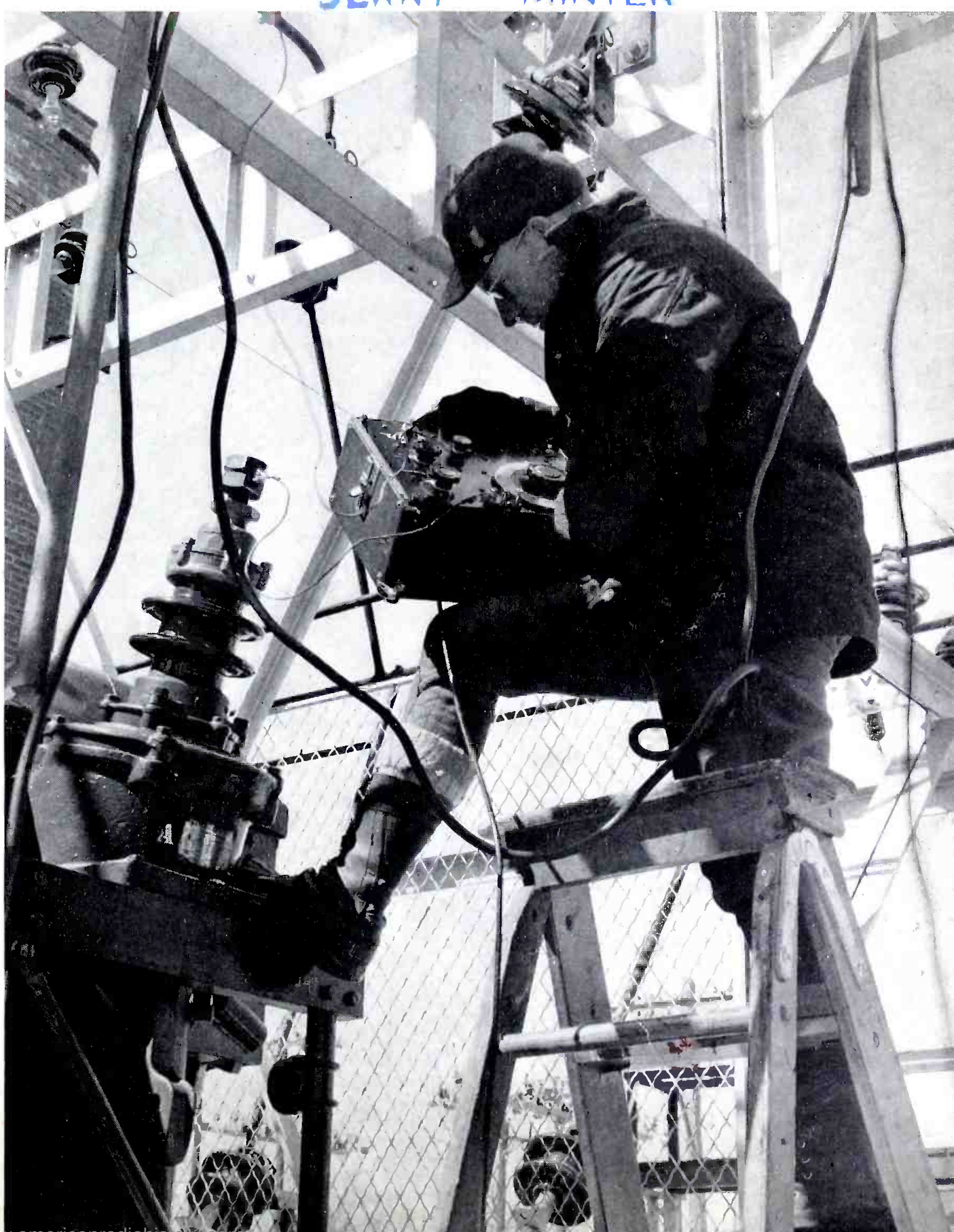
COMMUNICATIONS

JERRY MINTER



IRE CONVENTION

FREQUENCY-MODULATION

TELEVISION

JUNE

1940

JERRY MINTER

COMMUNICATIONS

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1940

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer.
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VOLUME 20
NUMBER 6

RAY D. RETTENMEYER
Editor

•Contents•

COVER ILLUSTRATION

Measuring losses in transformer bushings.
Photo courtesy General Radio Company.

•Editorial Comment•

AS we go to press, the Annual IRE Convention, to be held in Boston, Mass., June 27–29, is close at hand. The program for the gathering appears on pages 7 and 8 of this issue. From all indications it appears that this meeting will be both interesting and successful.

Other summer convention dates to keep in mind follow:

National Association of Broadcasters, August 4–7, St. Francis Hotel, San Francisco, Calif.

Pacific Coast Convention, IRE - AIEE, August 28–30, Ambassador Hotel, Los Angeles, Calif.

More data on these meetings in a later issue.

THE Federal Communications Commission have recently made decisions on the status of both frequency modulation and television. Both rulings had been awaited with considerable interest by the radio industry.

Hailing frequency modulation as "one of the most significant" contributions to radio in recent years and stating that commercial f-m broadcasting was in the interest of the public, the FCC made available the 42,000–50,000 kc band for that purpose. This will provide 40 f-m channels, each 200 kc wide. Of these channels, 35 will be given over to regular high-frequency broadcast stations, the remaining 5 will be assigned as non-commercial educational broadcast stations.

In assigning the 42–50 mc band to frequency modulation it was, of course, necessary to readjust the ultra-high frequencies. Old television channel No. 2 now becomes channel No. 1, and a new television channel, No. 2, will be assigned from 60,000 to 66,000 kc.

In reporting on television, the FCC have said in effect that there will be no commercial television until "the engineering opinion of the industry is prepared to approve any one of the present competing television systems". This latter decision is, we believe, a severe blow to the industry as a whole . . . and is likely to unduly retard the development of television.

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BRYAN S. DAVIS
President

JAMES A. WALKER
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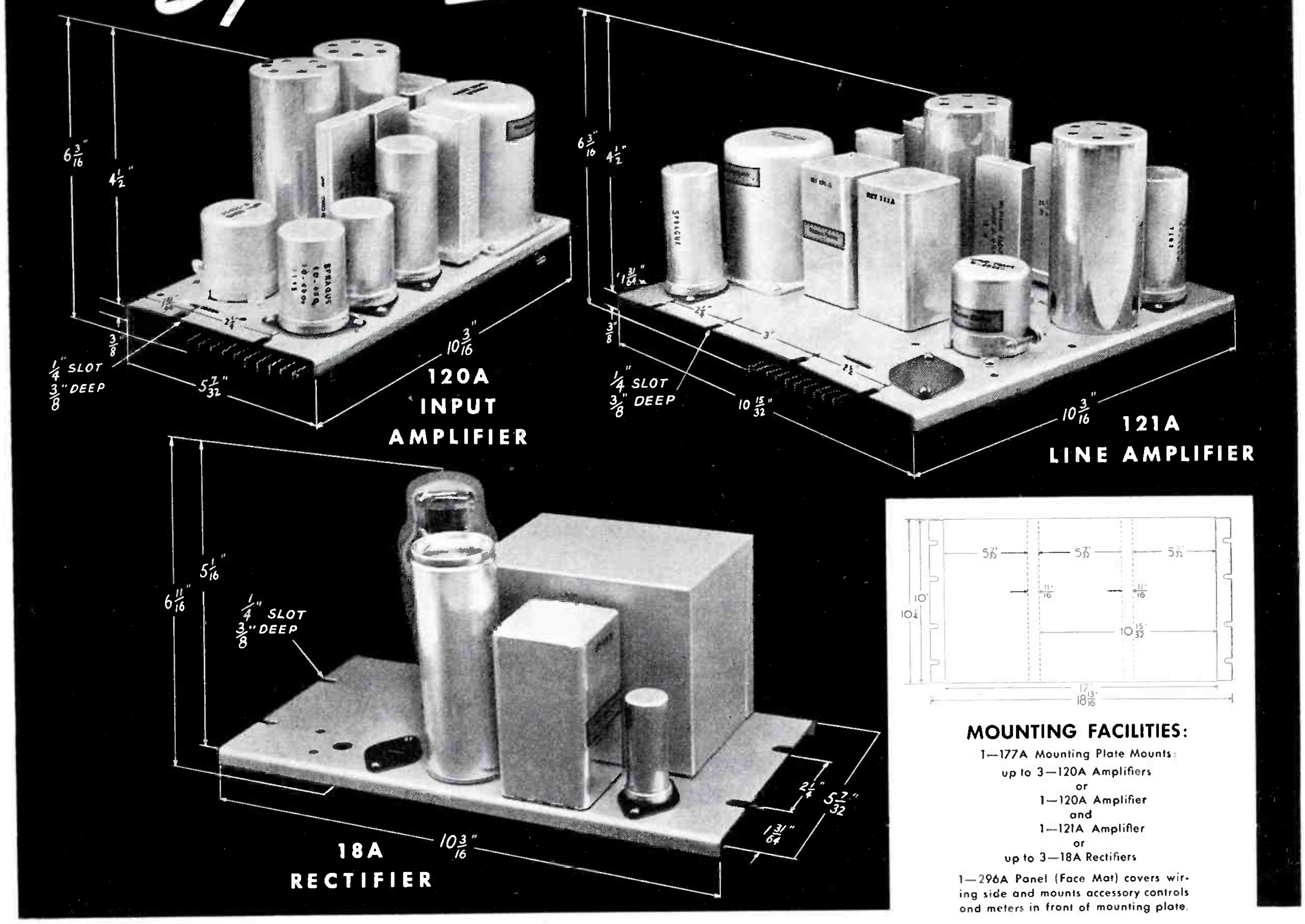
Plan your Speech Input System around these basic units



Quality OK for Frequency Modulation

120A INPUT AMPLIFIER: a compact, high quality, two stage premixing or booster amplifier for speech input. Frequency response 30 to 15,000 cycles with only ± 1 db variation. Source impedance 30, 250 or 600 ohms; load impedance 600 ohms. Gain 40 db. Level of noise contribution measured at output —82 db unweighted (0 level calibration 1 milliwatt). Maximum output level +16 db with 1% total harmonic distortion. Ask Graybar for Bulletin T-1659-A.

121A LINE AMPLIFIER: an adaptable three stage unit for high quality performance as a speech input intermediate level amplifier. Frequency response 30 to 15,000 cycles with only ± 1 db variation. Source impedance 30, 250 or 600 ohms; load impedance 600 ohms. Gain 78 db. Level of noise contribution measured at output —42 db unweighted (0 level calibration 1 mw). Output level + 28 db, with 1% total harmonic distortion. Ask Graybar for Bulletin T-1659-B.

18A RECTIFIER: a full wave vacuum tube rectifier with filter for use with amplifiers in speech input. Will supply up to 8 amperes at 6.3 volts, 60 cycles, for filaments and from .007 to .075 ampere DC at 285 ± 35 volts for plates. Power required: 110 to 120 volts, 60 cycles, 100 watts. For full details, get a copy of Bulletin T-1659-C from Graybar.

Western Electric

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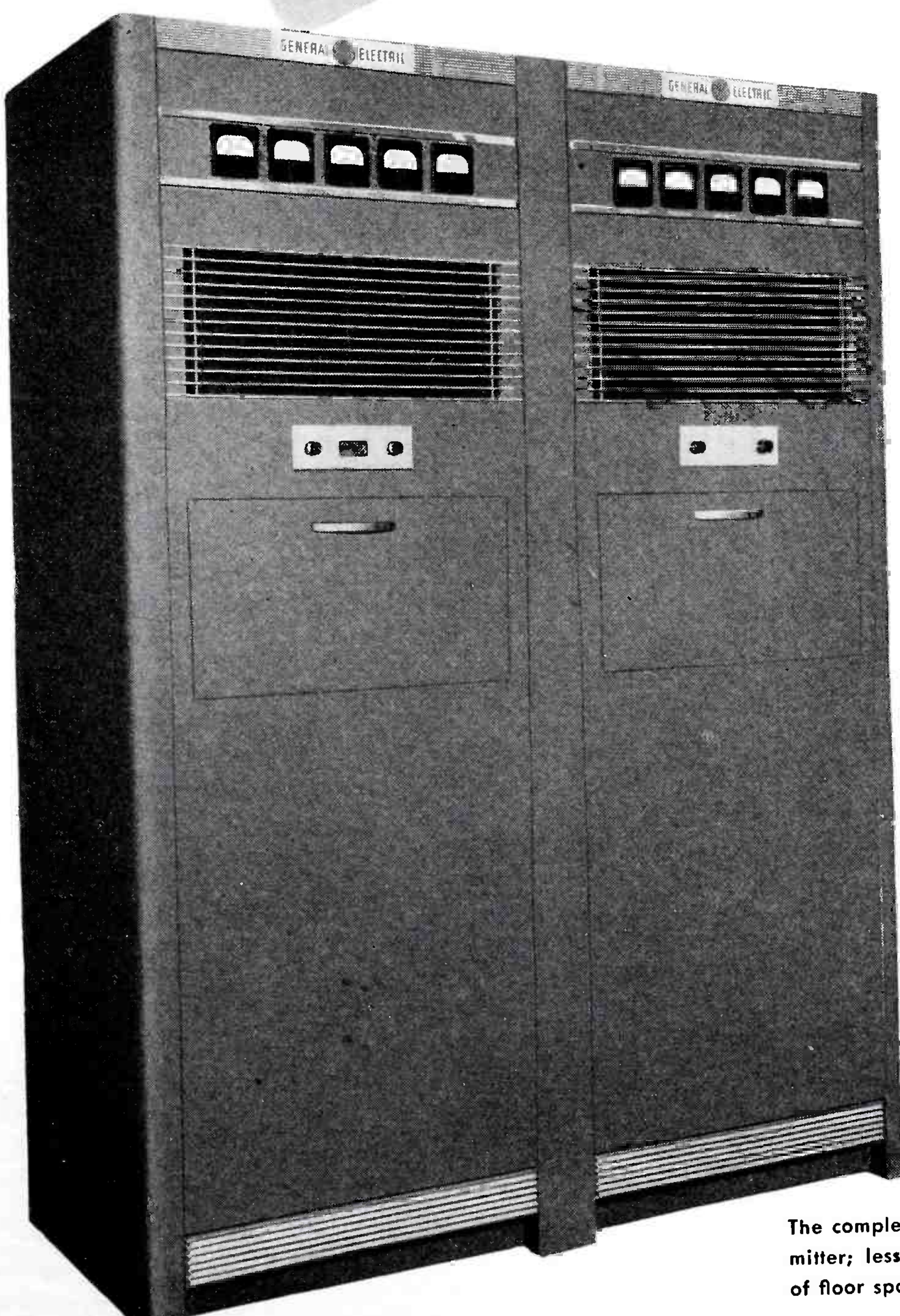
0.0025% FREQUENCY STABILITY OVER ROOM TEMPERATURE RANGE OF 32° TO 122°F

GENERAL ELECTRIC
FM
BROADCAST
TRANSMITTERS
ARMSTRONG SYSTEM



The complete G-E 1-kw FM transmitter; less than 10 square feet of floor space is required

Four Times Better Than F.C.C. Requirements!

. . . in a 5½-hour test over an ambient temperature range of 90° F. That's what actual measurements on a typical G-E frequency-modulation transmitter showed. And even better stability is obtained under normal conditions.

G.E. Does It Simply!

A single low-coefficient quartz crystal unit (temperature controlled) controls the frequency. Mean carrier frequency is electronically compared to a multiple of crystal frequency. Tendency to drift is instantaneously cancelled by automatic application of a corrective voltage of the proper magnitude to the reactance-tube modulator.
Correct carrier frequency is thus maintained by direct comparison to a precise crystal frequency.

Why the Simplified G-E Design?

Greater dependability; keeps you "on the air" — an important feature in commercial operation.
Amazing accessibility; *every part and wire easily reached without disassembly; all tubes instantly accessible by opening main access doors!*
Small tube-complement; only 31 tubes in entire 1-kw transmitter
Low tube cost
Single crystal control; *accurate; positive*
Easy to operate
Small floor-space requirement
Only simple shielding required, giving easy access to circuit components
Fewer parts; less space needed

Additional Performance Characteristics

(measured on typical production transmitter)

Audio-frequency response: Flat to within ±0.5 db, from 30 to 15,000 cycles.

Harmonic distortion:

30 cycles = 0.9 % RMS
100 cycles = 0.6 % RMS
1000 cycles = 0.55% RMS
5000 cycles = 1.25% RMS
7500 cycles = 1.5 % RMS

Carrier noise-level: FM noise down 65 db from modulation level at ±60 kc carrier-frequency deviation. (Down 70 db at ±100 kc deviation) A-M hum down 55 db. All values unweighted.

Linearity: Within ±0.1 db up to ±75 kc carrier frequency deviation.

Cross Modulation: 0.7% RMS at ±60 kc deviation with signal inputs of 400 and 700 cycles, and 4000 and 7000 cycles.

CALL or WRITE the nearest G-E sales office (there are 80 throughout the United States) for the whole story on how General Electric FM broadcast transmitters will give you more dependable performance at less cost. General Electric, Radio and Television Department, Schenectady, N. Y.

GENERAL ELECTRIC

160-2

IRE CONVENTION PROGRAM

THE Fifteenth Annual Convention of the Institute of Radio Engineers is scheduled for June 27, 28, and 29 at Boston with headquarters at the Hotel Statler. A full program has been prepared and, because of the number of technical papers, several duplicate sessions will be held.

The American Institute of Electrical Engineers is holding its Summer Convention at the New Ocean House in Swampscott on June 24-28. On Tuesday, June 25, a morning session on electronic subjects will be held while in the afternoon there will be a conference on communication networks. On Wednesday morning a group of communications papers will be read. For full details see the June issue of Electrical Engineering.

It is expected that only minor changes will be made in the program which follows:

PROGRAM

Wednesday, June 26

7:30 P.M.-9:30 P.M.

Registration

8:00 P.M.-10:30 P.M., Parlor C

Annual Meeting of the Sections Committee

Thursday, June 27

8:00 A.M.-6.00 P.M., Mezzanine

Registration

9:30 A.M.-5:00 P.M., Ballroom Foyer

Exhibition

10:00 A.M.-12:00 Noon, Ballroom

Official welcome by L. C. F. Horle, President of the Institute

General

(1) "Marine Radiotelephone Design," by H. B. Martin, Radiomarine Corporation of America, New York, N. Y.

(2) "50-Kilowatt Air-Cooled Broadcast Transmitter," by R. N. Harmon, Westinghouse Electric and Manufacturing Company, Baltimore, Md.

(3) "RCA-NBC Orthacoustic Recording," by R. A. Lynn and B. F. Fredendall, National Broadcasting Company, New York, N. Y.

(4) "Instrument Production," by E. H. Locke, General Radio Company, Cambridge, Mass.

1:00 P.M.-7:45 P.M.

Trip No. 1. Inspection trip to Hygrade Sylvania and United States Coast Guard Air Base at Salem.

1:15 P.M.-5:45 P.M.

Trip No. 2. Inspection trip to Harvard University and the General Radio Company.

1:30 P.M.-5:00 P.M.

Trip No. 3. Women's trip to the Isabella Stewart Gardner Museum.

1:45 P.M.-5:45 P.M.

Trip No. 4. Inspection trip to the new WBZ transmitter at Hall.

2:00 P.M.-5.45 P.M.

Trip No. 5. Sightseeing tour to Lexington and Concord.

6:00 P.M.-9:30 P.M.

Trip No. 6. Trip to the Massachusetts Institute of Technology at Cambridge.

8:00 P.M.-9:30 P.M., Room 10-250, Huntington Hall

Massachusetts Institute of Technology Popular Lecture

(5) "Microwaves—Present and Future," by a Massachusetts Institute of Technology Group, led by W. L. Barrow, Massachusetts Institute of Technology, Cambridge, Mass.

Friday, June 28

9:30 A.M.-3:00 P.M.

Trip No. 7. Women's Sightseeing tour of Cambridge, Lexington and Concord.

9:30 A.M.-5:00 P.M., Ballroom Foyer

Exhibition

10:00 A.M.-5:00 P.M., Mezzanine

Registration

10:00 A.M.-12:30 P.M., Ballroom

Vacuum Tubes and General

(6) "Ultra-Short-Wave Transmission Over a Fixed Optical Path," by C. R. Englund, A. B. Crawford, and W. W. Mumford, Bell Telephone Laboratories, Inc., New York, N. Y.

(7) "Centimeter - Wave Detector Measurements and Performance," by E. G. Linder and R. A. Braden, RCA Manufacturing Company, Inc., Camden, N. J.

(8) "The Inductive-Output Tube Characteristics and Performance," by Bernard Salzberg, RCA Manufacturing Company, Inc., Harrison, N. J.

(9) "A New Ultra-High-Frequency Tetrode and Its Use in a 1-Kilowatt Television Sound Transmitter," by A. K. Wing, Jr., and J. E. Young, RCA Manufacturing Company, Inc., Harrison, N. J., and Camden, N. J., respectively.

(10) "Available High-Mutual-Conductance Tubes," by E. W. Schafer and E. R. Jervis, National Union Radio Corporation, Newark, N. J.

(11) "An Ultra-High-Frequency Dosemeter-Diatherm," by J. D. Kraus and R. W. Teed, University of Michigan, Ann Arbor, Michigan.

(12) "Sparking of Oxide-Coated Cathodes in Mercury - Vapor - Filled Tubes," by J. W. McNall, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.

10:00 A.M.-12:30 P.M., Georgian Room

Measurements

(13) "Recent Advances in the Design of Cathode-Ray Oscillographs," by P. S. Christaldi, Allen B. DuMont Laboratories, Inc., Passaic, N. J.

(14) "Oscilloscope Patterns of Damped Vibrations of Quartz Plates and Q Measurements with Damped-Wave Amplitudes," by H. A. Brown, University of Illinois, Urbana, Ill.

(15) A Method of Measuring the Magnetic Properties of Small Samples of Transformer Laminations," by H. W. Lamson, General Radio Company, Cambridge, Mass.

(16) "A Radio-Frequency Bridge for Measurements Up to 30 Megacycles," by D. B. Sinclair, General Radio Company, Cambridge, Mass.

(17) "The Measurement of Coil Reactance in the 100-Megacycle Region," by Ferdinand Hamburger, Jr., and C. F. Miller, Johns Hopkins University, Baltimore, Md.

(18) "A New Electron Microscope," by L. Marton, M. C. Banca, and J. F. Bender, RCA Manufactur-

turing Company, Inc., Camden, N. J.

(19) "Stable Power Supplies for the Electron Microscope," by A. W. Vance, RCA Manufacturing Company, Inc., Camden, N. J.

