for only...

As a man who is seriously interested in hi-fi, you will certainly want to be among the first to take advantage of this new and important test record. It will enable you to know your system inside-out. As a result, your listening enjoyment will be even greater than ever before.

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?*

You'll get on-the-spot answers to these and many other questions when you use this stereo-monophonic test record. It's the *most complete test record* of its kind—contains 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!*

You can immediately see the extraordinary 2-way value you get from this special test record. 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! Add up the advantages! Check the special low-price! This is the value of the year for everyone who owns a hi-fi monophonic or stereo system!

Special Features of ELECTRONICS WORLD 7" Stereo-Monophonic Test Record

- Four bands for stereo checks only—plus three bands for checking stereo or monophonic equipment!
- Non-breakable!
- Made of top-quality virgin vinyl for long wear!
- Specially-reinforced center resists warping!
- Delivered in special polyethylene envelope—dust and dirt are sealed out!
- Fully guaranteed!

Supply limited—Order your Test Record for just $1 now!

This stereo-monophonic test record has been produced as a service for readers of *Electronics World*. It will only be sold to you by mail, at the special reader-price of just $1. You can be sure that it comes as close to perfection as is humanly possible, because the editors of *Electronics World* have poured their accumulated know-how into this project for a period of many, many months. But the supply is limited, so it will have to be *first-come, first-served!* Avoid disappointment—place your order right now. Fill in and mail the coupon, together with your check ($1 per record) *today!*

ELECTRONICS WORLD • P.O. Box 211, New York 46, N. Y.

Please send me_____test records at $1 each. My check (or money order) for $_____is enclosed. I understand that you will pay the postage and that each record is fully guaranteed.

Name_____
Please print

Address_____

City_____ Zone_____ State_____

SORRY—no charges or C.O.D. orders!

M

Full details on the "Powerotor" will be supplied by the manufacturer on request.

DUMMY LOAD

Barker & Williamson, Inc., Bristol, Penna, has announced the availability of a versatile dummy load device which has been especially designed for off-air transmitter tests by labs. in the ham shack, or service shops.

The unit, tradenamed the "Matchmaster," consists of a dummy load with

direct-reading r.f. wattmeter and standing-wave-ratio bridge. It is suitable for applications where adjustment of radio transmitter power output must be checked before going on the air as well as other uses.

The device is housed in a gray-finished cabinet measuring 6" x 8" x 8".

DIAGRAMS FOR OLD SETS

Supreme Publications, 1760 Balsam Road, Highland Park, Ill. has announced that it is now able to supply diagrams and service data on radio receivers going as far back as 1927.

This information is currently available in two forms—as bound copies covering specific years or as individual schematics at 40 cents each. The years covered are 1926 through 1948 with newer set schematics also available if required.

A 48-page "Master Index" which lists all available radio and TV material can be obtained from the publisher for 25 cents.

NEW HEATH SCOPE

Heath Company, Benton Harbor, Michigan has added the Model OR-1

five-inch d.c. oscilloscope to its line of assemble-it-yourself test instruments.

The circuit features identical d.c.-coupled vertical and horizontal amplifiers, a 5ADP2 flat-face cathode-ray tube, and edge-lighted graticule. The transformer-operated power supply employs silicon diodes in full-wave voltage doubler circuits for "B+" and bias supplies. Critical voltages are regulated by gas-filled VR tubes. Both vertical and horizontal channels feature d.c. to 200,000 cps bandwidth (1 db point) and a sensitivity of .1 volt peak-to-peak/cm. (uncalibrated).

The scope is suitable for use as a read-out indicator in computer applications, in industrial testing, audio development work, and general utility usage. Normal frequency coverage is from 5 to 50,000 cps in four overlapping ranges.

TRANSISTOR TRANSFORMERS

Microtran Company, Inc., 145 E. Mineola Ave., Valley Stream, N. Y. has added five new microminiature transistor transformers to its catalogue line.