2:00 P.M.-5:00 P.M., Ballroom
Aircraft Radio

(20) "Aircraft Antennas," by G. L. Haller, Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.

(21) "Rain and Snow Static," by H. K. Morgan, Transcontinenal and Western Air, Inc., Kansas City, Mo.

(22) "The Entrance of Ultra-High Frequencies into Air-Transport Communication," by J. G. Flynn, Jr., American Airlines, Inc., New York, N. Y.

(23) "Microwave Beams for Instrument Landing of Airplanes," by W. L. Barrow, Massachusetts Institute of Technology, Cambridge, Mass.

(24) "A Microwave Receiver for Instrument Landing," by F. D. Lewis, Massachusetts Institute of Technology, Cambridge, Mass.

(25) "Panoramic Reception," by Marcel Wallace, Panoramic Radio Corporation, New York, N. Y.

(26) "Radio Navigation and the Omnidirectional Radio Range," by D. G. C. Luck, RCA Manufacturing Company, Inc., Camden, N. J.

2:00 P.M.-4:00 P.M., Georgian Room
Large Vacuum Tubes

(27) "Optimum Conditions for the Operation of a Class C Amplifier," by E. L. Chaffee, Harvard University, Cambridge, Mass.

(28) "Power-Tube Performance as Influenced by Harmonic Voltage," by R. I. Sarbacher, Harvard University, Cambridge, Mass.

(29) "High - Efficiency Frequency Doublers," by J. E. Shepherd, Harvard University, Cambridge, Mass.

(30) "Space-Charge Relations in Triodes and the Characteristic Surface of Large Vacuum Tubes," by E. L. Chaffee, Harvard University, Cambridge, Mass.

(31) "Equivalent Electrostatic Circuits for Vacuum Tubes," by W. G. Dow, University of Michigan, Ann Arbor, Mich.

(32) "Water and Forced-Air Cooling of Vacuum Tubes with External Anodes," by I. E. Mouromtseff, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.

(33) "Large Air-Cooled Tubes in 50-Kilowatt Transmitters," by I. E. Mouromtseff and W. G. Morgan, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.

4:00 P.M.-5:30 P.M., Georgian Room

Informal discussion on "Power-Tube Operating Characteristics and Ratings," led by E. L. Chaffee, Harvard University, Cambridge, Mass.

6:30 P.M., Ballroom

Fifteenth Annual Banquet. The Institute Medal of Honor and the Morris Liebmann Memorial Prize will be presented and newly elected Fellows will receive their certificates. Professor G. W. Pierce will be the guest of honor.

Saturday, June 29
9:30 A.M.-3:00 P.M., Ballroom Foyer

Exhibition

9:45 A.M.-11:30 A.M.

Trip No. 8. Women's boat ride on the Charles River.

10:00 A.M.-3:00 P.M., Mezzanine

Registration

10:00 A.M.-12:30 P.M., Ballroom
Television

(34) "A Portable Television Transmitter," by C. D. Kentner, RCA Manufacturing Company, Inc., Camden, N. J.

(35) "Small Iconoscopes of Recent Design," by W. H. Hickok, RCA Manufacturing Company, Inc., Harrison, N. J.

(36) "A New Method of Synchronization for Television Systems," by T. T. Goldsmith, R. L. Campbell, and S. W. Stanton, Allen B. DuMont Laboratories, Inc., Passaic, N. J.

(37) "Synchronizing and Deflection Circuits of a Television Receiver," by R. E. Moe, General Electric Company, Bridgeport, Conn.

(38) "A Type of Light Valve for Television Reproduction," by J. S. Donal, Jr., and D. B. Langmuir, RCA Manufacturing Company, Inc., Harrison, N. J.

(39) "Television Radio Relaying," by F. H. Kroger, Bertram Trevor, and J. E. Smith, RCA Communications, Inc., New York, N. Y.

(40) "The Influence of Filter Shape-Factor on Single-Sideband Distortion," by J. C. Wilson and H. A. Wheeler, Hazeltine Service Corporation, Little Neck, N. Y.

1:45 P.M.-4:30 P.M., Ballroom
Frequency Modulation

(41) "Interference Between Stations in Frequency - Phase - Modulation Systems" by Dale Pollack, Cambridge, Mass.

(42) "Interference Between Two Frequency-Modulated Signals" by Stanford Goldman, General Electric Company, Bridgeport, Conn.

(43) "A New Broadcast Transmitter Circuit Design for Frequency Modulation" by J. F. Morrison, Bell Telephone Laboratories, Inc., Whippany, N. J.

(44) "Frequency-Modulation Systems Characteristics" by M. L. Levy, Stromberg - Carlson Telephone Manufacturing Company, Rochester, N. Y.

(45) "National Broadcasting Company's Field Test of Frequency Modulation" by R. F. Guy and R. M. Morris, National Broadcasting Company, New York, N. Y.

(46) "Demonstration of Frequency-Modulated - Wave Broadcasting Systems" by E. H. Armstrong and P. A. deMars, Columbia University, New York, N. Y., and The Yankee Network, Boston, Mass., respectively.

4:30 P.M.-9:30 P.M.

Trip No. 9. Inspection trip to the frequency-modulated transmitter of the Yankee Network at Paxton.

TELEVISION IN NATURAL COLOR

IN the past, the transmission and reception of television in natural color by electronic means, that is, the transmitter employing photoelectric pickup tubes and the receiver cathode-ray tubes, was complicated and expensive. Several pickup tubes were needed at the transmitting end, and, worse still, several cathode-ray tubes were needed at the receiving end. In addition, either separate channels were required for the transmission of the differently colored images, or else, where but a single channel was employed there were required mechanically operated switching devices. Actually, the case against color television was even more serious, for even assuming that the foregoing handicaps had been overcome there still arose the question of the type of transmission which was employed. This problem is analogous to the one existing at present in the transmission of black and white pictures, except that for color it would have been necessary for two separate standards of transmission to be set up.

In Patent No. 2,200,285, which was issued to R. Lorenzen on May 14, 1940, and which is entitled Television in Natural Color, means are described whereby it is possible to transmit and receive pictures in natural color as easily as black and white images. One of the features of this new system is that no change is necessary in either the transmitting or receiving station, with the single exception of the photoelectric pickup tube at the transmitter and

(Continued on page 27)

The General Radio Company

Twenty-Five Years of Manufacturing Instruments for the Communications Industry

THE General Radio Company, one of the oldest organizations manufacturing equipment for the communications engineer, celebrates its twenty-fifth anniversary this month. In 1915, when the Company was started, radio communication had emerged from the phase where most design was empirical and had begun to develop into a science based on theoretical considerations and laboratory research. In common with other branches of electrical communication, radio needed instruments for laboratory measurements, and it was to supply this need that the General Radio Company was formed by Melville Eastham in 1915. The Company was founded with a distinct field in view. It was desired to reduce measuring methods to practical forms of a type suitable for use in everyday shop and commercial tests—a field which may well be described as tool-making for the communications engineer.

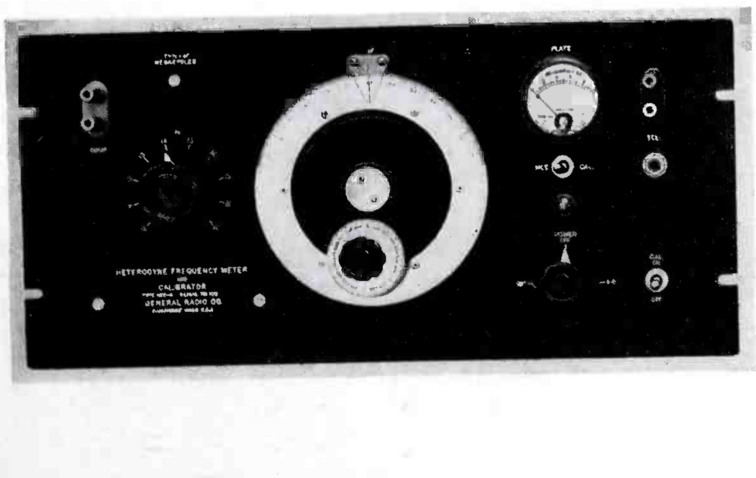
The Company's first catalog lists a modest total of eight items: a variable air condenser; a universal wavemeter; a high-frequency thermo-junction and meter; an oil-filled fixed condenser; three laboratory inductors; and a spark indicator. This last item was described as follows: "This instrument is a sensitive vacuum tube rotated by an electrical motor. It is mounted in a dull black cylindrical case, and when the vacuum tube is connected with a high potential point on an oscillating circuit, the glowing of the tube can be seen. The rotation of the tube causes each spark to be seen as a separate band, up to about 10,000 sparks per second. The regularity of the intensity and spacing of the separate sparks can be seen, thus allowing the user to form a correct idea of the tone value and spark quality of a set." Apparently this was the first stroboscope manufactured by the General Radio Company!

In the next two or three catalogs new items appear: decade resistance boxes, an audibility meter, more wavemeters, a decade bridge, an impedance-matching transformer, hot-wire ammeters, and the first GR oscillator (a buzzer).

In these early catalogs the beginnings of the present GR line can be seen. Decade resistance boxes, air condensers, impedance bridges, and other standard communication laboratory items are still important items in the Company's sales. Two type numbers that appeared in the first catalog are still used, Type 106 Standard Inductance and Type 107 Variable Inductor. The instruments they designate have, however, been through many changes in design in the interval of twenty-five years.

General Radio's first customer was Fulton Cutting, at that time of the firm of Cutting and Washington, manufacturers of radio transmitters, and now head of Colonial Radio. A close second was George Cabot, of Holtzer-Cabot, who for many years bought each new instrument as it appeared on the market. Many other familiar names appear on the sales ledger during the first three years of the Company's existence: Alfred N. Goldsmith, then at the College of the City of New York; L. W. Stevens, now of Veeder-Root, Inc., who was then a radio experimenter; W. W. Hanscom, of San Francisco; Frank Conrad, "The Father of Radio Broadcasting"; Edwin H. Armstrong, whose latest work on frequency modulation bids fair to rival in importance his earlier development of the superheterodyne and the super-regenerative circuit; John Hays Hammond, Jr.; S. W. Dean; A. S. Moffat, now owner of WMAS; John H. Morecroft; and Hiram Percy Maxim. Henry S. Shaw, now chairman of General Radio's board of directors, first appears as a customer in 1917, shortly before he became associated with the Company.

A modern heterodyne frequency meter and calibrator.



An early type of wavemeter. Compare with modern instrument at left.

J. K. Clapp, Engineer (left), and H. H. Hollis, assistant, General Radio's specialists in frequency standardization.

The Company's sales records for these first three years list 38 educational institutions of collegiate grade and several manufacturing companies, including Western Electric, General Electric, Submarine Signal, Westinghouse, the Texas Company, Sears-Roebuck, Sperry Gyroscope, and Waltham Watch, as well as many companies no longer in existence, such as National Electric Signalling Company, Amrad, International Signal Company, and DeForest Radio Tel. and Tel. Company.

Among the research laboratories buying equipment were the U. S. Bureau of Standards; Hammond Radio Research Corporation, Electrical Testing Laboratories; and Kalmus, Comstock, and Westcott, who developed the Technicolor process.

The General Radio Company has introduced to the communications industry many new instruments and new methods of measurement. Not all of these were General Radio "inventions," but General Radio made them available commercially for the first time in the United States.

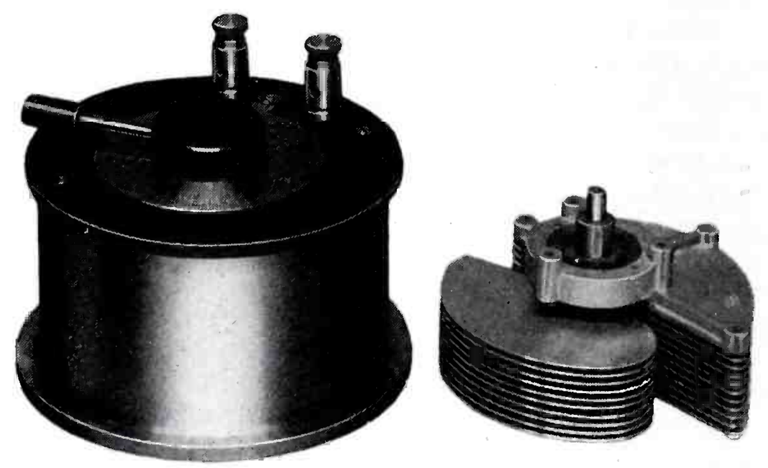
One example of this is the closed-core audio transformer, the first model of which was made in 1915 as part of an amplifier designed for the inventor of a talking movie system.

This Mr. Freistatter had the idea that a narrow band of fine iron filings could be cemented to the edge of a movie film, and sound stored as a magnetic charge, as was done with a wire in the Poulsen telegraphone. A two-stage amplifier was built, using DeForest audions, which could be used to get enough energy from the microphone to magnetize the filings, and also to reproduce the output of the film of a loud speaker. The transformers designed for this amplifier were afterward sold in great quantities to experimenters. They were probably the first audio transformers, having closed cores, to be generally available for purchase. A frequency-response curve of such an early two-step amplifier would be very interesting to look at, but would have little resemblance to that of a modern unit.

Dr. W. N. Tuttle, Engineer (left), and R. G. Alexander, assistant, examining a frequency-modulated signal generator.

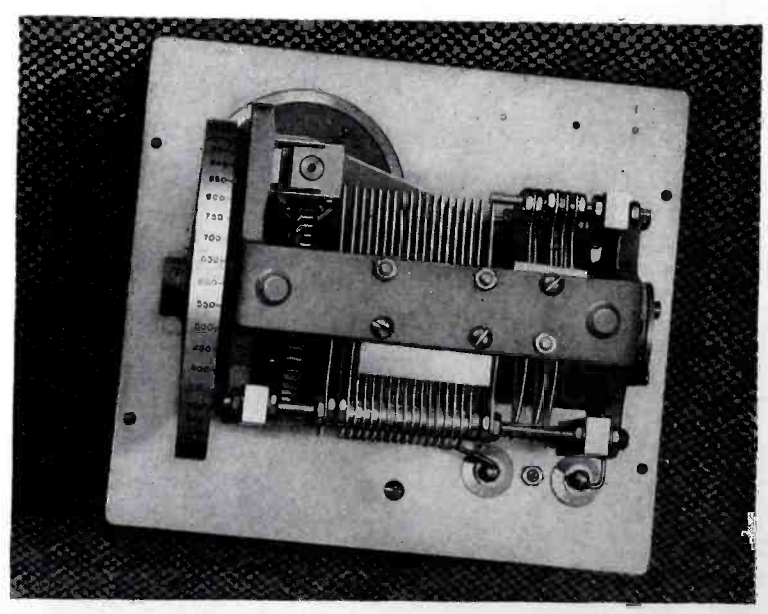
The first quartz crystals for controlling radio transmitters were furnished by General Radio. One of these went to station WEAF in 1922. Since frequency standard for accurate calibration were not common in those days, the crystal was adjusted to zero beat with the frequency of WEAF's transmitter, which in turn was held as closely on its assigned frequency as the Telephone Company could determine at that time.

Two other early crystals were sold to the Radio Corporation of America, and were used to control the frequencies of two transmitting stations, one on Long Island and one in Maine. The transmitted frequencies were separated by an audio-frequency interval, and the beat between the local and remote transmitters was used at each station for receiving.



An early type of laboratory condenser.

Other instruments first made available commercially by General Radio were beat-frequency oscillators, standard-signal generators the crystal-controlled primary standard of frequency, the heterodyne wave analyzer, the copper-oxide meter type of power-level indicator, direct-

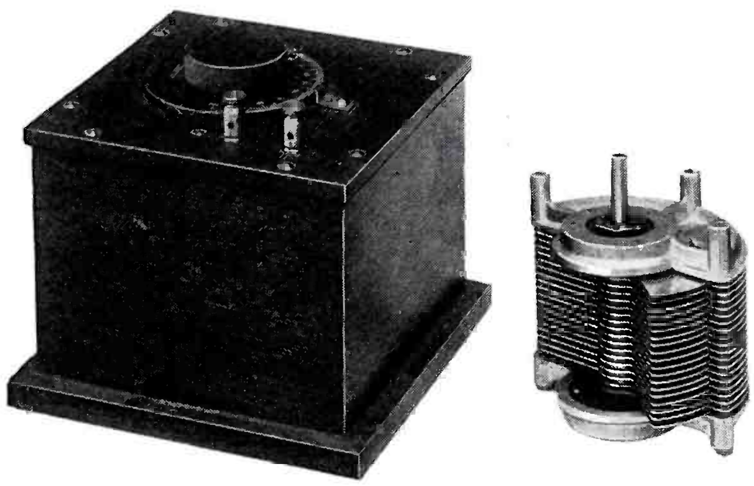


The latest type G-R precision condenser. Compare with early types above.

reading modulation and distortion meters, and quartz crystal frequency monitors.

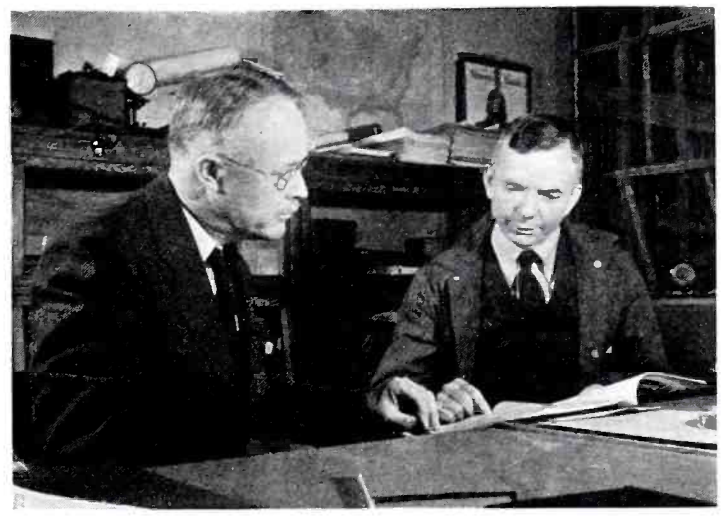
In the spring of 1919, William Dubilier asked the Company to design a bridge that he could use to measure accurately the capacitance and power factor of mica condensers. The result was the Type 216 Capacity Bridge, hundreds of which are still in use. The Type 222 Precision Condenser was built at the same time, and was the first commercial condenser having low losses and precision drive. Mr. Dubilier still has in his laboratory the first capacity bridge and precision condenser of this make.

One of the main problems facing the Company in the first dozen years of its existence was how to remain a laboratory instrument company. Only two years after the Company started, the United States entered the first world war. From a small organization largely engaged in research work, it was necessary to expand the Company to a large production group, capable of turning out quantities of war material. This material included radio training equipment, field equipment, airplane sets, and in general, radio equipment required by the Signal Corps and the communications service of the Navy.



Another early model G-R condenser.

At the close of the war, the Company returned to its original plan of developing and manufacturing laboratory apparatus, but the post-war readjustment processes had just been completed when radio broadcasting and home receiver building became popular. Again the long-range plans of the Company were put aside, and production activities were concentrated on equipment that could be assembled into radio receivers. The demand grew and continued to grow, until the Company found itself expanded to a greater extent than was necessary even during war time. This time, however, instrument development work still continued during the expansion process. There was always the feeling that after the wave of novelty of broadcasting had passed over, there would no longer be a consumer demand for radio parts. It was anticipated that a new demand would come from companies organized to manufacture receivers under mass production methods, and that this demand would be for measuring and test equipment.



Henry S. Shaw (left), Chairman of the Board, and Melville Eastham, President, General Radio Company.

This belief proved to be correct, and in the period between 1927 and 1930, the Company rearranged its methods of manufacturing and selling, expanded its engineering facilities and personnel, and devoted all its effort to instrument manufacture.

Since 1930, the business of the General Radio Company has grown considerably beyond the limits implied by its name. The methods of electrical measurement and testing development by the communications industry have gradually been adopted by other industrial groups, and, as a consequence, General Radio instruments are now used by manufacturers of chemicals, paper, machinery, plastics, metals, and automobiles. As these industrial markets have grown, specialized instruments have been developed for them, such as stroboscopes, noise meters, and high-speed cameras.

Present plant facilities include three connected buildings of four floors each, a total of more than 75,000 square feet of floor space. The total employment is 215, 30 being engaged in engineering and allied activities.

Dr. D. B. Sinclair, Engineer (left), and C. A. Woodward, assistant, specialists in high-frquency measurements.

L. E. Packard, Engineer (left), and C. T. Burke, Engineering Manager, discussing a power-factor bridge.

TELEVISION ENGINEERING

Fundamentals Of Television Engineering

Part IX: Foreign Developments

By F. ALTON EVEREST

Department of Electrical Engineering
OREGON STATE COLLEGE

BECAUSE of the old American custom of believing that little, if anything worth while is ever done outside the bounds of these United States, it would seem appropriate in this series to pause long enough to take a hurried glimpse at the development work in television in other countries. While such a study does not fit any too well into the main title of the series, an appreciation of foreign television activities is absolutely necessary to view our domestic developments in their proper perspective.

England

The television activities in England are perhaps the most intensive of any foreign country. The British authorities have led the world in providing an ambitious program service. The radio listener fee of ten shillings per year was the source of the funds which made this possible. At the outbreak of the war there were reported to be about 25,000 television receivers in use with others being purchased at the rate of 1000 to 1500 per month. The television broadcasts of one hour each afternoon and two hours each evening were abandoned "for national defense purposes" when the war began, and at this writing have not been reestablished.

The London transmitter is located at the edge of the city in Alexandra Palace where broadcasts began in August, 1936. The standards adopted are 405 lines, 50 frames interlaced, giving 25 complete picture scans per second. The equipment in use was provided by the Marconi-E. M. I. company and is built around the "Emitron" camera which is basically a mosaic-storage tube patterned after the iconoscope. The transmitter has a peak output power of 17 kw corresponding to "full picture white," and is modulated by the conventional grid system. Double-sideband amplitude modulation, "infra-black" synchronizing pulses, and positive modulation are used.

Outside broadcasts are accomplished by mobile units utilizing radio-link transmitting special balanced-pair low-capacitance cables primarily designed for television signals, and a limited use of ordinary telephone-cable pairs suitably equalized for short distances. A line utilizing the special balanced pair runs past points from which many broadcasts emanate, such as Buckingham Palace, Trafalgar Square, and Piccadilly Circus. The British system has been covered quite thoroughly in several recent articles published in the United States.