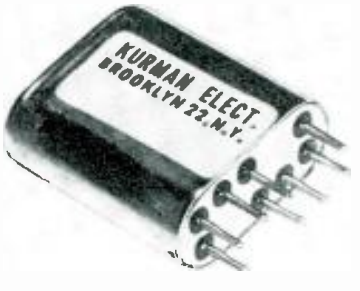
The new units are available in open frame construction with standard channel or plug-in tah mounting channel. The transformers measure less than ½ cubic inch and weigh approximately ⅛ths of an ounce. Impedance ranges are designed to meet the requirements of many new transistors.

A 24-page catalogue carrying specifications on these new transformers is available on request.

MICROMINIATURE RELAY

Kurman Electric Company, 191 Newel Street, Brooklyn 22, New York has recently introduced a new microminiature relay as its Model KX.

The new unit measures .4" wide x .8" long x .875" high. Operating tempera-



ture range is from −65 degrees C to +125 degrees C. Sensitivity is 200-250 milliwatts. The new model is offered in three different header combinations. The relay will withstand shock tests of 50 G's; vibration frequency of 20 to 2000 cps at 20 G's. Coil resistance is up to 10,000 ohms maximum and contact resistance is .020 ohm maximum.

Detailed information and prices will he supplied by the manufacturer on request.

TRANSISTOR CONVERTERS

Freed Transformer Company, Inc., 1773 Weirfield St., Brooklyn 27, N. Y. is now offering a complete line of static d.c.-to-d.c. transistor converters as stock items.

The new units are designed and constructed for quiet, maintenance-free operation and long-life service. They

feature high power-to-weight ratio and arc-free operation. They are available with from 6 to 26 volt battery input with output voltages ranging from 150 to 600 volts d.c.

Further information on this new line, as well as details on custom units the company is prepared to design, is available from the manufacturer direct.

PHILCO TUBE TESTER

The Accessory Division of *Philco Corporation*, Philadelphia, Pa. has just released a new tube tester which has been designated the Model 9200.

The new instrument tests cathode emission, checks for shorts and leakage between elements, shorts and leakage in cathodes, and continuity in the heater circuit as well as of internal connection between base pins.

Each section of multi-purpose and multiple-section tubes is tested individually.

The roll chart covers all tubes commonly encountered in today's electronic equipment—including 1959 production. Numerous additional seldom-used tubes are covered in a supplement—including many foreign types now appearing in the U.S.

New roll charts will be prepared periodically and will be available at nominal cost from the firm's distributors.

CITIZENS BAND GEAR

Electronics Design Company, 400 East Cornell, Enid, Oklahoma has announced production of a new and compact two-way radio unit for the Citizens Band and the CAP Band.

The *EDCO* Model 100 measures 11" wide, 10" deep, and 11" high, including handle, and weighs 15 pounds. It is being offered with either a.c. power supply or 6/12 volt and 117-volt power, as required by the user. Power output is 5 to 6 watts and output impedance is 50 ohms nominal. Either dynamic or carbon microphone may be used. The unit is supplied without microphone or antenna but comes with crystal and one a.c. and one d.c. power cable. The receiver and transmitter sections each employ seven tubes.

A data sheet on this new equipment is available from the company. Write the firm at P.O. Box 401 for further details and prices.

100-WATT TRANSLATOR

Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N. Y. is now offering a new 100-watt TV translator for u.h.f. service.

The Type RA-7 is intended for use by those communities for which the standard 10-watt units are inadequate. The translator provides 100 watts peak

(*Continued on page* 152)

visual power output when driven by the 10-watt unit, operates on any u.h.f. channel (14 through 83), and provides correct drive impedance and low input v.s.w.r. All critical circuits are metered. The translator is designed for both black-and-white and color transmissions.

A 12-page brochure describing this and other units in the company's line of translators will be forwarded on request.

NEW PRECISION V.O.M.

Precision Apparatus Company, Inc., 70-31 84th Street, Glendale 27, Long Island, N. Y. is now offering a new version of its Model 120 v.-o.m. for applications in industry, laboratories, technical schools, and service shops.

Newly incorporated into the Model 120 is a chrome-mirrored scale plate which makes possible high accuracy readings by eliminating parallax. Also new is the d.c. polarity reversing switch whereby the number of ranges is increased from 44 to 59. The a.c. and db frequency response has been widened so that it is now flat from 15 to 100,000 cps ±1 db.