Italy

A relatively insignificant amount of information on the Italian television activities has appeared in the English-language press. A consistent, though limited, program of research has been conducted by the Societa Anonima Fabbricazione Apparecchi Radiofonici (the "Safar") in Milan, the efforts of Mr. Arturo Castellani being conspicuous. Outstanding in their list of accomplishments is the Rome station. This station is built on the top of Mount Mario so that the transmitting dipoles are at a

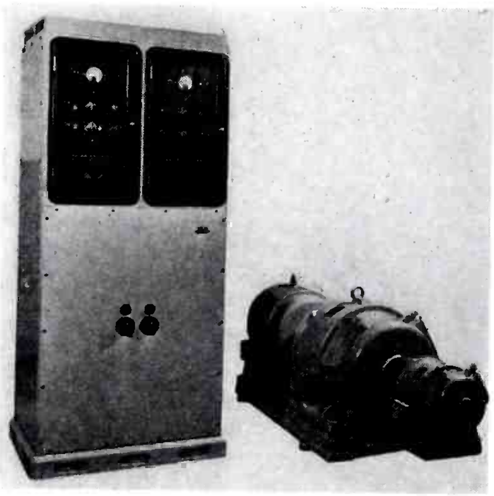
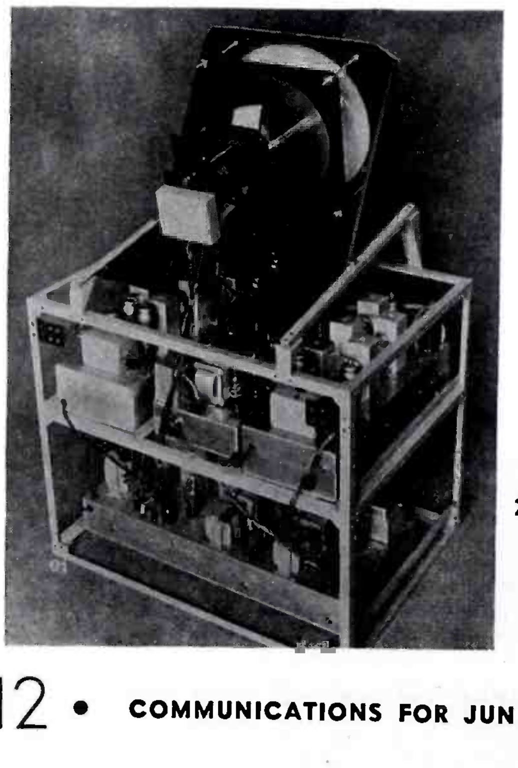


Fig. 4. Rotary converter and automatic anode voltage regulators of Italian transmitter.

Fig. 16. Rear chassis view of Allocchio Bacchini receiver.



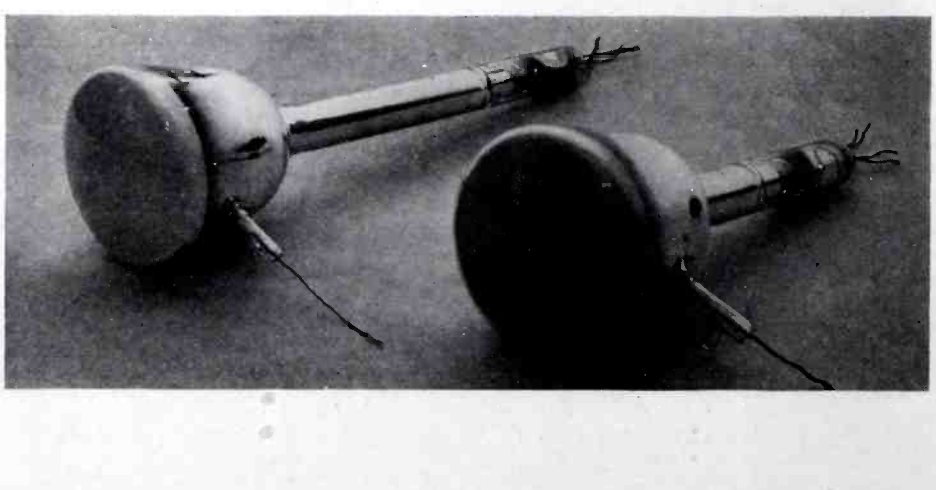


Fig. 21. (Right) French projection tubes for 20- and 40-kv anode potential.

height of about 500 feet over the city. This hilltop location is situated at the periphery of Rome and, naturally, has the greatest field strength direct toward it. A signal of at least 200 microvolts is delivered to the receiver terminals by the usual dipole in all parts of the city. This Mount Mario antenna structure is shown in the photograph of Fig. 1.

The transmitter's voice carrier is 41 mc and the video carrier is 44.1 mc arranged for double sideband transmission. The output of the transmitter has a peak power of 5 kw for a 6-mc bandwidth. Figs. 2 and 3 are views of the Safar television transmitter with the front plates in place and with them re-

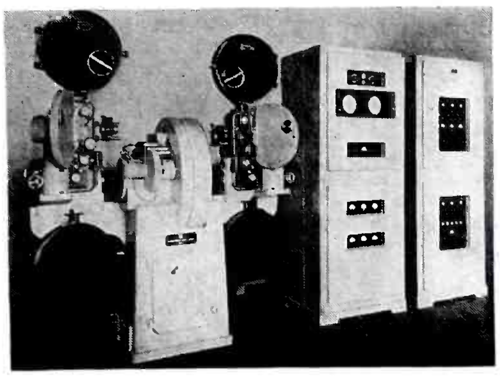


Fig. 28. Twin arrangement of mechanical film scanner (Fernseh A.G.).

moved. Some of the specifications of this transmitter are:

(a) Frequency distortion ± 1.5 db for 0-3 mc band.

(b) Phase distortion 1 microsecond 25-1000 c, 0.5 microseconds 1000 c to 1.5 mc, and 0.2 microseconds between 1.5 and 3 mc.

(c) Harmonic distortion 4% at 90% modulation.

(d) Noise level 0.5% at 100% modulation.

(e) Stability of radiated frequency 1 part in 200,000.

An interesting fact is that all tubes in this transmitter are pentodes. This results from the lower grid currents and the greater ease of neutralization. The final amplifier tubes are water cooled. All anode and bias voltages are supplied by conventional rectifier-filter systems; while the filaments are lit by a rotary converter. The anode voltages for the video section and the modulated r-f stages are equipped with automatic voltage regulators. Fig. 4 is a view of this voltage regulator equipment and the filament rotary converter. The transmitter is monitored and controlled from the operating desk shown in Figs. 5 and 6.

The Safar television theatre illustrated in Figs. 7 and 8 is a typical one shown at the Milan Leonard exhibition, after which theatres in other parts of Italy will eventually be patterned. These theatres have modern treatment in every way as evidenced by the photograph. Fig. 9 shows the synchronizing apparatus, mixer, and controls for the

Fig. 22. Photo of French television image, 450 lines interlaced, 50 fields.

cameras arranged so that all operations and apparatus is clearly visible through glass partitions from the main hallway.

The stage, shown in Fig. 10, is equipped with adequate lighting arranged to avoid dazzling, double wall and inclined glass for acoustic treatment, and a special air-conditioning system designed for low air velocities for mininum noise. The heart of the cameras is the Telepantoscope tube of Fig. 11, which is of the mosaic type and very similar to its prototype, the iconoscope.

One model of Safar television receiver is shown in Figs. 12 and 13. The cathode-ray tube is of the very short type having a diameter of 16 inches

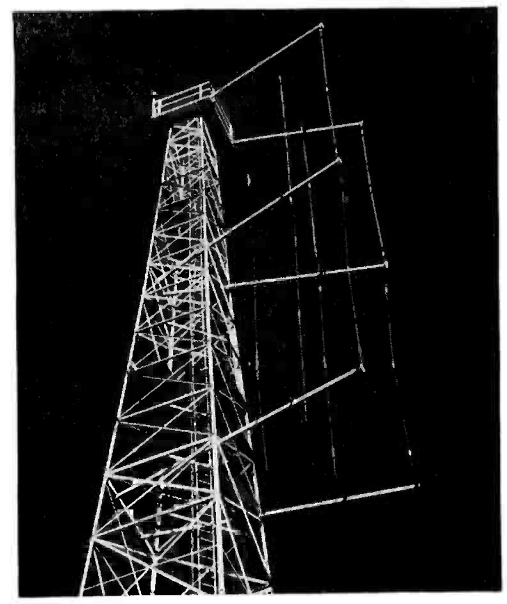


Fig. 1. Radiating system of Rome - Mount Mario television transmitter.

which allows pictures of 10 x 12 inches. Magnetic deflection and focus are used. Normal sound broadcasts may be received with these instruments as well as the television programs.

A high voltage projection tube designed for an anode potential of 40 kv is illustrated in Fig. 14. Persistent development work is being carried on along these lines.

A receiver manufactured by the Italian firm Allocchio Bacchini and Company is illustrated in Figs. 15, 16, and 17.

France

France has rather an impressive series of television experiments dating back to at least 1929. The greater part of this work, if not all, has been conducted under government sponsorship, under the Post Office Department.

At the present time, or at least prior to the advent of war conditions, an imposing program of experimentation is being conducted at the television research center located at Montrouge.

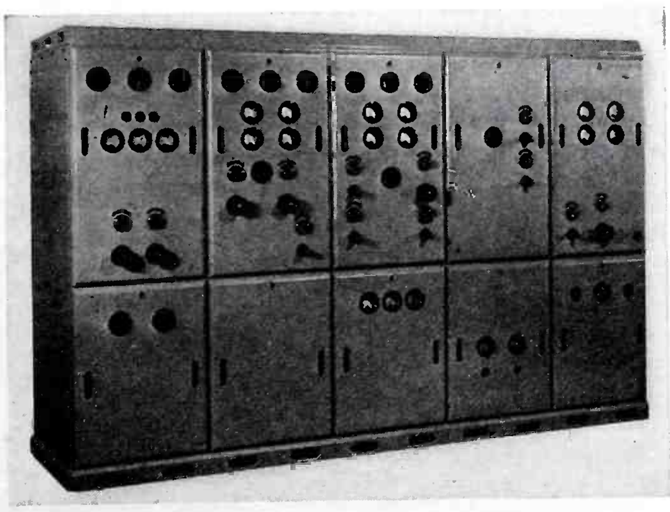


Fig. 2. (Left) Safar standard type television transmitter for Italian stations.

Fig. 3. (Right) The Safar transmitter with cover plates removed.

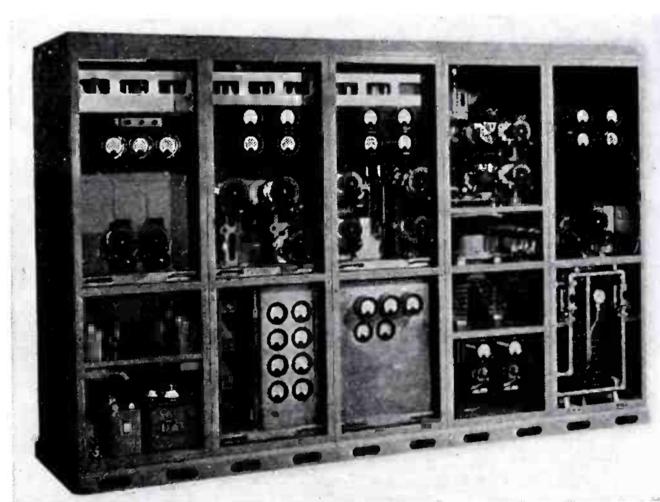


Fig. 34. (Above) Studio sound and vision control desks (Telefunken).

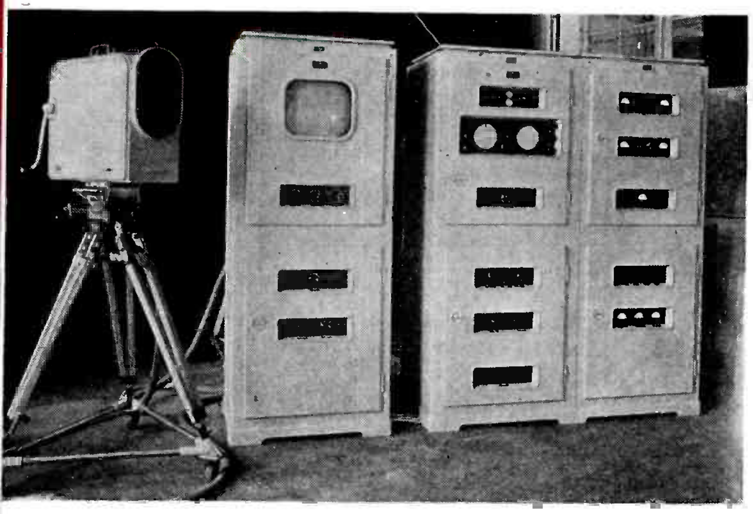
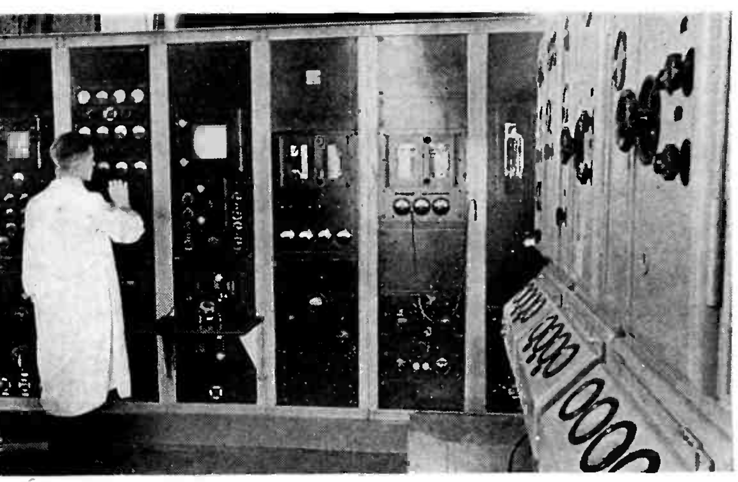


Fig. 24. (Above) A Fernseh camera with associated equipment.

Fig. 35. (Below) Telefunken vision transmitter and monitoring equipment at Reichpost transmitter.



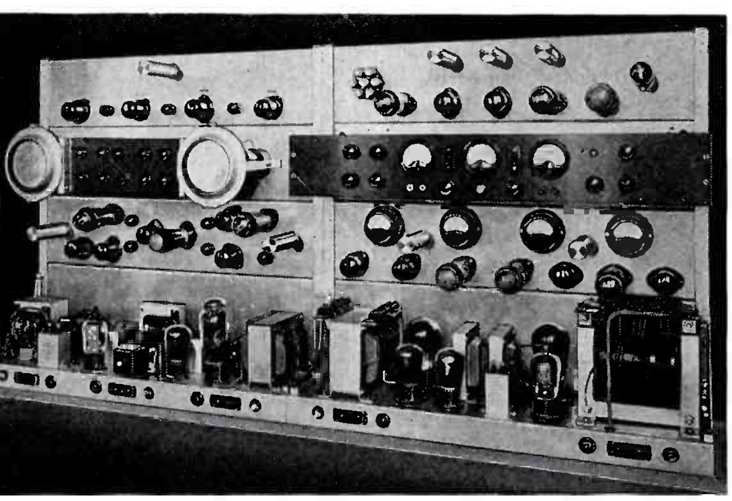


Fig. 30. (Above) An amplifier unit for television signals (Fernseh).

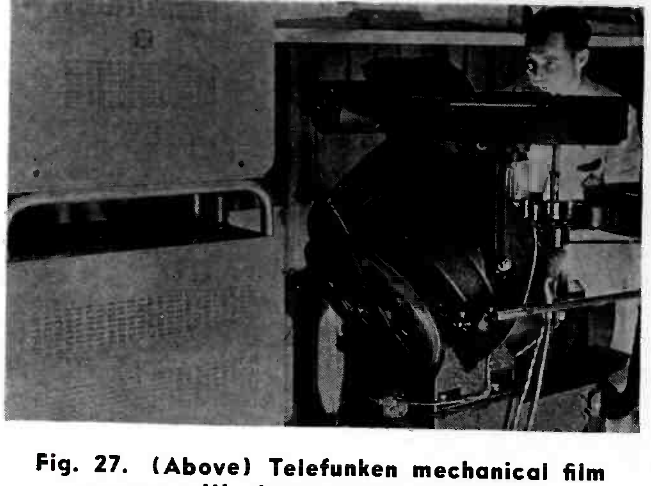
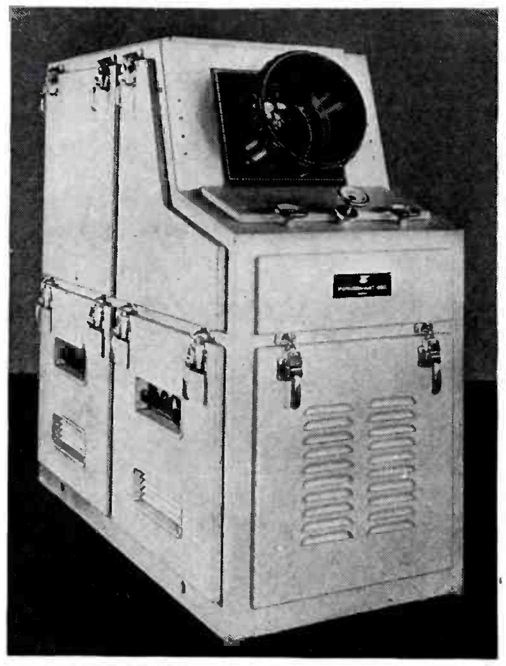


Fig. 27. (Above) Telefunken mechanical film scanner with storage-type pickup tube.

Fig. 29. (Below) A 60-80 kv projection type of reproducer (Fernseh).



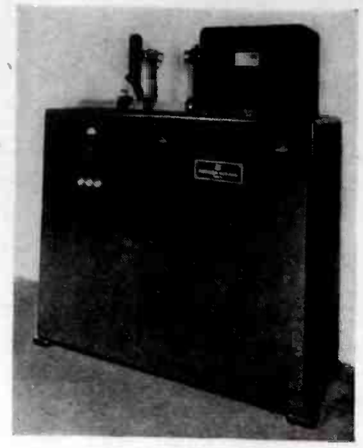


Fig. 26. Diapositive scanner for 24 x 28 mm transparencies (Fernseh).

This establishment comprises more than 4000 square meters of laboratory floor space, a television transmitting station, 20 technical men, about 20 technicians and draftsmen, as well as an executive staff of about 40. Through exchange of patents, the staff has a minumum of handicap in technical matters. A photograph of the outside of this Montrouge laboratory is shown in Fig. 18.

The Montrouge center has a studio for television program pickup, part of which is shown in Fig. 19. An interesting feature is the banks of 100-watt lamps overhead. By means of a special glass filter, 80% of the direct heat is absorbed for wavelengths below 8000 angstroms. The 23-foot ceiling height allows the remainder of the heat to be dissipated above.

The studio is equipped with an electronic camera, one type of which is shown in Fig. 20. The mosaic type of translating device is used in France as in most other countries. The studio camera, by means of a wheel mounting, can be moved into an adjoining garden for exterior views. An illumination of 200 lux, corresponding to an overcast sky, is sufficient to provide an acceptable image. Another iconoscope type of camera is used for film scanning.

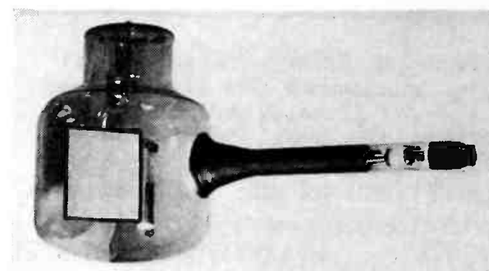


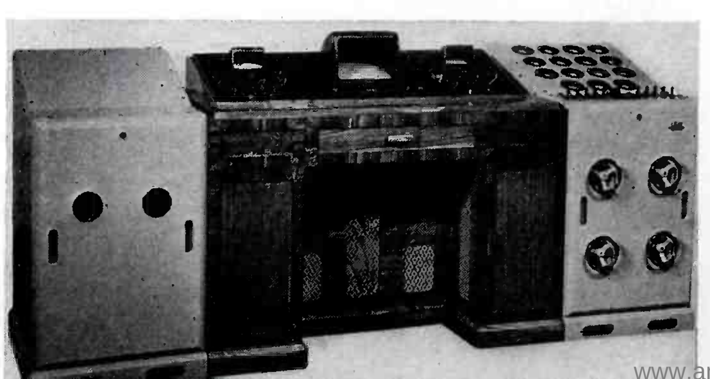
Fig. 11. (Above) Safar Type B Telepantoscope, a mosaic device used in telecameras.

Fig. 14. (Below) A 40-kv Safar tube for projection receivers.

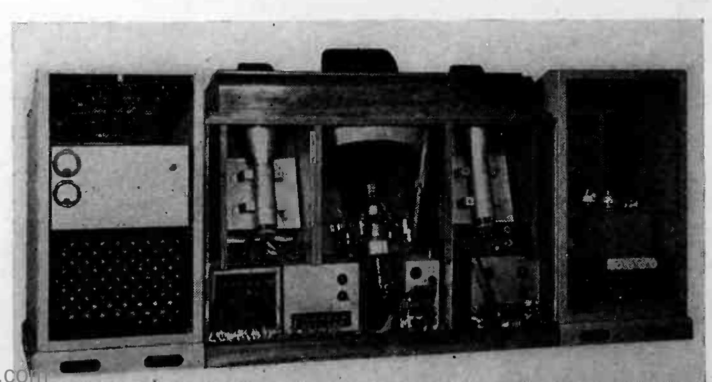
Complete synchronizing, amplifying, and mixing panels are of course provided. The video modulating signal is amplified without impairment of its amplitude or phase over a band from 25 cycles to 3 mc until its level is sufficient to modulate two push-pull, 3 kw, water-cooled tubes. The peak power output is from 6 to 8 kw.

In a reception hall located near the studio, a projection type of reproducer is located. An anode potential of 40 kv is used (Fig. 21), producing a highly luminous picture 8 x 10 cm

Fig. 15. A television receiver manufactured by Allocchio Bacchini & Co.



Front (Fig. 5, left) and rear (Fig. 6, right) views of Safar control desk.



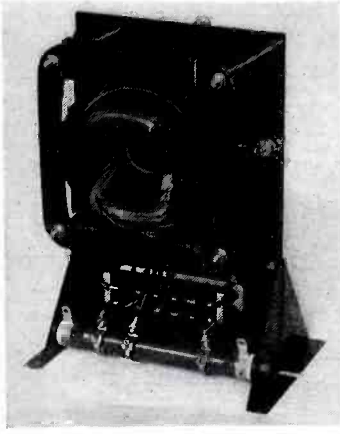


Fig. 17. Magnetic yoke for deflection and focus in receiver of Fig. 15.

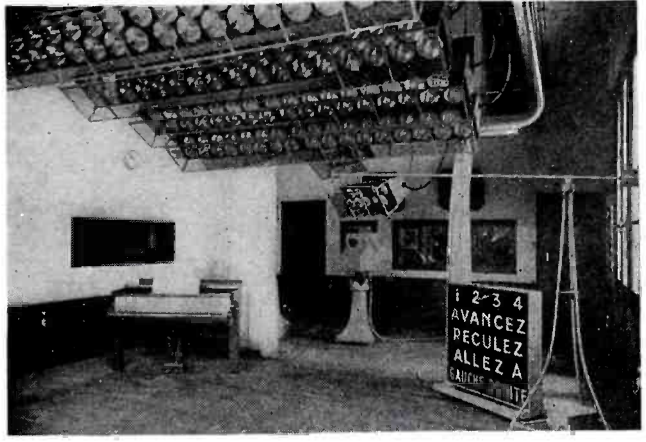
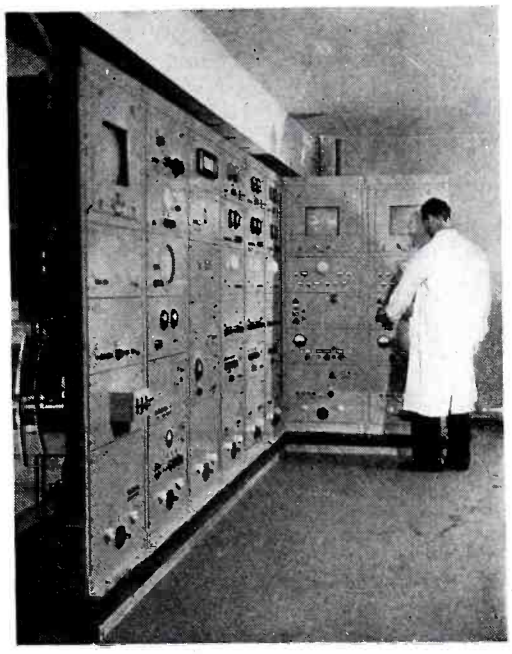


Fig. 19. (Above) Television studios at the Montrouge laboratories.

Fig. 18. (Right) Television research laboratories at Montrouge, France.

Fig. 33. (Below) Telefunken control panels.



which is projected on to a screen by means of a large f 1.4 objective lens. The overall quality of the television circuits, as well as this reproducer, is illustrated in the unretouched photograph image shown in Fig. 22. This picture utilizes 450 lines, interlaced, and 50 fields per second.

The Eiffel Tower television station, in operation since 1937, is one of the most powerful transmitters of its type. When full power is used, 30 kw peak will be fed to the antenna. The antenna is over 1000 feet above the ground and is fed by a special 5-inch coaxial cable

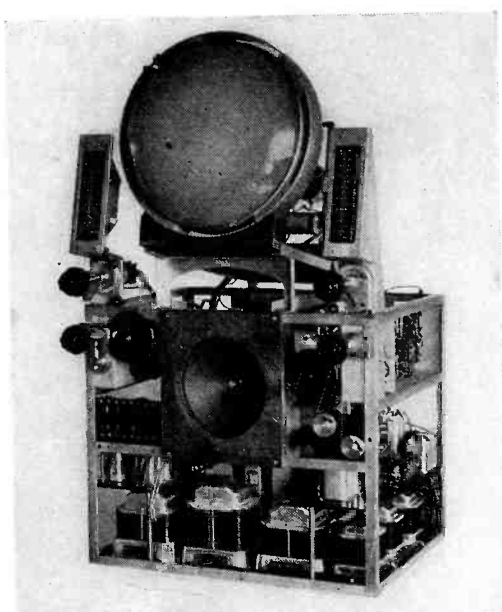


Fig. 13. Chassis of a Safar receiver.

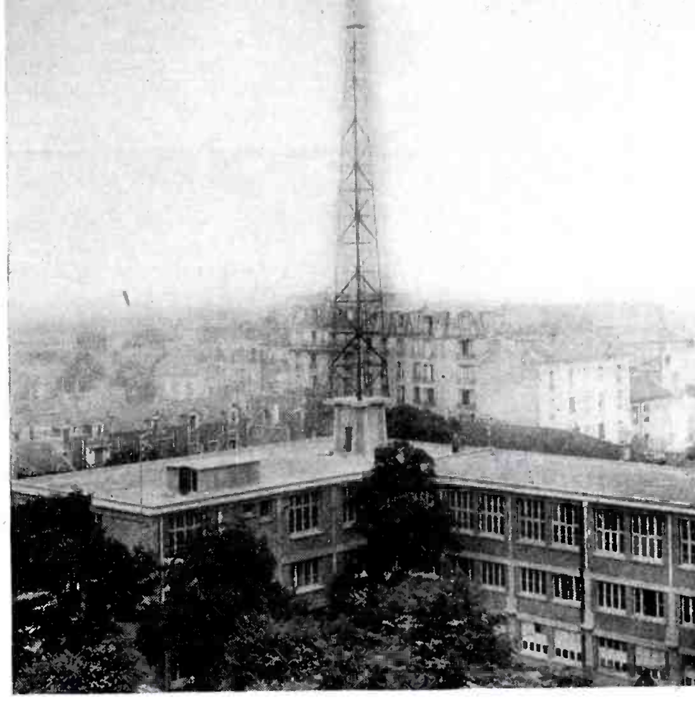
that has a total length of about 1250 feet weighing over 12 tons. Two studios, situated about 1½ and 3 miles from the transmitter, provide the program material. These are connected by special lines with the transmitter.

An interesting feature of the final r-f stage is that its plate is grounded, causing its filament and grid circuits to be highly negative. This allows the plate of the modulator to be connected directly to the grid of the modulated stage, eliminating the coupling condenser and grid resistor, and thereby aiding in maintaining the necessary band width.

Germany

Great television activity has characterized Germany's communication industry for years. Many manufacturing companies are interested in the commercialization of visual communication, among them being the Fernseh, Loewe, Lorenz, TE KA DE, and Telefunken companies. Recently a group of such establishments cooperated with the German Reichspost in the production of a standard television receiver as economically as possible in order that the maximum number of receivers be placed in the hands of the people.

Fig. 12. A standard type of Safar television receiver.



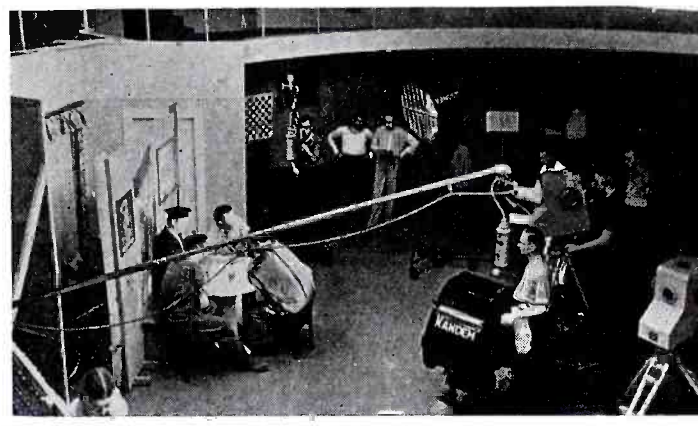
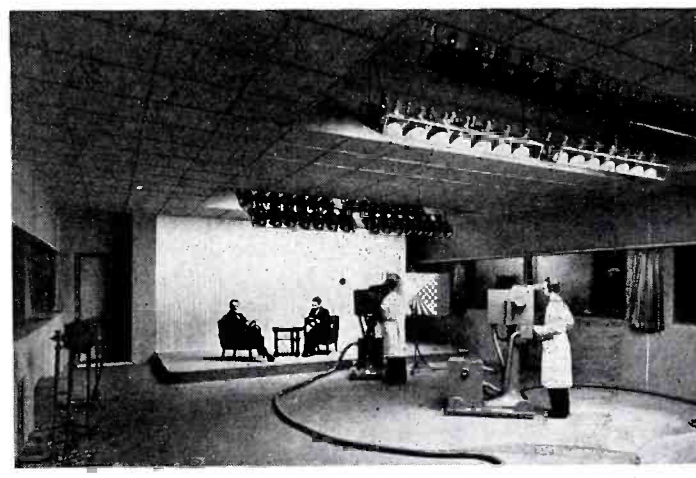


Fig. 25. (Above) A studio scene in Deutschland House (Telefunken).

Fig. 10 (Below) Stage in the Safar television theatre.



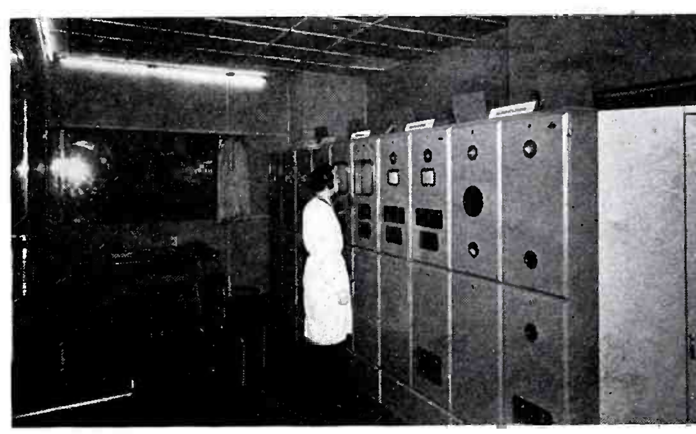
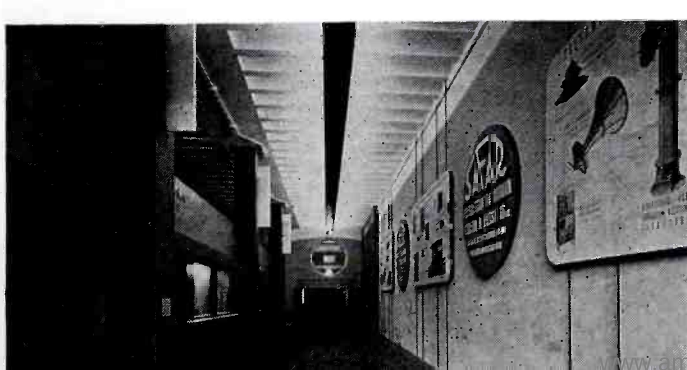


Fig. 9. (Above) Synchronizing apparatus, mixer and controls of Safar television cameras.



Entrance (Fig. 7, right) and inner hall (Fig. 8, left) of Safar television theatre.

An idea of the state of the television art may be obtained from Figs. 23 to 35 inclusive.

Figs. 23 and 24 show two models of television cameras, while the studio

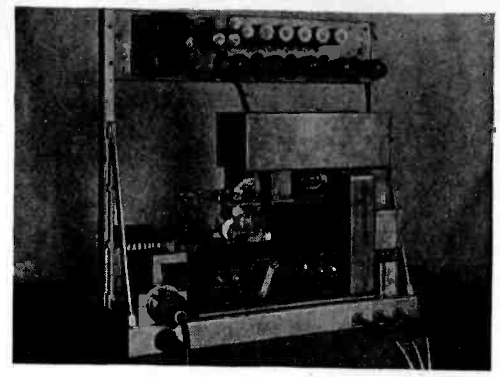


Fig. 32. (Above) A mechanical synchronizing impulse generator (Fernseh)

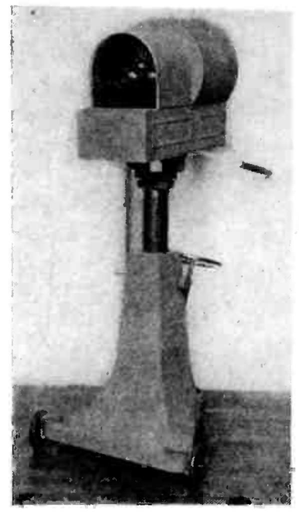


Fig. 20. (Left) French version of mosaic type of electronic television camera.

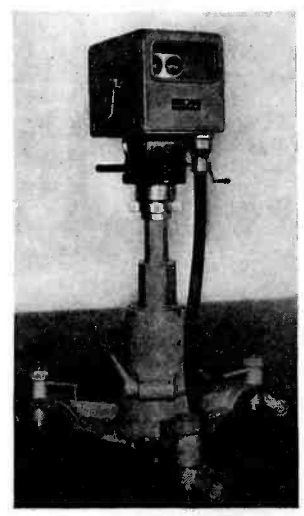
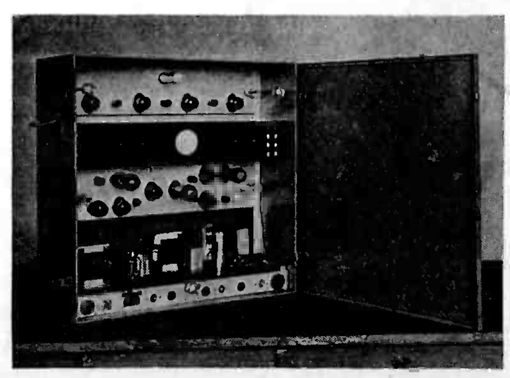


Fig. 23. (Right) A 1939 model of Fernseh A.G. television camera.

Fig. 31. (Below) A portable amplifier for television signals (Fernseh).



scene of Fig. 25 shows still a third. All are basically of the mosaic type. The image dissector type of scanner is represented in the commercial equipment by the still-film scanner of Fig. 26.

(*Continued on page 27*)

Frequency Modulation Receiver Design

By RICHARD F. SHEA

General Electric Co.

Presented at The Ohio State University Broadcast Engineering Conference, Feb. 17, 1940.

DURING the past year there has been a great deal of activity in the field of frequency-modulated transmission. At the present time there are transmitters in operation in New England and New York State, with others under construction in many parts of the country, with indications that within the next twelve months frequency-modulated transmissions, with their attendant advantages of high fidelity and low noise will be available in practically all parts of the country. The problem of designing apparatus to receive these transmissions properly, and for reproduction of the programs with all inherent fidelity, is obviously an important one. The object of this paper is to indicate the various phases of this design problem, and to illustrate the methods used to overcome them, as exemplified by two frequency-modulated receivers, currently on the market. These receivers are General Electric Models HM-80 and HM-136, eight and thirteen tube receivers, respectively. The former is designed exclusively for f-m reception, the latter also combines reception on the standard a-m bands from 540 to 21000 kc. Model HM-80 is a table model, and the same chassis is available in console form as Model HM-85. Model HM-136 is a console.

In the design of receivers for frequency modulation the fundamental difference between this mode of transmission and the more common amplitude modulated transmission must be borne in mind. In the former a radio-frequency carrier is transmitted of constant amplitude, this carrier being varied in frequency by the applied modulation, the variation or deviation being proportional to the amplitude of the modulation, the frequency at which the carrier is "swung" being the modulation frequency. Thus, if the normal carrier frequency is 42 megacycles, and a 400-cycle modulation is applied to the audio system of the transmitter, this 42-mc carrier will vary back and forth around a mean frequency of 42 mc at a rate of 400 times a second. The extent to which it varies from 42 mc will depend on the intensity of the 400-cycle note. Present practice is to limit peak swings to about plus or minus 65 kilocycles. The current upper limit of the audio frequency is about 15,000 cycles.

From the preceding it will be seen that the essential problems entering into the design of a receiver for f-m reception are:

(1) Operation in the 40-45 mc band.

(2) Reception of a signal varying over a band of about 130 kc.

(3) Conversion of this f-m signal into audio frequencies.

(4) Adequate amplification of these audio frequencies up to about 15,000 cycles.

In addition to these fundamentals, there is also the requirement that limiting be as effective as possible to provide maximum noise reduction, that distortion introduced anywhere in the system be held to a minimum to provide the full fidelity of which this system is capable. Bearing these problems in mind, the two previously mentioned receivers will be described and analyzed in detail.

R-f Amplifier

In the design of the customary amplitude-modulated receivers an r-f stage performs several functions:

(1) Increased sensitivity
(2) Increased selectivity
(3) Increased rejection at intermediate frequency
(4) Increased image ratio
(5) Increased signal-to-noise ratio

In an f-m receiver these five functions are likewise performed by an r-f stage, however, the relative importance is entirely different from the former case. For example, image ratio may be of extreme importance in an a-m receiver where the band to be received is relatively broad. In f-m reception, however, the present set-up of the assigned

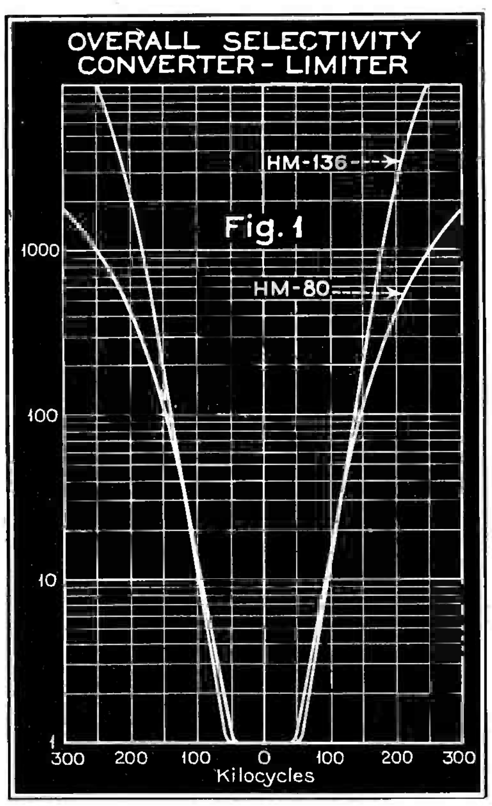


Fig. 1

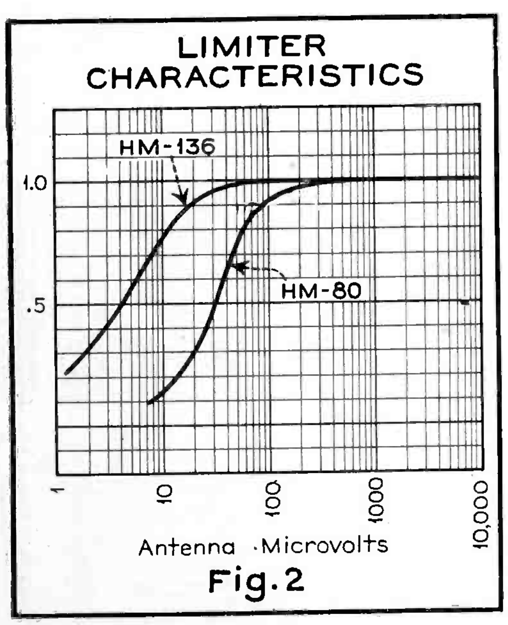


Fig. 2

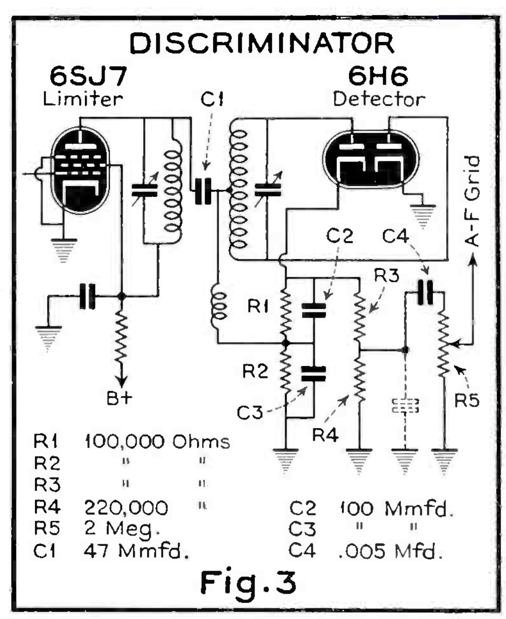
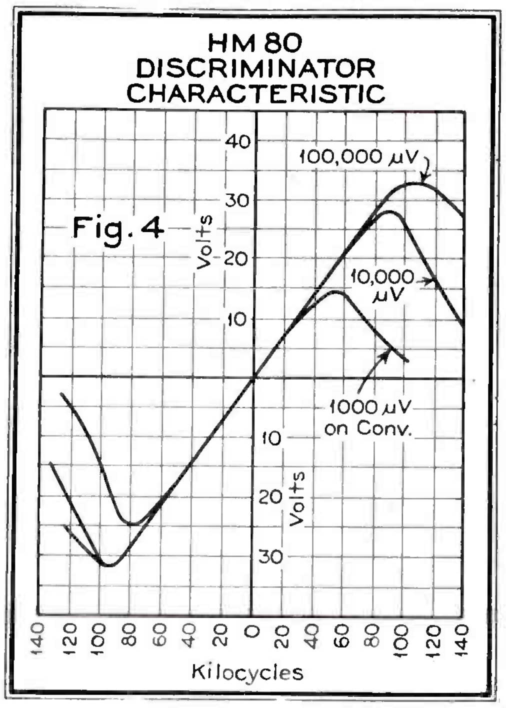


Fig. 3

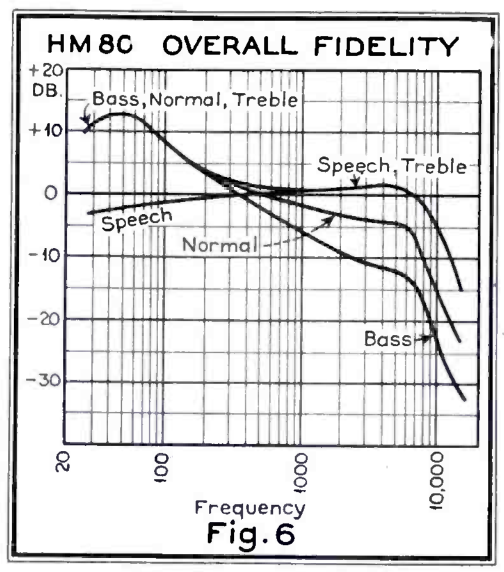


band is such that, with an i-f of about 2 mc the image of one extreme frequency will fall outside the other extreme. Consequently, this factor is of minor importance unless the band is widened, or strong other services assigned adjacent channels. Likewise, increased selectivity is not so important here, not because selectivity is not important, but because at these frequencies the selectivity contributed by the r-f system is slight compared to that of the i-f system. Similarly improved i-f rejection is not important as the i-f is chosen to be such that the possibility of interference on this frequency is minimized. Thus we find that the two principal reasons for employing an r-f stage are increased sensitivity and increased signal-to-noise ratio. These two go hand in hand in a receiver of this type, as increased sensitivity means that weak signals are brought up so that they operate the receiver on the effective portion of the limiter characteristic, with the result that reduction in noise is effected by limiter action. In this respect, however, it must be pointed out that, generally speaking, the amount of amplification prior to the limiter is the important factor, rather than the distribution of this amplification. Consequently, essentially the same results may be obtained with an extra i-f stage or an r-f stage, the over-all gain being the same in either case. Thus the decision as to whether or not to employ an r-f stage largely rests upon the economics of the case, the number of tubes which are permissible, the maximum amount of amplification which can be obtained with stability by either design. For the above reasons two i-f stages are employed in both receivers, and an r-f stage in only model HM-136. The r-f stage gain in this receiver is of the order of seven. Increased r-f gain may be obtained here by the substitution of a higher Gm tube, such as an 1852, for the 6SK7.