Other features of the instrument are the same as the earlier version. For complete specs on this v.o.m., write direct to the manufacturer.

NEW WESTON PANEL UNITS

Weston Instruments, division of *Daystom, Incorporated*, Newark, N. J. introduced several new and improved models of its panel instruments at the IRE Convention in New York.

The newest units include a.c. and d.c. models in the 2½" to 7" class and feature "Cormag" mechanism for positive shielding from external magnetic fields. In addition, the new instruments provide longer scale lengths, shadow-free scale illumination, interchangeable components, and accuracy ranging from ±.5 per cent to ±2 per-cent.

The unit shown in the photograph is the Model 1741, a 4½" d.c. panel instrument in the "Crown" series. This unit is representative of the line both in over-all design and general construction.

For full details on this and other meters in the company's new line, write the manufacturer direct. —30—

Hi-Fi Test Report

(Continued from page 59)

resonance effect could have been designed out of the pickup, but in doing this the manufacturer feels that the quality of reproduction in the rest of the audio spectrum would deteriorate. Since most current stereo records do not go much beyond 10,000 cps, this resonance does not have much effect. One thing that it does do is that it emphasizes record scratch noise. Our tests were made using a 33,000-ohm load and, although the manufacturer recommends a load resistance from 27,000 to 47,000 ohms, we believe that the best operation is with the lower figure. At this value the response of this cartridge can probably be within ±2 db from 30 to 15,000 cps.

The outputs from both channels were within 1 db of each other. Channel separation is about the highest that we have run across to date, being 24.5 db at 1000 cps. The output of 8.8 mv. per channel is as high as any we have checked. These figures were taken with 5 grams stylus pressure on a disc having a recorded velocity of 5 cm.-per-sec.

The hum was found to be about the same as other cartridges we have tested with our particular turntable and general set up.

With the high-frequency tone control cutting the highs down slightly, we found this cartridge pleasant to listen to and clean. It is available at a cost of $29.85, audiophile net. —30—

HI-PLAINS HAMFEST

THIS year's Hi-Plains Amateur Radio Club Hamfest has been set for Sunday May 17th at the Auditorium in Plains, Kansas. All hams and SWL's are invited to attend.

The registration fee is $1.50 and no pre-registration is required. If you are in the neighborhood—drop in.

This is the Tenth Annual Hamfest sponsored by the group and, as in previous years, many valuable prizes await those attending the affair. —30—

Answer to Puzzle appearing on page 119

P	E	N	T	A	G	R	I	D		P	O	W	E	R
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Profit and Growth

(Continued from page 48)

sale of tubes and parts used in performing service in the home. However, the sale of time should *not* be confused with the sale of repair products. A service business performs a dual function. First, it sells time, knowledge, and skill. These should be priced at a level that will provide competitive wages for the person who performs the service, plus all of the costs involved in making that service available.

Second, a service operation is a retail business engaged in the sale of tubes, parts, and supplies used in service. The sale of time must be analyzed and priced as an entity separate and apart from the sale of the products used in performing the service. The gross profit realized from the sale of these elements of service is badly needed to help to pay the operating costs of the service business as a retail store.

Recent surveys of small service businesses indicate that one-man shops now average only six calls per day on an annual basis. On the basis of available figures, the average small dealer who charges $5.00 per call for home service realizes an average of $180.00 per week from the sale of his time. This income, plus the gross profit from the sale of replacement tubes and parts, plus the profit on new equipment the dealer may handle, will support a small business operation. It will not, however, provide the surplus needed for growth.

Unfortunately, the average small dealer does not charge $5.00 for home service calls. The average seems to be close to $3.50 per call. Because of these substandard charges, these dealers are depriving themselves of the income they are justly entitled to for the services they perform.

Many dealers insist they cannot raise their service charges and stay in business. They claim they would lose all their customers if they increased their home-call fees. Experience has proven, however, that this is not a fact. Those dealers who finally whipped their own mental blocks on adequate pricing for their time found that it improved their businesses, both financially and psychologically. When the increased income pulled them back from the rim of financial disaster, they found their own improved mental outlook was mirrored in better customer relations.