In conjunction with the r-f amplifier and converter, it might be well to mention the effect of input circuit Q. At the lowest frequency, 40 mc, a pass band of 150 kc will require that the Q be not in excess of 266. In practice, this value will not be exceeded by usual designs of r-f coils, with the additional loads of the associated circuits and tubes.

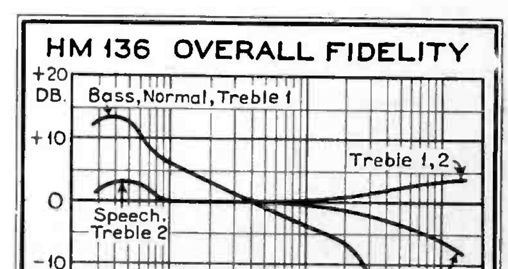
Converter

In both these receivers the converter employed is the 6K8 tube. It has been found that this tube is a very stable oscillator at these frequencies, possesses desirable freedom from interaction between input and oscillator circuits, and has a good conversion gain. The converter circuit is strictly conventional, the incoming f-m signal being converted to a mean i-f of 2.1 mc. This frequency was chosen to avoid the higher end of the amateur band, which falls at 2.05 mc, yet to be low enough to give adequate gain with the desired band width to accommodate the frequency swing of plus or minus 65 kc. In the oscillator circuit various elements are incorporated to provide frequency stabilization, on which more will be given later. On the 8-tube receiver, which is designed solely for f-m reception, a plate-tuned oscillator is employed, to obtain somewhat better stability from line-voltage effects. On both receivers on f-m reception the oscillator is operated at a lower frequency than the signal to avoid interference to and with television broadcasts.



I-f Amplifier

In the i-f system is probably the biggest field for variation in design of receivers, as the compromises between gain, band width, selectivity, etc., are legion. In an ideal case the gain would be as high as possible, rejection would be infinite at adjacent channels, and the top of the curve would be flat over plus or minus about 75 kc. All this is obviously impractical, and some compromises must be made, even as in the case of amplitude modulated receivers. The top of the i-f curve should be as flat as possible, from 70 to 125 kc being a fairly normal range. In addition the gain is of utmost importance, as it directly influences the limit of usability of the receiver. Doubling the gain of such a receiver halves the required antenna signal which will operate the limiter sufficiently high on its characteristic to be effective for noise reduction. The adjacent channel selectivity directly influences the ability to receive weak signals in the locality of a strong local, even though the desired signal may be strong enough to operate the limiter in the absence of interference. Fig. 1 illustrates these factors on the two receivers before mentioned. These curves show the over-all selectivity, between the converter grid and the limiter grid, measured at i-f. The over-all selectivity on the antenna at signal frequency is substantially the same, as the antenna and r-f circuits contribute little additional selectivity. It will be observed that these two receivers possess adequate selectivity, although Model HM-136 is somewhat broader on the nose. Adjacent channel rejection ratio is 500-5000. Band width is about 90 kc on the eight-tube set and 120 kc on the HM-136. In thinking about these curves, however, it must be borne in mind that the limiter has a very decided effect on the final design of the i-f amplifier. Every limiter circuit has a certain "knee," or threshold, above which limiting is fully effective. Consider now two i-f systems differing considerably in gain and in band width, working into a limiter characteristic such as that shown on Fig. 2, for Model HM-80. The knee of this curve is at approximately 250 microvolts. This means that any signal exceeding this on the antenna will produce no increase in



output from the limiter, as long as the frequency is unchanged. However, the minute the frequency is varied from the mid-frequency, say 42 mc, the voltage applied to the limiter is reduced due to the i-f selectivity. Refer again to Fig. 1, for the HM-80. If the swing is 65 kc, the voltage on the limiter grid will be reduced by a ratio of approximately three. This means that if the limiter is to be operated at its knee by the extreme frequency, the applied antenna signal at mid-frequency, 42 mc, must be three time 250 microvolts, or 750 microvolts. This then becomes the limit in signal which can be handled without non-linearity by the limiter. Now let us assume a change in the shape of the i-f curve, such that the reduction for a 65 kc variation is now only two, instead of three, but where this has been achieved at the expense of gain, which has been reduced by 50%. At center frequency 500 microvolts would be required on the antenna for limiting, at 65 kc off the center frequency 1,000 microvolts would be required. As a result the effective sensitivity of the receiver has been reduced from 750 to 1,000 microvolts. Beyond this, however, for modulations which produce swings less than 65 kc, the reduction in sensitivity is even greater, approaching 2-1 at very small modulations. Random noise falls generally in this category, consequently the latter case would be nearly twice as bad as the former for noise ratio.

The foregoing example was based on operation at the knee of the limiter characteristic. If even weaker signals are employed, the shape of the limiter characteristic now enters the picture, as its slope will determine the amount of limiting, even though partial, taking place. From the above it can be seen that the design of the i-f system is based largely on compromise between gain, selectivity, fidelity, noise ratio, stability, etc. In general it can be said that the best design is the one which will produce a minimum of distortion out of the discriminator system at the lowest possible antenna input, for varying amounts of swing, up to 65 kc.

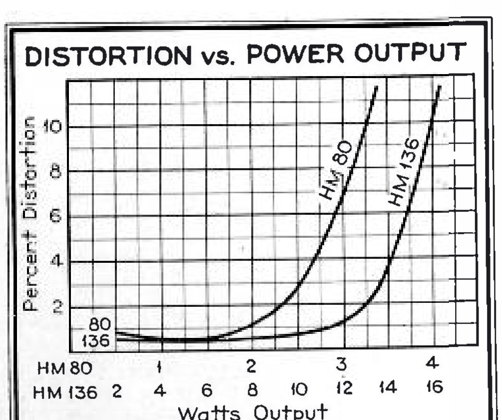


Fig. 8

Limiter

The limiter is probably one of the most vital parts of the frequency-modulation receiver, and consequently its design has a great bearing on the performance of the set. The principal function of the limiter is to iron out any amplitude variations before the signal is applied to the frequency detector, so that this signal will be a strictly constant-amplitude, variable-frequency signal. Any noise components, either random or impulse, produce primarily amplitude variations in the signal, consequently, if these amplitude variations can be ironed out these noises will be very considerably reduced. A limiter in general is some form of current or voltage-limited device, such that above a certain operating point no further increase in plate current may be produced by a change in input voltage. This current limiting may be accomplished by grid limiting, screen limiting, plate limiting or any combination. In general, the design of the limiter is a compromise between limiting effectiveness and gain. Fig. 2 shows the limiter characteristics of the two receivers. The difference in the two curves is principally due to the added gain of the r-f stage. Both sets use the same type of limiter, a 6SJ7 tube, operated without bias and with 330,000 ohms in the grid circuit. Plate and screen are operated at reduced voltages. As signals on the limiter exceed the threshold point the increasing grid bias, combined with plate current cut-off, prevents the plate current from increasing, thereby providing limiting action. It can be seen that the knee is at about 30 microvolts on the HM-136 and about 250 microvolts on the HM-80. Substituting an 1852 for the 6SK7 in the r-f stage of the HM-136 will bring this knee down to about 7.5 microvolts.

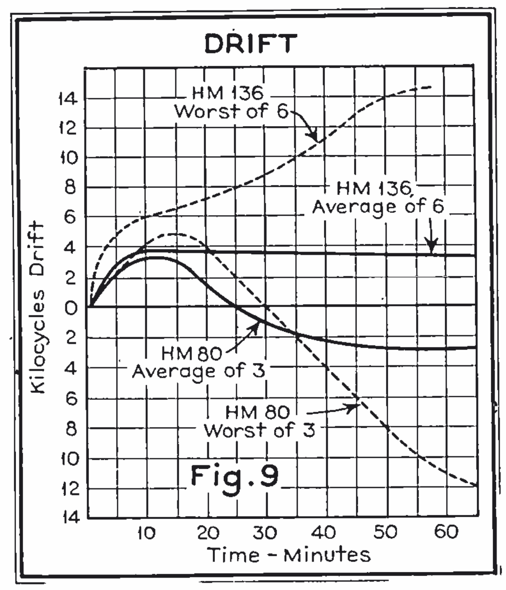


Fig. 9

Frequency Detector

The term "frequency detector" has

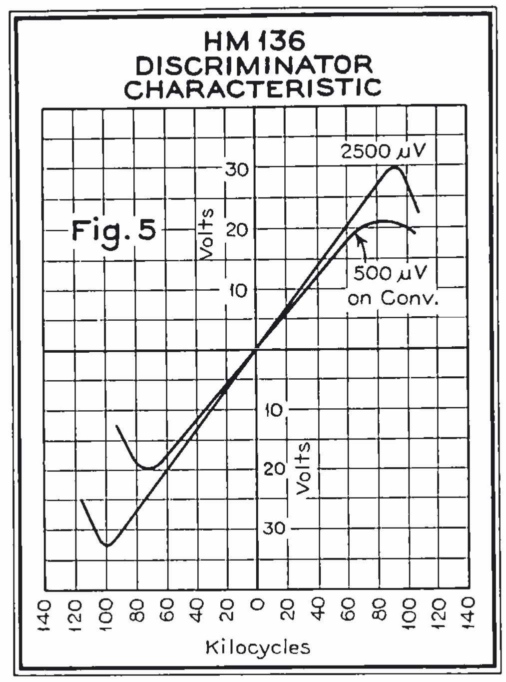


Fig. 5

been applied to this device to distinguish it from the conventional detector employed in amplitude-modulated circuits, although this detector also incorporates an a-m detector. In operation the frequency detector transforms the constant-amplitude varying-frequency signal supplied by the limiter into a variable-amplitude signal and then detects this in normal manner, thus producing the audio envelope for further audio ampilfication. The device used for this purpose is the familiar a-f-c circuit of a few years back. Where originally it was intended to transform variations in applied frequency into control voltages for the purpose of reducing those variations, now its purpose is slightly modified. It still operates on a varied applied frequency, however, the resultant output is converted to audio, not direct current, and is not used for correction. This frequency detector consists of a double tuned i-f transformer, wherein the center of the secondary is returned to the plate of the preceding tube through a coupling condenser. A double diode is connected to the extremes of the secondary, with a balanced load connected between the two cathodes, one extremity being grounded. The center of the load is returned to the center of the secondary through a choke. The load resistors are bypassed at i-f, and the audio developed across them is applied to the volume control, and thence to the subsequent audio amplifier. Fig. 3 shows the connections of this discriminator transformer and frequency detector. In operation the combination of primary and secondary maximizes at two peaks on either side of the mid-frequency, in the same manner as in the original a-f-c usage, and a frequency swung up and down between these two peaks produces an audio output, when rectified. The most important feature here is that the characteristic of the frequency detector must be linear between the two peaks, and that the peaks must be far enough apart to accommodate the swings which will be encountered during modulation. Fig. 4 shows the discriminator characteristic of model HM-80 and Fig. 5 of Model HM-136. Referring to the former it will be noted that these characteristics are essentially linear between the peaks, but that the distance between peaks varies with input signal. This is due to a combination of i-f selectivity, limiter effectiveness and discriminator characteristic. The curve for 100,000 microvolts is essentially that of the discriminator itself. The lower curves fall short of this one because the signal level is too low to be ironed out completely by the limiter.

Referring to these characteristics it may be seen that for very strong signals a swing of over 80 kc could be accommodated without excessive distortion, whereas with only 1000 microvolts on the converter only 50 kc either side of the center of linearity could be properly detected. This indicates that quality would be acceptable in the latter case with moderate swings and about 500 microvolts on the antenna, but that full 65-kc swings could not be handled without peak distortion. This does not indicate at all that such field strengths are necessary for enjoyable reception, as these swings are peak, and are only encountered on loudest passages. Thus, it is noted in operation that this receiver gives enjoyable reception, far better than customary a-m quality, with antenna signals of only 100-200 microvolts. On lower signals than this reception is still possible, but random noise becomes apparent, and to a large degree masks peak distortion. Fig. 5 for model HM-136 indicates that this set is capable of handling 65-kc peaks with 30 microvolts on the antenna.

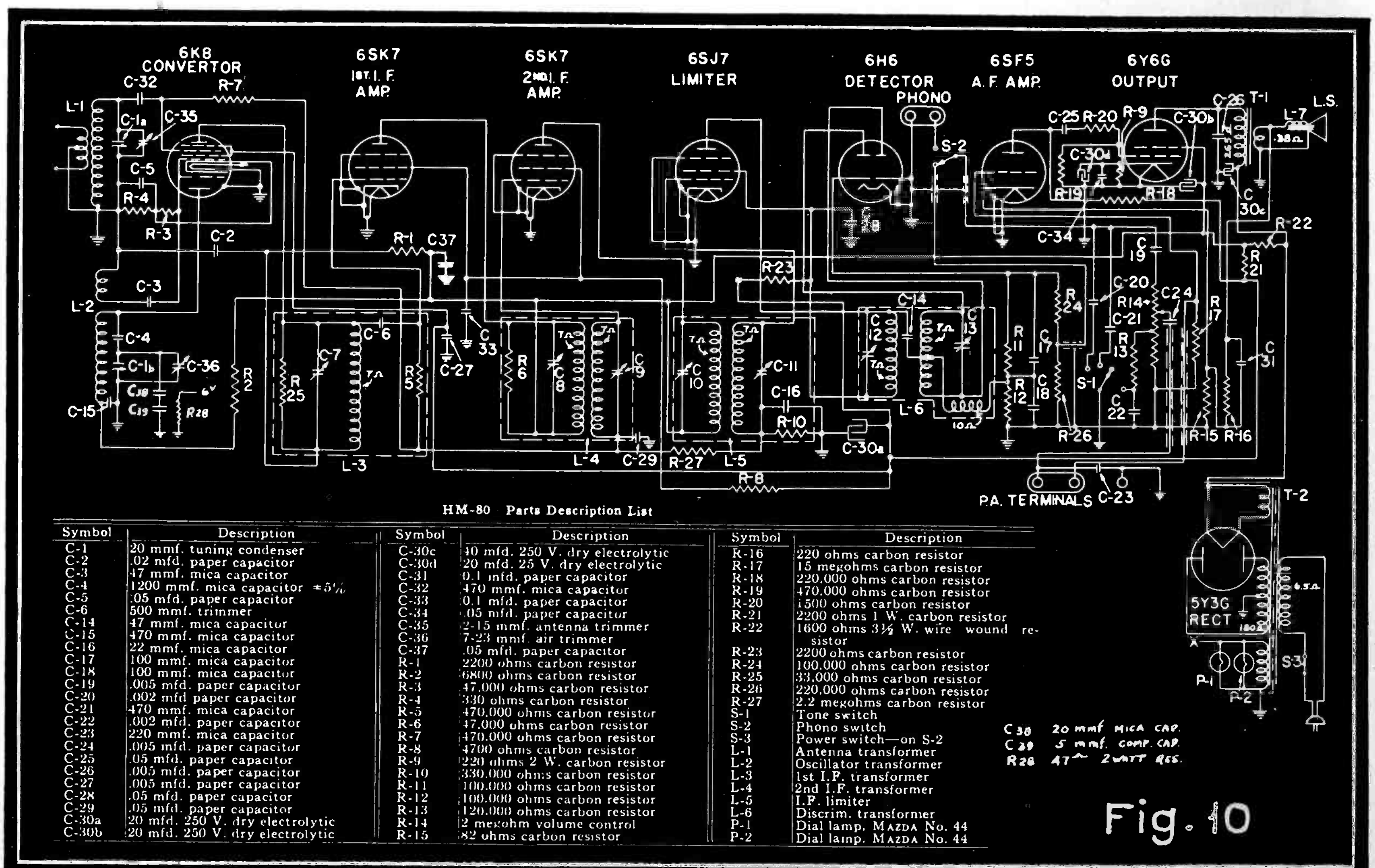
The degree of linearity of these characteristics is measured by the resultant distortion on reception. On strong signals both receivers are capable of handling full swings with under one percent total distortion. As the applied signal is reduced the distortion at full swings will increase, and is mainly second harmonic, but moderate swings are still handled with low distortion.

Frequency Correction

In frequency-modulated transmission, as in television, pre-emphasis of the high-frequency end of the audio spectrum is employed to improve the signal-to-noise ratio. Consequently in the receiver some form of compensation network must be used to restore the overall audio characteristic to its proper shape. In addition it is commercially desirable to be able to produce bass emphasis at the customer's will. All these elements are combined in the circuit elements associated with the volume control on both of these receivers. The frequency correction is obtained by a combination of resistance and capacitance, the latter being obtained from the shielded audio leads as well as by additional capacitors. Bass compensation is applied at the volume control, using the conventional tap method. Tone control switches are provided on both models to modify the response as desired. Figs. 6 and 7 give the over-all audio response from transmitter to voice coil, including pre-distortion at the transmitter, correction at the receiver and the effects of the tone control switch. It will be seen from these curves that the over-all response extends from 30 to 15,000 cycles.

Audio Amplifier

In both of these receivers a considerable amount of audio degeneration is employed to reduce any distortion introduced by the audio and output tubes, and produce the excellent quality of which this system is capable. This degeneration takes the form of voltage fed back from the voice coil to the preceding stages of the audio amplifier. The details of these feed-back circuits will best be seen from the schematic diagrams. The use of degeneration also facilitates the obtaining of an excellent over-all audio characteristic with normal components. Fig. 8 shows the over-all distortion obtainable with these receivers. As mentioned previously, distortion is considerably under one percent at normal listening levels.



HM-80 Parts Description List

Symbol	Description	Symbol	Description	Symbol	Description
C-1	20 mmf. tuning condenser	C-30c	40 mfd. 250 V. dry electrolytic	R-16	220 ohms carbon resistor
C-2	.02 mfd. paper capacitor	C-30d	20 mfd. 25 V. dry electrolytic	R-17	15 megohms carbon resistor
C-3	47 mmf. mica capacitor	C-31	0.1 mfd. paper capacitor	R-18	220,000 ohms carbon resistor
C-4	1200 mmf. mica capacitor ±5%	C-32	470 mmf. mica capacitor	R-19	470,000 ohms carbon resistor
C-5	.05 mfd. paper capacitor	C-33	0.1 mfd. paper capacitor	R-20	1500 ohms carbon resistor
C-6	500 mmf. trimmer	C-34	.05 mfd. paper capacitor	R-21	2200 ohms 1 W. carbon resistor
C-14	47 mmf. mica capacitor	C-35	2-15 mmf. antenna trimmer	R-22	1600 ohms 3½ W. wire wound resistor
C-15	470 mmf. mica capacitor	C-36	7-23 mmf. air trimmer		
C-16	22 mmf. mica capacitor	C-37	.05 mfd. paper capacitor	R-23	2200 ohms carbon resistor
C-17	100 mmf. mica capacitor	R-1	2200 ohms carbon resistor	R-24	100,000 ohms carbon resistor
C-18	100 mmf. mica capacitor	R-2	6800 ohms carbon resistor	R-25	33,000 ohms carbon resistor
C-19	.005 mfd. paper capacitor	R-3	47,000 ohms carbon resistor	R-26	220,000 ohms carbon resistor
C-20	.002 mfd paper capacitor	R-4	330 ohms carbon resistor	R-27	2.2 megohms carbon resistor
C-21	470 mmf. mica capacitor	R-5	470,000 ohms carbon resistor	S-1	Tone switch
C-22	.002 mfd. paper capacitor	R-6	47,000 ohms carbon resistor	S-2	Phono switch
C-23	220 mmf. mica capacitor	R-7	470,000 ohms carbon resistor	S-3	Power switch—on S-2
C-24	.005 mfd. paper capacitor	R-8	4700 ohms carbon resistor	L-1	Antenna transformer
C-25	.05 mfd. paper capacitor	R-9	220 ohms 2 W. carbon resistor	L-2	Oscillator transformer
C-26	.005 mfd. paper capacitor	R-10	330,000 ohms carbon resistor	L-3	1st I.F. transformer
C-27	.005 mfd. paper capacitor	R-11	100,000 ohms carbon resistor	L-4	2nd I.F. transformer
C-28	.05 mfd. paper capacitor	R-12	100,000 ohms carbon resistor	L-5	I.F. limiter
C-29	.05 mfd. paper capacitor	R-13	120,000 ohms carbon resistor	L-6	Discrim. transformer
C-30a	20 mfd. 250 V. dry electrolytic	R-14	2 megohm volume control	P-1	Dial lamp. Mazda No. 44
C-30b	20 mfd. 250 V. dry electrolytic	R-15	82 ohms carbon resistor	P-2	Dial lamp. Mazda No. 44