The electronic service industry has a big job to do in indoctrinating the public that it must pay adequate labor charges to get honest, competent, efficient service on electronic devices. Every individual dealer must assume his share of this responsibility by establishing time charges that are commensurate with his cost of doing business and that will pay him an income comparable to that of other men who operate successful independent businesses. —30—

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						5
						12
						19
						26

CALENDAR of EVENTS

MAY 5-7

URSI Spring Meeting. Sponsored by National Academy of Science, National Research Council, IRE Professional Groups on Antennas, Circuit Theory, etc. Willard Hotel, Washington, D. C. Information from URSI National Committee, 2101 Constitution Ave., N. W., Washington 25.

MAY 6-8

1959 Electronic Components Conference. Sponsored by EIA, A.I.E.E., IRE, and WCEMA. Benjamin Franklin Hotel, Philadelphia. Program chairman, Brig. Gen. E. W. Petzing, AGEP Secretariat, University of Pennsylvania, Philadelphia.

IRE Seventh Regional Conference and Trade Show. Sponsored by the 7th Region IRE. University of New Mexico, Albuquerque, N. M. Information from IRE, P.O. Box 3262, Albuquerque, N. M.

MAY 11-13

Radio Technical Commission for Marine Services. Mt. Royal Hotel, Montreal. New date. Information from R. T. Brown, Executive Secretary, RTMA, % FCC, Washington 25, D. C.

MAY 17

Annual Get-Together of Radio's Old Timers. Held in connection with Electronic Parts Distributors Show, Chicago. Additional information from Herbert Clough, Belden Mfg. Co., Chicago 80, Illinois.

MAY 18-20

1959 Electronic Parts Distributors Show. Conrad Hilton Hotel, Chicago. Program and registration data from Electronic Industry Show Corporation, 11 S. LaSalle St., Chicago 3, Ill.

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62 (bottom left)	Electronic Engineering Co. of California
62 (bottom right)	Rohn Mfg. Co.
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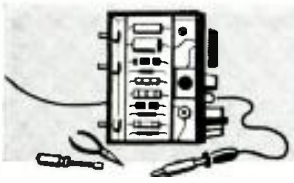
125	Bell Telephone Laboratories

ERRATUM

On page 134 of our April issue, a statement was made to the effect that G-E's "slim-look" TV receivers are series-filament operated. This is an error since all G.E sets are transformer powered.



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TELEVISION & Radio Tubes, Parts and Supplies Guaranteed. Hi-Quality Tube Co., Inc., 284 Lafayette St., Rahway, New Jersey.

TUBES—Radio—Television, Guaranteed big discount. Atom Tube Co., Inc., 1709 Lawrence Street, Rahway, New Jersey. Distributorship openings at present.

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GOVERNMENT Sells—Surplus Electronics: Walkie-Talkies; Transceivers; Test Equipment; Oscilloscopes; Radar; Voltmeters; Misc—Fraction of Army costs—Buy direct now from U. S. Government—"Depot List & Procedure" $1.00—Brody, Box 8-RT, Sunnyside 4, New York.

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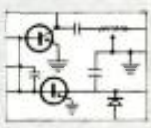