Fig. 10

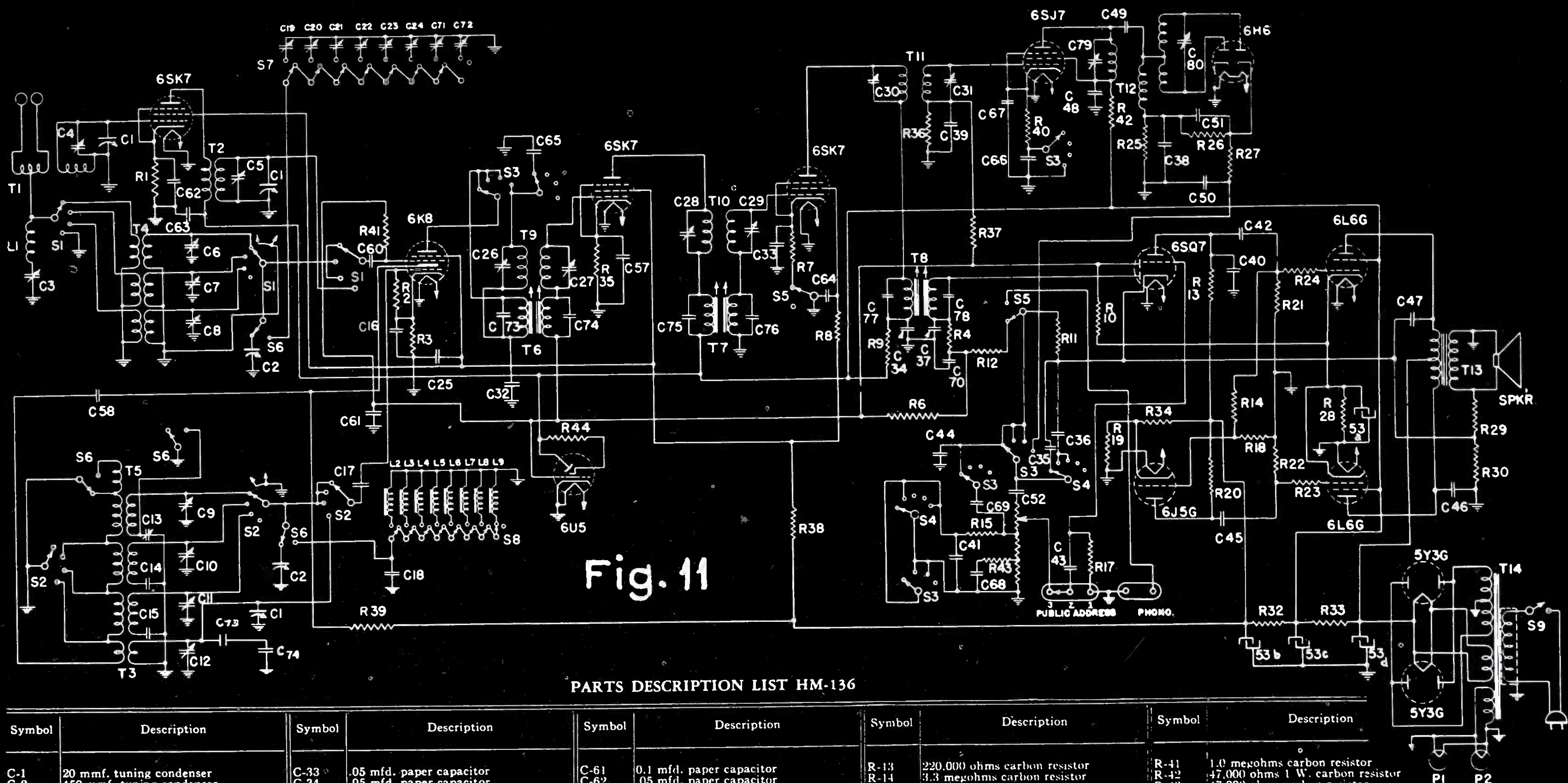


Fig. 11

PARTS DESCRIPTION LIST HM-136

Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description
C-1	20 mmf. tuning condenser	C-33	.05 mfd. paper capacitor	C-61	0.1 mfd. paper capacitor	R-13	220,000 ohms carbon resistor	R-41	1.0 megohms carbon resistor
C-2	450 mmf. tuning condenser	C-34	.05 mfd. paper capacitor	C-62	.05 mfd. paper capacitor	R-14	3.3 megohms carbon resistor	R-42	47,000 ohms 1 W. carbon resistor
C-3	Wave trap trimmer, 45-145 mmf.	C-35	.0015 mfd. paper capacitor	C-63	.005 mfd. paper capacitor	R-15	180,000 ohms carbon resistor	R-43	47,000 ohms carbon resistor
C-4	"F.M." antenna trimmer, 5-40 mmf.	C-36	470 mmf. mica capacitor	C-64	.05 mfd. paper capacitor	R-16	2.0 megohms volume control	R-44	1.0 megohms carbon resistor
C-5	"F.M." R.F. trimmer, 3-30 mmf.	C-37	47 mmf. mica capacitor	C-65	.001 mfd. paper capacitor	R-17	4.7 megohms carbon resistor	S-1, 2, 3	Band switch
C-6	"B" antenna trimmer, 3-30 mmf.	C-38	220 mmf. mica capacitor	C-66	0.1 mfd. paper capacitor	R-18	270,000 ohms carbon resistor	S-4	Tone control
C-7	"C" antenna trimmer, 3-30 mmf.	C-39	22 mmf. mica capacitor	C-67	0.1 mfd. paper capacitor	R-19	220 ohms carbon resistor	S-5	Phono switch
C-8	"D" antenna trimmer, 3-30 mmf.	C-40	150 mmf. mica capacitor	C-68	.01 mfd. paper capacitor	R-20	68,000 ohms carbon resistor	S-6	Manual Switch
C-9	"B" oscillator trimmer, 5-40 mmf.	C-41	.003 mfd. paper capacitor	C-69	100 mmf. mica capacitor	R-21	220,000 ohms carbon resistor	S-7, 8	Station selector switch
C-10	"C" oscillator trimmer, 3-30 mmf.	C-42	.05 mfd. paper capacitor	C-70	47 mmf. mica capacitor	R-22	220,000 ohms carbon resistor	S-9	Power switch
C-11	"D" oscillator trimmer, 3-30 mmf.	C-43	.01 mfd. paper capacitor	C-71	7-65 mmf. antenna trimmer	R-23	1000 ohms carbon resistor	T-1	"F.M." antenna transformer
C-12	"F.M." oscillator air trimmer, 3-30 mmf.	C-44	100 mmf. mica capacitor	C-72	20-180 mmf. antenna trimmer	R-24	1000 ohms carbon resistor	T-2	"F.M." R.F. transformer
C-13	300-600 mmf. padder	C-45	.05 mfd. paper capacitor	L-1	Wave trap coil	R-25	100,000 ohms carbon resistor	T-3	"F.M." oscillator transformer
C-14	1800 mmf. mica capacitor ±5%	C-46	.002 mfd. 1500 V. paper capacitor	L-2-9	Oscillator tuning coils	R-26	100,000 ohms carbon resistor	T-4	B. C. D. antenna coils
C-15	4300 mmf. mica capacitor ±5%	C-47	.002 mfd. 1500 V. paper capacitor	P-1	Dial lamp, Mazda No. 44	R-27	220,000 ohms carbon resistor	T-5	B. C. D. oscillator coils
C-16	.05 mfd. paper capacitor	C-48	.2 mfd. paper capacitor	P-2	Dial Lamp, Mazda No. 44	R-28	180 ohms 3 W. wire wound resistor	T-6	1st I.F. transformer
C-17	50 mmf. mica capacitor	C-49	47 mmf. mica capacitor	R-1	330 ohms carbon resistor	R-29	56 ohms carbon resistor	T-7	2nd I.F. transformer
C-18	750 mmf. mica capacitor ±5%	C-50	47 mmf. mica capacitor	R-2	47,000 ohms carbon resistor	R-30	15 ohms carbon resistor	T-8	3rd I.F. transformer
C-19	7-65 mmf. antenna trimmer	C-51	47 mmf. mica capacitor	R-3	220 ohms carbon resistor	R-32	4700 ohms 10 W. wire wound resistor	T-9	"F.M." 1st I.F. transformer
C-20	20-180 mmf. antenna trimmer	C-52	.01 mfd. paper capacitor	R-4	47,000 ohms carbon resistor	R-33	3000 ohms 3.6 W. wire wound resistor	T-10	"F.M." 2nd I.F. transformer
C-21	20-180 mmf. antenna trimmer	C-53a	40 mfd. 25 V. dry electrolytic	R-6	2.2 megohms carbon resistor	R-34	15,000 ohms 2 W. carbon resistor	T-11	"F.M." 3rd I.F. transformer
C-22	100-490 mmf. antenna trimmer	C-53b	30 mfd. 450 V. dry electrolytic	R-7	330 ohms carbon resistor	R-35	330 ohms carbon resistor	T-12	"F.M." 4th I.F. discrim. transformer
C-23	100-490 mmf. anntena trimmer	C-53c	20 mfd. 450 V. dry electrolytic	R-8	4700 ohms carbon resistor	R-36	330,000 ohms carbon resistor	T-13	Output transformer
C-24	100-490 mmf. antenna trimmer	C-53d	20 mfd. 400 V. dry electrolytic	R-9	1000 ohms carbon resistor	R-37	2.2 megohms carbon resistor	T-14	Power transformer
C-25	0.1 mfd. paper capacitor	C-57	.05 mfd. paper capacitor	R-10	5.6 megohms carbon resistor	R-38	5600 ohms carbon resistor	C-73	20 mmf. MICA CAPACITOR
C-32	0.1 mfd. paper capacitor	C-58	.002 mfd. paper capacitor	R-11	150,000 ohms carbon resistor	R-39	6800 ohms carbon resistor	C-74	5 mmf. COMP. "
		C-60	150 mmf. mica capacitor	R-12	47,000 ohms carbon resistor	R-40	220 ohms carbon resistor		

HM 136 PERFORMANCE DATA·

BAND	FREQ.	ANT. µV FOR 1.0 VOLT ON LIMITER	ANT. µV FOR .5 WATT	ANT. COIL GAIN	R.F. COIL GAIN	I.F. RATIO	IMAGE RATIO
B	1500 Kc.		10	4.4			
	1000 "		11	4.0		910	127
	580 "		9.3	4.5			
C	6.0 Mc.		2.5	18.5			6.7
	4.0		8.0	5.2			14.8
	2.5		25.0	1.8			25.0
D	21 Mc.		9.0	5.6			10
	18		10.0	4.3			9
	15		9.0	4.6			5.8
	12		9.0	5.4			7.7
	10		10.0	4.0			9.2
	8		22.0	2.2			11.6
FM	41 Mc.	20		2.3	7.2	15,000	
	43 "	20		2.3	7.2	15,000	

Fig. 12

Antenna System

In conventional broadcast reception almost anything will do for an antenna, occasionally nothing. However, in f-m reception the preceding remarks should make it plain that every bit of signal amplification is of value here, even as in television. Depending upon the antenna pick-up just as upon the sensitivity of the receiver itself, is the ability of the receiver to go out and pick up distant stations. For local reception a short wire may be adequate, but for all-round reception standard television practice should be followed. To this end, therefore, the input system is designed to work with a dipole antenna, the antenna coil being a balanced center-tapped affair. The General Electric Company has a dipole antenna available designed especially for use with these frequency-modulated receivers. This antenna is of the self-supporting type, incorporating horizontal rods supported on a vertical pole. The location and direction of this antenna is important, as in television practice. For added pick-up a reflector may be used, but when it is considered that f-m transmissions will eventually be available from many stations it is obvious that a reflector would probably be as great a disadvantage as an advantage, as it would reduce the pick-up in one direction, making the dipole sensitive in only one direction. Excellent results can be obtained with any half-wave dipole, whether self-supporting or stretched between two points.

Drift

One serious problem in the design of f-m receivers is the reduction of oscillator drift. This very easily becomes apparent when it is considered that the linear portion of the discriminator curve may be only long enough to accommodate full swings on the signal being received. In this case the receiver must be tuned accurately to the middle of the linear portion for best quality. Now any subsequent drift away from this point will result in distortion being introduced, making it necessary to retune the receiver. Another factor is that the point for minimum random noise background is also quite sharply tuning on weak signals, and drifting will produce more hiss background. On both receivers this problem received special attention. It was found that the drift could not be satisfactorily eliminated by component design, consequently some form of special compensation was incorporated. In both these receivers this takes the form of liquid compensating condensers, 5 mmfd in capacitance, connected through series condensers across the oscillator tank circuit. Additionally, in order to follow the warm-up trend of the receiver, additional heating had to be applied to these compensators. This is supplied by carbon resistor connected across the filament string and located in proximity to the compensator, so that it applied a quick heating to this compensator. The effectiveness of this arrangement can be judged by reference to Fig. 9 which shows the warm-up drift on both sets. As may be noted this drift is of the order of 10 kc, which can be tolerated in the great majority of cases.

Fig. 10 is the schematic of Model HM-80 receiver.

Standard A-m Reception Plus F-m

As can readily be appreciated the problem of combining amplitude and frequency-modulated receptions in the same receiver is not a simple one. Of course, two practically complete receivers can be combined in one cabinet, but this is hardly an economical solution. When the two receivers are combined, and the same tubes used on both receptions as much as possible, some special problems arise. For one thing, the

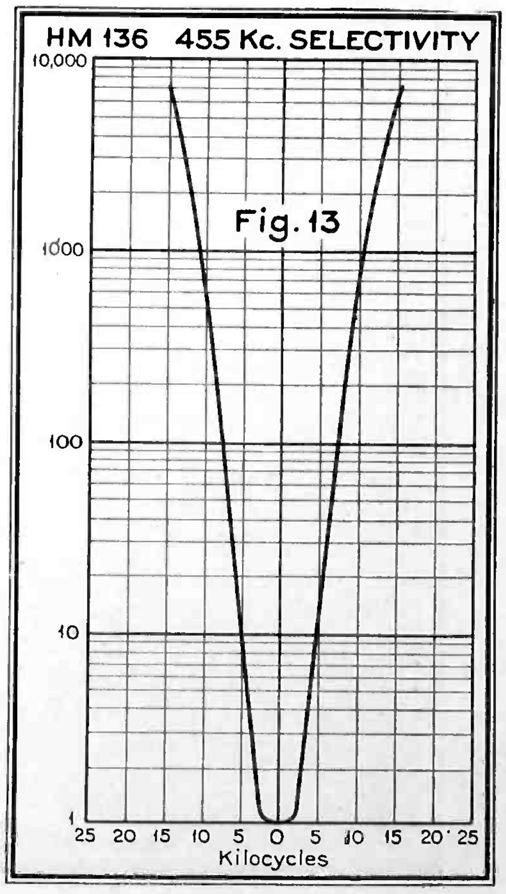


Fig. 13

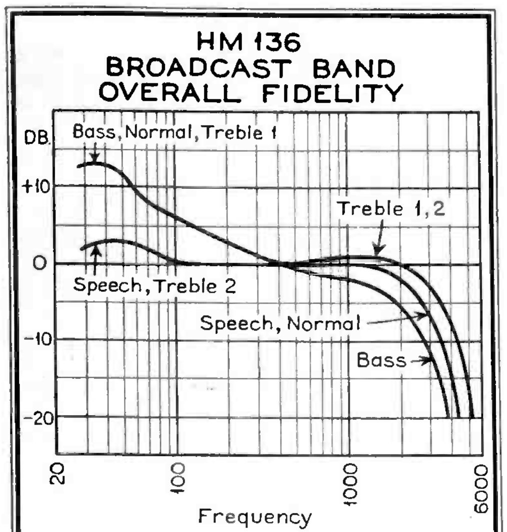


Fig. 14

same i-f cannot properly be used for both usages. The standard 455-kc i-f is altogether too low for use for a f-m amplifier, as adequate band width is impossible to obtain at such a frequency, without tremendous difficulties. Similarly an i-f of about 2 mc would be too high to provide proper selectivity and gain for regular usage, especially when widened out. Thus it becomes evident that the two frequencies must be used, and switched in independently. In model HM-136 this is accomplished by using separate i-f transformers, connected together in the i-f amplifier. In this manner the amplifier becomes responsive to both 455 kc and 2.1 mc. The first i-f transformer must not be responsive to 2.1 mc while on the broadcast band, however, otherwise the oscillator voltage or harmonics thereof will be imposed on the i-f amplifier grid and will cause grid currents to flow, producing dead spots. For this reason the 2.1-mc coil is shorted when not on f-m. The other f-m coils are left in their respective i-f circuits, however.

Another problem is the combining of the outputs of the two systems in one common volume control. This may be solved either by devising a detector system which may be made operative on either a-m or f-m reception, or by using two different detectors and switching the volume control to the proper one. In the former case there is the problem of having unequal numbers of i-f stages in the two systems, as two stages are required for f-m usage, whereas one is usually adequate for a-m reception. Additionally, there is a limiter interposed between the last i-f stage and the detector. In the HM-136 it was felt that the simplest method of overcoming these problems was to use two separate detectors, operating the a-m detector off the output of a single i-f stage. The volume control circuit is switched to the proper system by the band switch, when on f-m band. The frequency correction circuits required by the f-m portion are incorporated prior to this switching point, so that the a-m band is not affected. The audio system otherwise is the same for both uses. The r-f stage in this receiver is not used on other than the f-m band.

Fig. 11 gives the schematic of Model HM-136.

On Fig. 12 is a chart of performance of this receiver on the amplitude-modulated bands. Sensitivity varies from about 10 microvolts on the broadcast band to about 25 microvolts on the higher frequency bands. Fig. 13 gives the over-all selectivity on the broadcast band. Fig. 14 gives the over-all audio fidelity, showing the effect of the various positions of the tone switch.

Speaker

Model HM-80, being a table model, employes a 6½" speaker, utilizing Alnico, permanent-magnet excitation. This provides extremely high excitation, and produces sensitivity and quality exceptional for a speaker of this size. The console model of this receiver, Model HM-85, and the other receiver, model HM-136, both use a 10" speaker, likewise employing Alnico magnet, and equipped with a curvilinear cone. The resultant combination of tone of this speaker and the f-m receivers produces a remarkable audio fidelity.

In conclusion the author wishes to express his appreciation to Messrs. J. A. Worcester, Jr., D. F. Vrooman, and L. Ewing for assistance and for material incorporated in this article.

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BOOK REVIEW

SERVICING BY SIGNAL TRACING, by John F. Rider, published by John F. Rider, Publisher, 404 *Fourth Avenue, New York City,* 1939, 360 *pages, price* $2.00.

A definite need in the service field has been a method for locating trouble in a receiver while it is operating, for only then will certain ills show up. Moreover, such a method should be universal in scope, i. e., it should be applicable to simple t-r-f receivers as well as the most complicated multi-tube superheterodyne and the type of tubes in the receiver should make no difference. In this book the author describes such a testing system, which is based upon the signal, the one thing common to every receiver or piece of electronic equipment.

In his foreword the author states that it is essential that the user of the signal-tracing system be thoroughly familiar with the behavior of the signal in detectors, amplifiers, coupling devices, etc., and so has devoted the first seven chapters of the book to such descriptions. The remaining five chapters deal with the testing procedure itself and how it is applied to receivers, public-address systems, television and facsimile receivers, etc. A chapter is also devoted to signal-tracing instruments and how they are used.

The book is recommended. L. M.

CUMULATIVE INDEX, VOLUMES 1-10 OF THE JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, published by the American Institute of Physics, Inc., 175 Fifth Avenue, New York City, 1939, 131 *pages, paper covers, price* $3.00.

This extraordinary bibliography records not only the articles which have appeared in the *Journal of the Acoustical Society of America,* but also the summaries of contemporary literature on sound which appeared therein. Accordingly, the Cumulative Index may be said to be a bibliography on sound and related subjects covering the world output for the period 1929 to 1930.

Some slight idea of the completeness with which the Cumulative Index has been compiled may be obtained by considering the main classification of subjects: (1) Acoustical Society of America, (2) Architectural Acoustics, (3) Books and Bibliographies, (4) Ear and Hearing, (5) Applied Acoustics, Instruments and Apparatus, (6) Musical Instruments and Music, (7) Noise, (8) Standards, (9) Speech and Singing, (10) Supersonics (Ultrasonics), (11) Waves and Vibrations, (12) General, Unclassified. Most of these main classifications are divided and subdivided in a number of different ways, so that the rapid localization of specific information is a matter of easy accomplishment.

This book is unqualifiedly recommended to the communication engineer who wishes to find references to particular phases of sound and related subjects in a minimum of time. R. L.

RADIO HANDBOOK, Sixth (1940) *Edition, by the Editors of "Radio," published by Radio, Ltd.,* 1300 *Kenwood Road, Santa Barbara, Calif.,* 1940, 600 *pages,* price $1.50.

The 1940 edition of the *Radio Handbook* is a reference manual on the theory, construction and operation of amateur radio equipment. Much of the text of previous editions has been rewritten. Two new chapters have been added: "Introduction to Amateur Radio" and "Transmitter Construction." The chapter order has been changed and gives a more satisfactory progression from fundamental theory through more advanced material. Certain chapters containing related material, presented separately in previous editions, have been combined in this edition.

The book should be useful to anyone contemplating the construction and operation of low-power transmitting equipment. R. H.

THE HOT-CATHODE LOW-VOLTAGE CATHODE-RAY TUBE, by G. R. Mezger, published by Allen B. DuMont Laboratories, Inc., Passaic, New Jersey, 1939, 24 *pages, paper covers, price* 35 *cents.*

This book, although containing a relatively small number of pages, covers a surprisingly large amount of ground. This is accomplished by employing a highly compressed style and by restricting the discussion to the cathode-ray tube itself and by omitting descriptions of associated circuits and applications of the tube.

The first two chapters dispose of the history of the cathode-ray tube and of the operation and disadvantages of the gas-focused tube. The next two chapters then discuss: Electrostatic focusing, Magnetostatic focusing, Electrodynamic deflection, Distortions in electrodynamic deflection systems, Magnetodynamic deflection, Disadvantages of magnetodynamic deflection, Comparison of magnetic and electric systems. The final chapter concerns itself with fluorescent screens, and covers such topics as general screen characteristics, types of screen material, and effect of spot writing-rate. A full page is devoted to an illustration of a cross-sectional view of a cathode-ray tube, including the positioning of the DuMont intensifier electrode.

This is an interesting book and is recommended both to the serious worker in the field of cathode-ray oscillography and to the engineer who is interested in securing general information about the tube. D. B.

MALLORY-YAXLEY RADIO SERVICE ENCYCLOPEDIA, 3rd edition, published by P. R. Mallory & Co., Inc., Indianapolis, Ind., 1939, 264 *pages, paper covers, price* $1.25.

Just as Rider's Manuals have been called the service man's Bible, so might this volume well be named the service man's Koran. No single service man, no matter how wide his experience, could hope to have at his fingertips the information made instantly available on 22,000 radio receivers given in this edition.

The data are tabulated in such a manner as to give instant information on the manufacturer and model, controls, condensers, vibrators, number of tubes in the set, the number and type of all the tubes, i-f peaks, and reference to pages in Rider's Manuals. The data on controls are further broken down to include the function of the particular control, a schematic of the circuit, the Mallory-Yaxley replacement of both control and switch, the bias, and notes.

Following this compilation are three sections devoted to a discussion of controls, condensers and vibrators, respectively. These brief and well-written explanations contain data not available from other sources.

Purchasers of this book can obtain the Mallory Supplemental MYE Monthly Technical Service for one dollar. These excellent supplements contain data on phono-radios, vibrator, power supplies, half-wave and doubler power-supply systems, receiving tubes, to mention a few.

The usefulness of both the Encyclopedia and the Supplemental service will be recognized by the reader. Both are highly recommended. R. L.

THE 1940 *RADIO AMATEUR HANDBOOK, seventeenth edition, by the headquarters staff of the ARRL, published by the American Radio Relay League, Inc., West Hartford, Conn.,* 1939, 456 *pages plus* 120-*page catalog section, paper covers, price* $1.00.

The seventeenth handbook, like its predecessors, is a comprehensive and authoritative manual on amateur radio. There are introductory chapters, four on principles and design, fourteen on construction and adjustment of amateur equipment, five on antennas, and five on ultra-high frequencies. The tabular data on vacuum-tube characteristics is one of the most complete compilations to be found anywhere. A few typographical errors mar the excellence of these tables. In listing the characteristics the title heads call for the output in watts, yet for the low-power battery series the number given is actually milliwatts. The plate and screen current ratings for the type 6W7G are interchanged in the listing as shown.

The 1940 *Radio Amateur's Handbook* is especially recommended to anyone interested in amateur radio and also for its listing of tube characteristics. R. H.

RADIO RESEARCH BOARD: REPORT NO. 14, *BULLETIN NO.* 127, *published by the Council for Scientific and Industrial Research,* 314 *Albert Street, East Melbourne, Victoria, Australia,* 1939, 30 *pages, paper covers.*

This bulletin contains three papers: (1) Further Studies of Directions of Atmospherics at Toowoomba and Canberra, (2) An Aperiodic Amplifier for Investigating the Wave-Form of Atmospherics, and (3) Applications of the Modulating Electrode of Television Cathode-Ray Tubes in Investigations of the Wave-Form of Atmospherics.

In view of the highly localized nature of the first paper, it is not believed to be of general interest and will not, therefore, be commented upon here.

The second paper describes an amplifier for use with cathode-ray oscillographs and has an essentially flat frequency characteristic between 50 cycles and 500 kilocycles. The amplifier is of the compensated type and employs both the choke-resistance method and cathode-resistance method for eliminating the customary attenuation of amplification which occurs at the high frequencies. With the exception of the first tube which is employed as a phase inverter, all stages are connected in a push-pull arrangement. This is done in order to prevent the possibility of deflections of the cathode-ray beam due to fluctuations in the power supply.

The third paper describes an apparatus which "when applied to the modulating electrode of an electron-lens cathode-ray oscillograph tube, prevents the electron-beam current from flowing except when a deflecting voltage in excess of a defined minimum is present between one pair of deflecting plates, and/or for a predetermined time following the occurrence of a specified deflecting voltage." R. L.

PROCEDURES IN EXPERIMENTAL PHYSICS, by John Strong, in collaboration with H. Victor Neher, Albert E. Whitford, G. Hawley Cartwright, and Roger Hayward, published by Prentice-Hall, Inc., 70 *Fifth Ave., New York City,* 642 *pages, price* $5.05.

Prof. Strong says in his preface: "The ideal way to learn the procedures of experimental physics is by direct contact with them in the laboratory. Realizing this, we have endeavored to bridge the gap between laboratory demonstrations and experience, on the one hand, and exposition on the other, by the liberal use of figures."

In this avowed purpose, the book has been successful. The expositions are written in a clear, often non-technical style, yet with full mathematical formulae. The working directions and laboratory procedure are set forth in a simple unmistakable manner, aided by excellent illustrations.

In addition to chapters on electrometers and electroscopes, photocells, construction and design of apparatus, there are also chapters dealing with the operations of glassblowing, optical work, gauges and pumps, coating of surfaces, counters, vacuum thermophiles, photography, optics, thermostats, and molding and casting. There is also a concise description of the principal metals and elements, as well as alloys.

We recommend this book for the research engineer, the laboratory technician, and others interested in the background and application of experimental physics. T. H.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary

Honolulu

THE Honolulu Chapter, variously known by several nicknames—Surfboard, Hula Hula, Wakiki, etc.—purposely delayed the annual meeting from February until the evening of April 6th in order to do special honor to the retired president, John Adrian Balch, of the Mutual Telephone Company, Ltd. (of Hawaii). The Honolulu meeting was held at the Pacific Club and was attended by many communications people, including Commander H. L. Thompson, DCO, 14th Naval District; Captain Raymond C. Maude, United States Army Signal Corps; S. B. Maddams and others from Mackay Radio; M. Axelrod of Commercial Pacific Cable; Lee Dawson, Federal Communications Commission; George Street, Superintendent of RCA Communications and Chairman of the Honolulu Chapter and Toastmaster of the evening; H. B. Morris, G. Paul Gray and A. McLain, all of RCA Communications. The Civil Aeronautics Authority was represented by Mr. Banks and there was a good turnout from Pan-American Airways, Press Wireless the Army and the Navy and the Coast Guard and some outstanding amateurs.

The outstanding event of the evening was the presentation of a VWOA Wireless Pioneer Medal to Mr. Balch. The medal was engraved: "Wireless Pioneer Medal awarded to John A. Balch, Wireless Pioneer 1907-1940, Territory of Hawaii, April 6, 1940."

In graciously accepting this outstanding recognition by our association, Mr. Balch interestingly related his early experiences in wireless in the Territory. Earlier in the day the presentation had been made by Mr. Street to Mr. Balch in the Patio of the Moana Hotel at Wakiki Beach, where there was an audience of more than five hundred people. The presentation at the Moana Hotel was broadcast on the "Hawaii Calls" program to the mainland and thence over the coast-to-coast network of the Mutual Broadcasting System in the United States.

We at headquarters very much appreciate Mr. Balch's acknowledgment of the Wireless Pioneer Medal awarded him by our Association. Mr. Balch wrote our President as follows:

"I wish you to know how deeply I appreciate the honor of receiving recently the Wireless Pioneer Medal of your Association.

"Presentation of this medal was first made over the Mutual Broadcasting System on the program 'Hawaii Calls,' on Saturday, April 6, 1940, and again that same evening at a dinner at the Pacific Club, this city, of the Honolulu Chapter of your Association.

"During the thirty-three years that I have been active in communications in Hawaii it never occurred to me that I would ever be singled out as recipient of this great honor, so therefore its complete unexpectedness greatly added to my deep appreciation of your thoughtful action.

"With very kind regards and trusting that we may some day have the pleasure of meeting, either here in Hawaii or in New York City, I am very sincerely (Signed) J. A. Balch."

We congratulate George Street, Honolulu Chapter Chairman, on a splendid program at the annual meeting of the Surf-Board Chapter.

Personals

Glad to hear from A. F. Wallis, Mackay Radio District Manager in New Orleans, on his recent trip to New York. . . . J. F. De Bardeleben will be glad to hear from old-timers in the Houston area. . . . The Los Angeles Chapter under the direction of Messrs. Styles, de Forest and Bremmer have been doing a bang-up job in rounding up new members among the veteran wirelessmen in the Los Angeles area. . . . Gilson Willets, Chairman of the San Francisco Chapter, will appreciate cooperation of all interested in furthering the program of "De Forest Day" at the San Francisco Fair. . . . Our prexy, who has written this page since its inception, has been extremely busy lately—which explains the absence of a "News" page in the May issue. . . . Our secretary has also been very much occupied in his daily work, but will be most pleased to receive your dues for this year. . . . The indulgence of those who have written desiring information recently is requested. We hope to get out from under the many details of business and have more time to devote to VWOA activities. . . . Remember "Wireless Pioneer's Day" at the New York World's Fair in August. Those interested please communicate with us at Radio City. . . . Bill Simon, our energetic treasurer, has been most active equipping United Fruit ships with the latest radio communications devices.

Medal of Merit

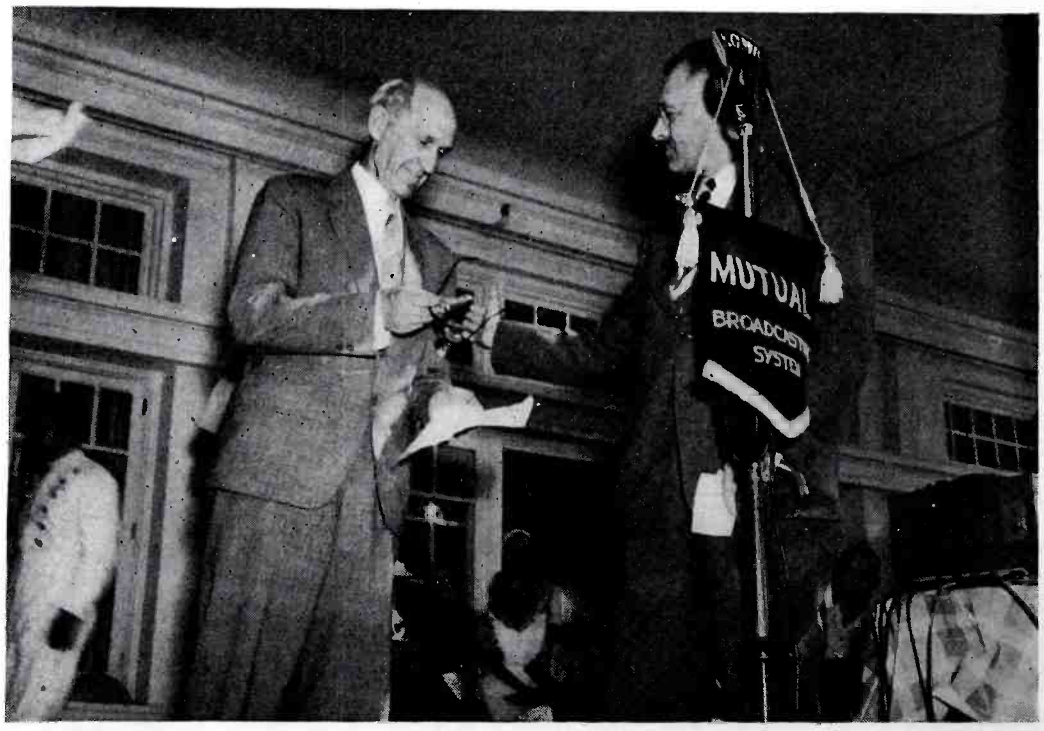
The Marconi Memorial Medal of Merit of our Association was awarded, this year, to Admiral Stanford C. Hooper, U. S. N., for Meritorious Radio Service in building up the Naval Communications system of the Navy into the finest in the world.

Admiral Hooper, who was aboard the *S. S. Brazil* en route to New York at the time of the presentation wirelessed in his own "fist" as follows:

"Mr. Toastmaster and Gentlemen—From smooth seas just off the beautiful harbor of Rio Janeiro I acknowledge your kind remarks in my behalf and accept with great pleasure and gratitude the Marconi Medal of Merit.

"I wish I could feel deserving of the compliment. My only regret is one that you can appreciate, that is, absence while on line of duty at sea. I have had the pleasure of knowing many of your members since their first venture into the radio field and have had great pride in their achievements. Their well being has been one of my greatest interests.

"Your organization is unique in that once a year it records in the annals of history the names of those radio operators who have been responsible for the saving of human lives and property through their



John A. Balch (left), retired president, of the Mutual Telephone (and Wireless) Co., of Hawaii, receives Pioneer Medal from VWOA Honolulu Chairman, George Street. MBS "Hawaii Calls" program, April 6, 1940.

courage, skill and devotion to duty. Such an organization will never perish.

"My regards to you all, especially the old-timers who carried me to success, and to your President, Mr. McGonigle, your zealous Secretary, Mr. Clark, and to Mr. Sarnoff, who has transmitted your greetings on the key, and whose salvos have fallen so pleasantly on my ears at a distance of over five thousand miles. In the name of Marconi whose memory we all revere I submit my '73.'—S. C. Hooper, Rear-Admiral, U. S. Navy."

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TELEVISION FUNDAMENTALS

(*Continued from page* 16)

Film scanning, of course, is very necessary for a sustained service. The need for dependable scanners is met in the devices of Figs. 27 and 28. Both are capable of switching from one film to another without interruption.

Typical of the theatre projectors for television reproduction is the Fernseh A. G. high-potential cathode-ray unit of Fig. 29. This unit operates with a second anode potential of from 60 to 80 kv. The objective lens has an aperture of f 1.9. A projected image of approximately 10 x 12 feet can be obtained.

German transmitting apparatus of the transportable type is illustrated by the photographs of Figs. 30, 31, and 32. Fig. 33 shows the amplifier arrangement on the television stage of Deutschsland Hauses. Two cathode-ray tubes allow monitoring of two channels. The sound and vision control desks are shown in Fig. 34. Fig. 35 is a view of the television transmitter of the Reichspost in Berlin. Complete monitoring facilities are likewise provided.

(*To be concluded*)

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COLOR TELEVISION

(*Continued from page* 8)

the cathode-ray tube at the receiver. External to the existing transmitting or receiving system are the mirrors or prisms which effect the superposition of the separately colored images into a single picture.

Several methods are described whereby the colored images are each separately scanned in toto or else the separate colors are scanned sequentially line by line. No additional frequency bandwidth is necessary for the psychological effect of color upon the eye is such that even for a considerable decrease in detail when the picture is in color the eye apparently sees more detail than it would in a black-and-white picture having much greater detail. In the case of the present invention the effect of color is believed to counterbalance the greater detail of a black-and-white picture where both use the same width of channel.

One of the important features of this invention is the fact that only a single cathode-ray beam is utilized for the purpose of scanning the television picture at both the transmitter and receiver. In other words, the essential constructional details of existing photoelectric pickup tubes at the transmitter and the cathode-ray tube at the receiver are unchanged. The only modification of these tubes are the separation of the sensitive photoelectric surface of the photoelectric pickup tube into either two or three separate areas, and a similar division of areas in the case of the cathode-ray tube used at the receiver. When the primary color system is employed these separate areas may either have a coating sensitive to red, green and blue, respectively, or else may utilize a uniformly coated screen which responds to each of the three primary colors. In this latter case it is obvious that the change needed to adapt existing pickup tubes and receiving cathode ray tube is but a minor matter. Furthermore, even the necessity for external color filters may be dispensed with when, as is suggested by the inventor, the glass envelope of the tube be colored so as to act as a color filter. In this latter event the only additional auxiliary equipment needed at the receiving end to receive colored images instead of the usual black-and-white images is the external attachment of a simple mirror or prism system to cause the superposition of the variously colored images. The problem, therefore, of the transmission and reception of television images in natural color becomes almost as simple as that for black-and-white, and, since this system requires none of the expensive complications inherent in colored moving pictures, it would appear that natural color will become a practical reality in the field of television sooner than will be the case for the cinema despite the fair degree of success that has been experienced in this latter field. It also remains within the realm of possibility that this new television system may be slightly modified to adapt it to lowering production costs of colored moving pictures.

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OVER THE TAPE

REINIGER JOINS R. E. L.

Lt. Colonel Gustavus Reiniger, who pioneered network broadcasting as a salesman for National Broadcasting Co., has joined Radio Engineering Laboratories, Inc., as a Sales-Manager . Gus Reiniger is well known in many of the broadcasting stations in the United States.

PHEOLL CATALOG

The Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, have issued their 1940 catalog. The products listed in this catalog include various types of screws, washers, bolts, nuts, rods. Copies are available from the above organization.

DRIVER-HARRIS PUBLICATION

The Driver-Harris Co., Harrison, N. J., have recently issued Vol. 1, No. 1, of a new house organ. Known as the *D-H Alloy Craftsman*, the publication will be sent free to engineers requesting it from the above organization.

AUDAK BULLETIN

Audak Co., 500 Fifth Ave., New York City, have recently issued a new bulletin describing their Audax high-fidelity cutter for broadcast station and studio recording purposes. Copies are available from the above organization.

TELEX PRODUCTS BULLETIN

Telex Ponducts, Co., Minneapolis, Minn., have made available a bulletin covering electronic testing equipment. Telex products described in this bulletin include a cathode-ray oscillograph, beat-frequency audio oscillators and a beat-frequency standard signal generator.

KAINER BULLETIN

Kainer & Co., 763 W. Lexington St., Chicago, have issued Bulletin D41, illustrating and describing their latest sound projectors and exponential horns. Copies may be obtained directly from Kainer.

JEFFERSON-TRAVIS MOVES

Substantial growth in demand for radio telephone equipment, by owners of both pleasure and commercial boats, is said to be reflected in the recent move of Jefferson-Travis Radio Manufacturing Corp. from Baldwin, New York, to their larger and more adequate quarters at 136 West 52nd Street, New York City.

RADIO CITY CATALOG

Radio City Products announces publication of a new test equipment catalog. Noteworthy in this issue (Catalog No. 122) is the addition to the RCP line of several new test instruments. Free on request at Radio City Products, 88 Park Place, New York City.

KEN-RAD BOOKLET

The Ken-Rad Tube & Lamp Corporation, Owensboro, Kentucky, has just published a valuable and informative booklet, "Receiving Tube Handbook—Recommended Types for New Receivers." The handbook shows the ratings, characteristics and curves on types of receiving tubes sufficient in number and circuit function to meet design requirements of most radio receivers.

ASSOCIATED RESEARCH MOVES

Associated Research, Inc., have announced the removal of their laboratory, manufacturing facilities and offices to 431 S. Dearborn St., Chicago. The telephone number is HARrison 2544.

SCHOLLHORN HAND BOOK

The Wm. Schollhorn Co. of New Haven, Conn., has announced the publication of an engineering hand book. This book, consisting of seventy-three pages, gives full-sized detailed drawings of all their Bernard pliers and plier action tools. The book is the loose-leaf type so that any page may be removed for use on a drawing board and then replaced.

PERMAX BULLETIN

The latest bulletin issued by Permax Products, Niagara Falls, N. Y., describes the MM-125 Monel antenna. These antennas are said to be corrosion resistant under all normal service conditions.

KENYON CATALOG

A very attractive and useful catalog has been made available by the Kenyon Transformer Co., 840 Barry St., New York City. Rather complete data are given on the Kenyon line of transformers and filters. In addition there are five useful charts for easy computation of various quantities. Write to the above organization.

UNITED CINEPHONE MOVES

The United Cinephone Corp. have announced the removal of their offices and plant from 43-47 33rd St., Long Island City, N. Y. The new and larger quarters are located at Torrington, Conn.

ALLIANCE FACTORY

Due to increased business the Alliance Mfg. Co., Alliance, Ohio, have found it necessary to move to a new and larger factory. The new factory represents an expansion of more than twice the size of the company's former quarters.

TELEVISION CAMERA APERTURE PATENT

To Harry R. Lubcke, Director of Television for the Don Lee Television System, this week went U. S. Patent No. 2,185,640, which concerns the achievement of optical apertures for television use many times smaller than the physical apertures which are now utilized. Means are also shown in the patent application for insuring accurate time relation between synchronizing and image pulsations.

TERMINAL CATALOG

Terminal Radio Corp., 80 Cortlandt St., New York City, have issued their latest public-address catalog. The 12-page book illustrates and describes their line of amplifiers, tuners, microphones, phonograph motors and pickups, speakers and other sound equipment. Copies may be obtained directly from Terminal.

BURTON-ROGERS BULLETINS

Two interesting bulletins have recently been made available by the Burton-Rogers Co., 857 Boylston St., Boston, Mass. One bulletin deals with Hoyt Electrical meters, while the second one covers aerials and aerial accessories for police and fire car use. Copies may be secured by writing to the above organization.

SOLAR BULETINS

New bulletins released by Solar Mfg. Corp., Bayonne, N. J., cover the Solar Red Cap dry electrolytic condensers and the new Solar test instrument known as the Solar Condenser Quick-Check. Both bulletins are available on request.

HARVEY-WELLS APPOINTMENT

To meet the increasing demand for special radio equipment, Harvey-Wells Communications, Inc., of Southbridge, Mass., has added another engineer to their staff. . . . Mr. Lester S. Lappin. A graduate of Massachusetts Institute of Technology, Mr. Lappin will devote his time to the engineering of special equipment for police, aircraft, marine, governmental and commercial services.

RCA BULLETINS

The RCA Manufacturing Co., Inc., Camden, N. J., have recently issued two interesting bulletins. One of these, available from the Aviation Radio Section, covers the AVR-20 aircraft communication receiver. The second bulletin deals with speech-input equipment such as the 41-C three-channel preamplifier, 40-D de luxe program amplifier, 94-D de luxe monitoring amplifier, 40-C standard program amplifier, 41-B standard preamplifier, 15-B standard meter panel, 15-C illuminated meter panel.

CHANGE OF NAME

The name of Air Devices Corp., Meriden, Conn., has been changed to Connecticut Telephone and Electric Corp. The announcement was made by Harold W. Harwell, president of the company.

CATHODE-RAY TUBE CHARACTERISTICS

Technical bulletins covering 3-inch and 5-inch cathode-ray tubes for oscillograph applications, are available from Allen B. Du Mont Labs., Inc., 2 Main Ave., Passaic, N. J.

These bulletins cover the various characteristics of c-r tubes in considerable detail, together with installation notes, typical power supply, positioning circuit, base connections and dimensions of each tube.

RAYTHEON CHARACTERISTICS CHART

Raytheon Production Corp., 445 Lake Shore Drive, Chicago, have issued their latest Characteristics Data Chart. The 28-page chart lists characteristics for 331 receiving tube types, 56 plug-in resistors and 16 pilot lamps. It includes 121 basing diagrams, 52 outline drawings and a table of 194 interchangeable types.

DU MONT TELECASTING LICENSE

A construction permit for a television broadcasting station in New York City has just been granted by the Federal Communications Commission to the Allen B. Du Mont Labs., Inc., of Passaic, N. J. Work has already begun on the transmitter and studios which will be located on the top floor of the 42-story office building at 515 Madison Avenue.

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THE MARKET-PLACE

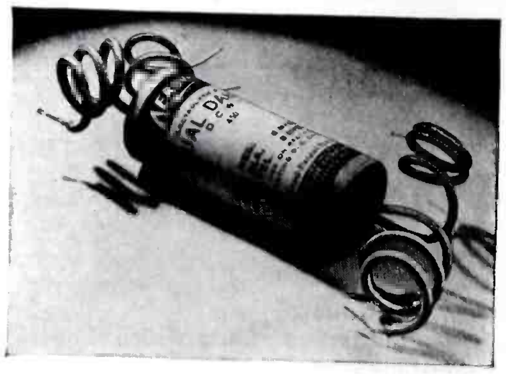
PORTABLE AMPLIFIER

Newest portable speech input equipment announced by Western Electric Co., 195 Broadway, New York City, features durable lightweight duralumin construction and complete studio channel amplifier and control facilities in an extremely small space. The new volume indicator, calibrated in vu., which the Bell System and the major networks collaborated in standardizing for network broadcasting, is employed in this unit. Known as the type 22D Portable Speech Input Equipment, the new apparatus is designed to operate from microphones of 30 ohms impedance into wire lines. Facilities for a degree of equalization is also provided when used with cable loops. The frequency response of the equipment is flat within one db from 30 to 10,000 cycles. Flexibility of operation is gained through the use of four parallel mixers and a master gain control.