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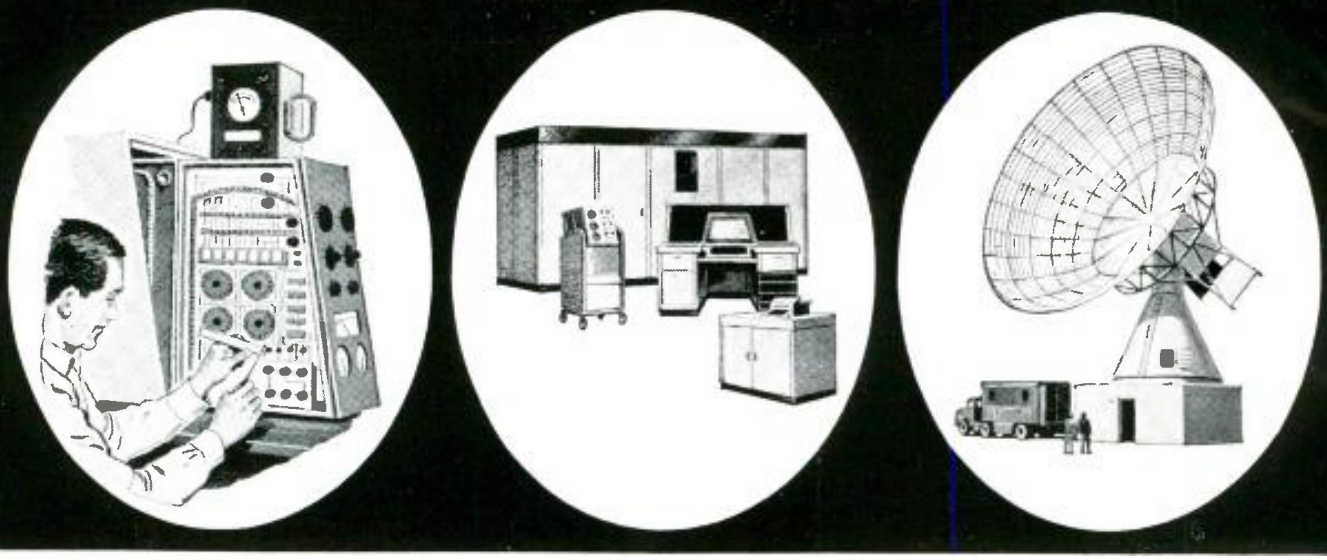

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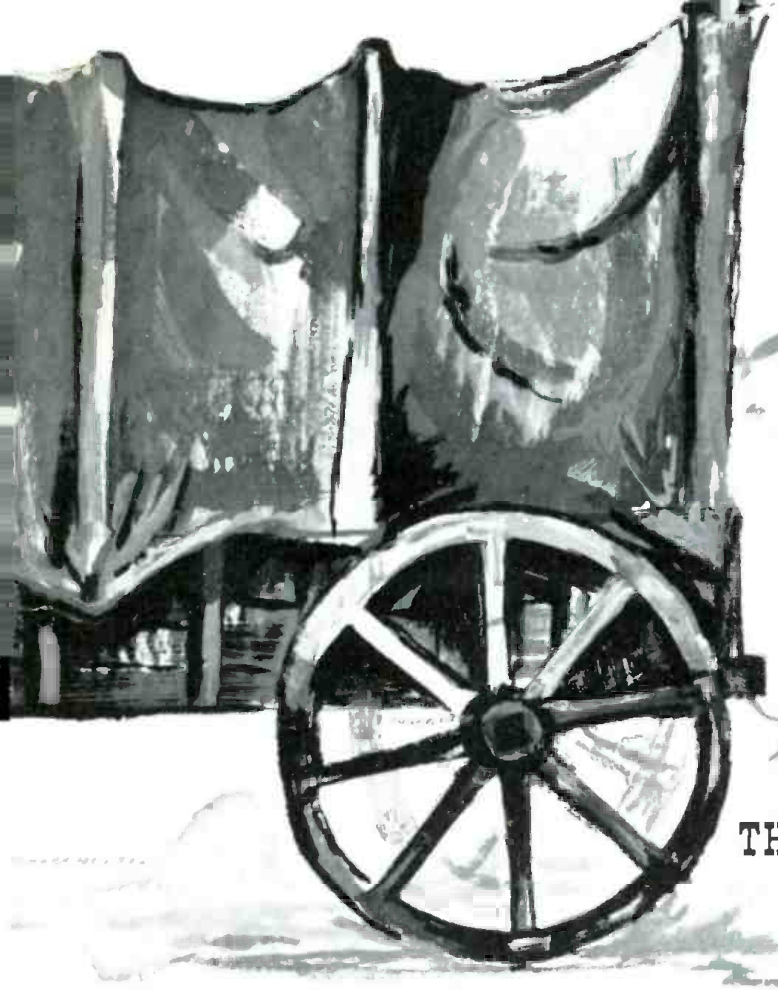

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