AEROVOX MIDGET ELECTROLYTICS

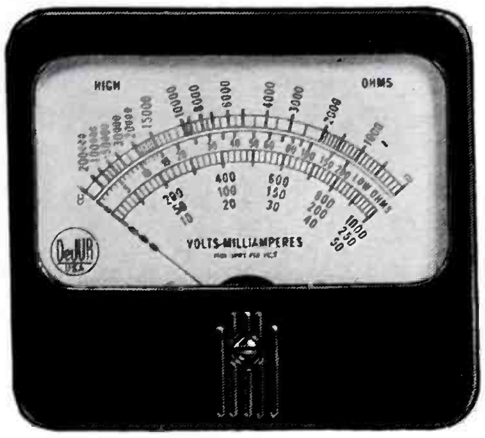
Smaller dimensions and two independent sections with four leads distinguish the PRS dual Dandees added to their line of midget-can electrolytics by Aerovox Corp., New Bedford, Mass.

The PRS 450 8-8 and the PRS 250 16-16 measure 1 x 2½ in., while the PRS 150 20-20 measures 1 x 2¼ in.



DEJUR-AMSCO METERS

The DeJur-Amsco Corp., Shelton, Conn., announces its entrance into the meter manufacturing field and is now in production on a complete line of DeJur ammeters, milli-



ammeters, microammeters and volt-meters in 2-inch, 3-inch and 4-inch sizes, round and square cases. This line is primarily intended for manufacturers of radio, recorder, transmitter, service and miscellaneous electrical equipment.

RME-99

The accompanying illustration shows the RME-99 12-tube communications receiver. This receiver features a 6-position variable crystal selectivity control, a voltage regu-

lator tube, wide-spaced tuning condenser for stability, calibrated band-spread dial, loktal type tubes, automatic noise limiter. Frequency coverage is from 540 to 33,000 kc. Radio Manufacturing Engineers, Inc., Peoria, Ill.

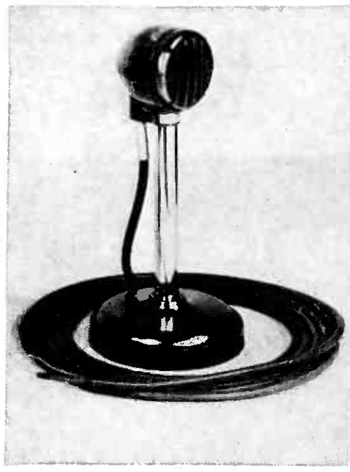
JENSEN PROJECTOR

Thomas A. White, vice president and sales manager of Jensen Radio Mfg. Co.,

6601 S. Laramie Ave., Chicago, announces the Type S Peri-dynamic projector. This projector employs a heavy duty p-m speaker capable of handling 15 to 25 watts.

CRYSTAL MICROPHONE

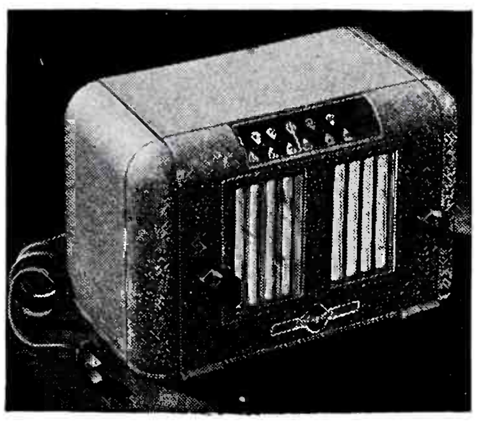
Universal Microphone Co., Inglewood, Cal., on May 1 issued a new loose-leaf catalog sheet announcing a new microphone



item in the form of the "KO" Model, with stands and accessories. "KO" is heralded as a new high output crystal unit with slightly rising frequency characteristics together with tonal quality with well rounded bass response. The output level is 48 db below one volt per bar and the frequency range from 50 to 6,000 cps.

P-A TUNER

A handy little 5-tube p-a tuner, designed to provide radio input to any amplifier system has just been introduced by Radio

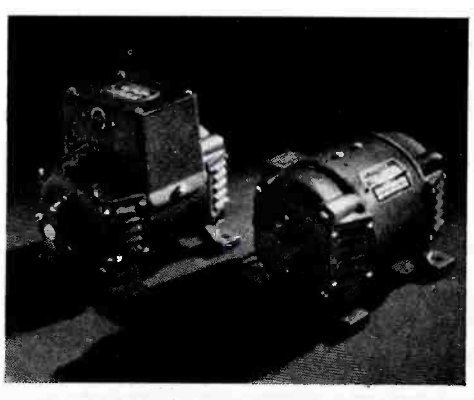


Wire Television, Inc., 100 Sixth Avenue, New York City.

The 5-tube superheterodyne circuit utilizes 6A7, 6D6, 6Q7G, 41 and 80 tubes and provides coverage of the entire broadcast and adjacent ranges to 1800 kc. A built-in, tuned loop is used with connections also provided for use of external antenna if desired.

ROTARY CONVERTER

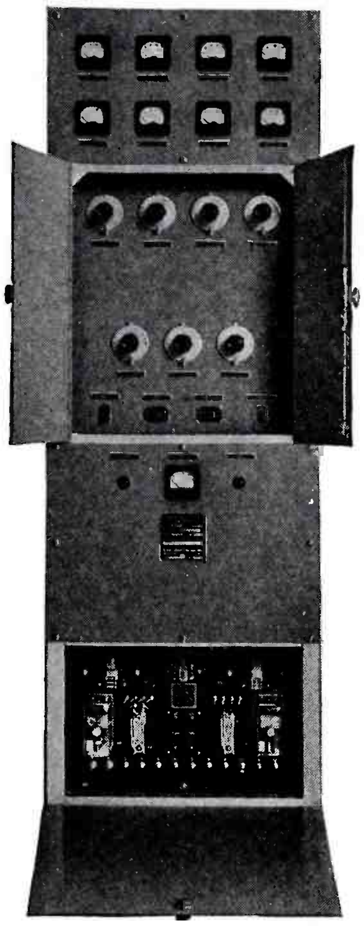
A new line of rotary converters has just been announced by Pioneer Gen-E-Motor Corp., 466 West Superior St., Chicago.



This line of Pincor rotary converters is said to be complete, comprising units of every size, type and capacity for operating radio receivers and transmitters, power amplifiers, public-address systems, electrical musical instruments, gaseous signs, and other equipment requiring alternating current. These converters are available less filter or with filter for converting 6, 12, 24, 32, 48, 110, 220 or any special voltages d-c to 110 or 220 volts a-c—capacities: 40 to 5,000 watts. A copy of a new catalog, No. HC-4-40, is now available.

AIRPORT TRANSMITTER

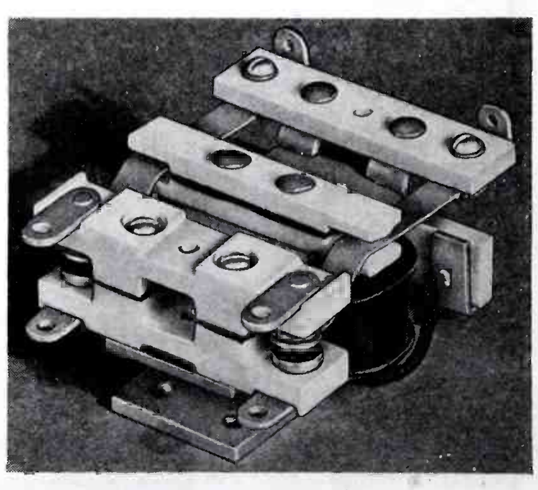
The ultra-high-frequency airport traffic control transmitter shown in the accom-



panying illustration has been made available by Radio Receptor Co., Inc., 251 W. 19th St., New York City. Designated as Model 421, this unit is said to give a power output in excess of 100 watts in the frequency range of 128 to 132 megacycles. Literature is available from the above organization.

KURMAN RELAY

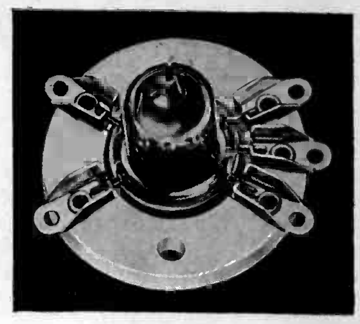
The Kurman Electric Co., Inc., 241 Lafayette St., New York City, have announced their Relay No. 25. This unit is designed for medium contact load and low



power input . . . it is said to have high r-f insulation. Complete information may be secured by writing to the above organization for Bulletin No. 250.

ACORN TUBE SOCKET

The new Hammarlund UHS-900 acorn tube socket is shown in the accompanying illustration. Its contacts are silver-plated



beryllium and are provided with grooves so that the tube snaps into place, permitting the socket to be mounted in any position. This new socket has a metal shield which, when used with the pentode type acorn tube, completes the shielding of the tube. Further information may be secured from Hammarlund Mfg. Co., Inc., 424-438 W. 33rd St., New York City.

NON-INDUCTIVE RESISTORS

To take care of applications calling for non-inductive resistors capable of handling appreciable power, the Clarostat Series Z resistors are made available. These re-

sistors are offered by Clarostat Mfg. Co., Inc., 285-7 N. Sixth St., Brooklyn, N. Y. Claimed to have the least inductance of any presently available non-inductive resistors, they are available in these wattages and resistance ranges: 10-watt, maximum resistance 3000 ohms; 25-watt, 7500 ohms; 50-watt, 12,500 ohms; 100-watt, 25,000 ohms. For one-half these power ratings, multiply the maximum resistance avail-

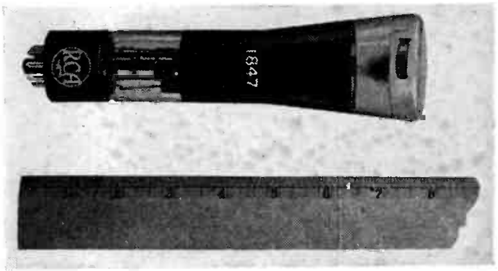
A-M AND F-M RECEIVER

The rapidly growing need among commercial engineers, amateurs and experimenters for a receiver to cover the regular and experimental services utilizing wavelengths down to 2 meters is met by the new Model S-27 just announced by Hallicrafters, Inc., 2601 S. Indiana Ave., Chicago. It not only offers continuous coverage of 27 to 145 megacycles in three ranges of 27-46, 45-84 and 81-145 mc, but provides

for reception of both amplitude and frequency modulated signals.

RCA-1847

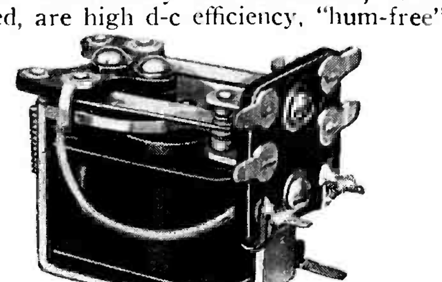
The RCA Radiotron Division, RCA Manufacturing Co., Inc., Harrison, N. J., have made available a new iconoscope for amateur and experimental use. Designated as the RCA-1847, it makes possible the



construction of compact, electronic television system at reduced cost. This tube can provide a 120-line, 30-frame picture suitable for transmission in the 2½ or 1¼-meter band. It operates at relatively low voltages, employs inexpensive electrostatic-deflection circuits, does not require keystone-correcting circuits, and can utilize low-cost, short-focal-length lenses.

MIDGET RELAY

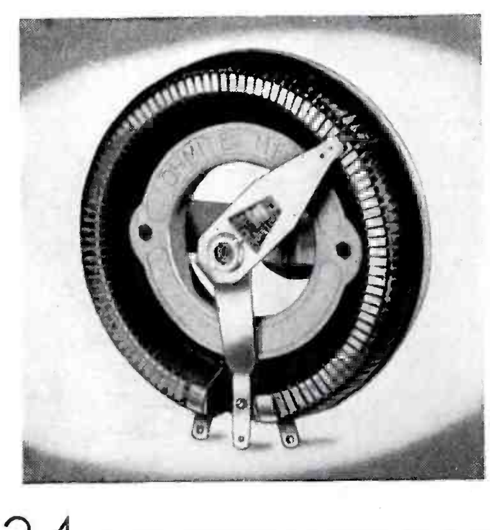
Of interest in applications where size is of importance is this new midget relay shown. Noteworthy characteristics, it is claimed, are high d-c efficiency, "hum-free"



a-c operation, and a wide range of coil voltages. Actual dimensions are 1½" by ¾", and mounting, on any type of panel, is permissible due to the ungrounded construction. Complete technical data and price information may be obtained by writing The Advance Electric Company, 1260 W. 2nd St., Los Angeles, Calif.

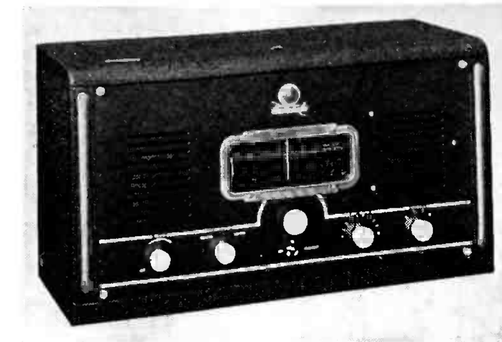
OHMITE RHEOSTAT

"Model T" 750-watt vitreous enameled rheostat is now offered by Ohmite in addition to their already wide range of rheostats. This new unit, fills in between the 500 and 1000-watt types. It is 10" in diameter, with a ⅜" shaft. Regularly supplied to mount on panels up to 1¼" thick. Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.



MARINE RADIO

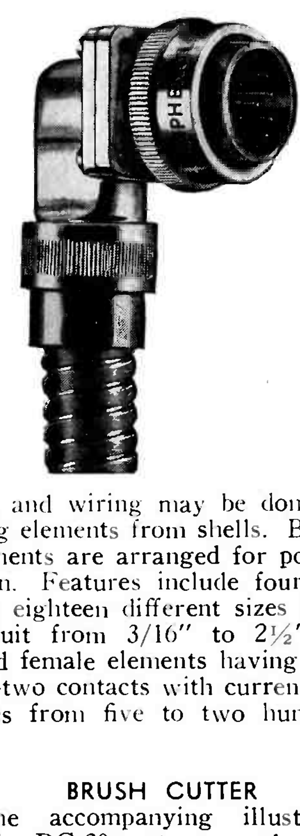
This new Harvey-Wells development was designed to provide commercial and pleasure boats with the convenience and safety offered by the land telephone. Good frequency stability, accurately calibrated "slide rule" dial, broadcast band, X band



reception for weather reports and beacons, "push-to-talk" operation, and choice of two colors are features of this unit. Receiver, transmitter and power supply are all housed in a single, compact cabinet 19¾" wide, 10¾" high and 8¼" deep. Harvey-Wells Communications, Inc., Southbridge, Mass.

ELECTRICAL CONNECTORS

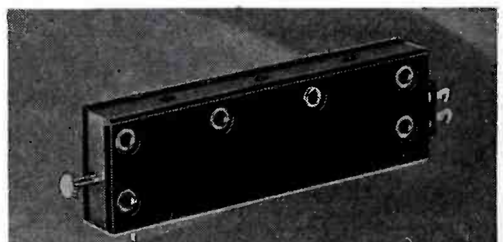
A new series of electrical connectors for aircraft, marine, electrical, electronic, railway and industrial applications is announced by American Phenolic Corp., 1250 W. Van Buren St., Chicago. "AN" shells are of aluminum, elements of high dielectric



bakelite, and wiring may be done without removing elements from shells. Both shells and elements are arranged for positive polarization. Features include four types of shells in eighteen different sizes for cables or conduit from 3/16" to 2½" O. D.; male and female elements having from one to forty-two contacts with current carrying capacities from five to two hundred amperes.

BRUSH CUTTER

In the accompanying illustration is shown the RC-20 cutter recently developed by the Brush Development Co., 3311-25 Perkins Ave., Cleveland, Ohio. The RC-20 is said to be a high-quality, inexpensive type of cutter which can easily be adapted



to commercial recording turntables. It is of the crystal actuated type and designed for engraving lateral cut records. The frequency response is uniform from 50 to 9,000 cycles within plus or minus 3 db. In addition its efficiency is said to permit the use of driving amplifiers of relative low output. This cutter will engrave commercial "constant velocity" such as is used in the production of commercial phonograph records, or it may be used for cutting "constant amplitude." Either of these methods is possible by proper selection of coupling components. Further information may be secured from the above organization.

ELECTRO-VOICE DYNAMIC

The Electro-Voice 605 dynamic microphone utilizes an aluminum voice coil, polystyrene insulated; Zamak-3 castings; Durev diaphragm; Armco magnetic iron circuit; Alnico magnet and weighs 15

ounces. It has a frequency response from 45 to 8,000 cycles, output, —57 db and is available in several impedances.

Additional information may be obtained directly from Electro-Voice Mfg. Co., Inc., 1239 South Bend Ave., South Bend, Ind.

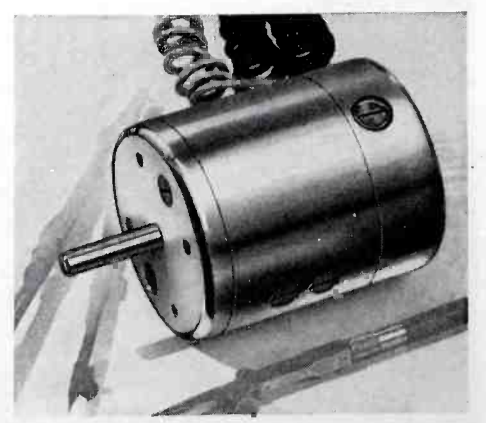
ATLAS P-M UNITS

Atlas Sound Corp., 1449-39 St., Brooklyn, N. Y., announce a new line of Dyna-Flux compression type Alnico p-m speaker units to be used in conjunction with Atlas Morning Glory reflexed Projectors. The units feature electro-chemically treated non-corrosive diaphragms that are also heat treated for protection against fatigue, crystallization and shattering, it is said. Three models are available with ratings from 18 to 20 watts.

Additional information may be obtained directly from Atlas.

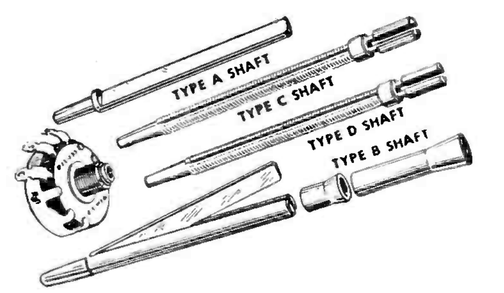
EICOR MOTOR

A new, small size, lightweight motor offered by Eicor is 2-5/16" in diameter, 2¾" long, weighs 1½ pounds, and delivers 1/13 hp at 8500 rpm. Eicor now offers motors in a range of sizes for all aircraft and similar applications. Eicor, Inc., 515 S. Laflin St., Chicago.



IRC PLUG-IN SHAFT CONTROLS

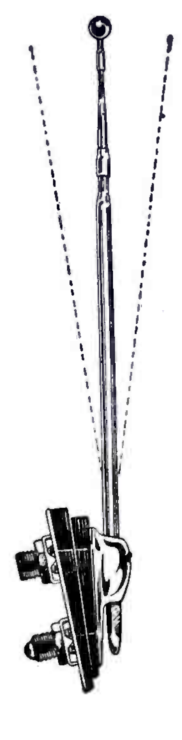
With the addition of a line of plug-in shafts, the International Resistance Co., 401 N. Broad St., Philadelphia, Pa., recommends their IRC midget controls for use in practically every control replacement which the Service Man is called upon to make. A comparatively small stock of the most popular midgets will handle the large majority of jobs, it is said.



Type A shaft, a standard 3" brass shaft with flat, is supplied with all IRC midget controls. Also available are the Types B, C and D shafts which meet most present day requirements for auto radio receivers and for other receivers requiring knurled, unknurled or split shafts. Shafts have tapered ends and may be driven securely in place in the control socket by a light tap with a hammer or other tool. A copy of the 1940 Supplement to the IRC Volume Control Guide, giving details as well as listing replacements for most radios introduced since Vol. 2 of the IRC Guide, will gladly be sent upon request.

WARD PRODUCTS TRI-MOUNT

Ward Products Corp., Cleveland, Ohio, announce their Tri-Mount, three purpose auto-radio antenna. The aerial may be mounted on the car in any one of three positions: alligator, underhood, or hinge. They are completely assembled and include a three-way lead and Uni-plug. Installation brackets are also supplied.



Additional information on these and other Ward Products may be obtained directly from Ward.

UTAH PRODUCTS

Utah Radio Products Co., 812 Orleans St., Chicago, announce a Baflex reproducer, a bi-directional speaker and a wall type reproducer.

The Baflex reproducer features absence of rear radiation and has a range to 9,500 cycles, it is said. The bi-directional speaker features a moulded non-metalic baffle and a swivel mounting joint. The wall reproducer also has a non-metalic moulded housing and an angle mounting bracket. Additional information on these and other Utah products may be obtained directly from Utah.

SPRAGUE DELUXE TEL-OHMIKE

A new, deluxe Tel-Ohmike condenser and resistor analyzer, announced by the Sprague Products Co., North Adams, Mass., includes built-in voltmeter and milliammeter with switch and pin-jacks provided so that the meters may be used for measurements external to the instrument.

Meter ranges, selected through an 8-position switch, are 15, 150, 500, 1500 volts d-c, and 1.5, 15. and 50 ma d-c.

Otherwise, the deluxe model is the same as the standard Tel-Ohmike announced some time ago by Sprague.

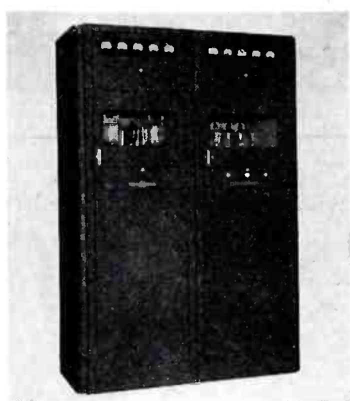
GENERAL ELECTRIC TUBE

The GL-266-B has been announced as a new addition to the General Electric line of tubes for broadcast service. It is a

high-power, high-voltage, mercury-vapor rectifier, structurally similar to the GL-857-B and completely interchangeable with other 266-B's. The new tube is forced-air-cooled, and has a shielded-filament cathode operating at 5 volts and 30 amperes, with a heating time of one minute. General Electric Co., Schenectady, N. Y.

COLLINS TRANSMITTER

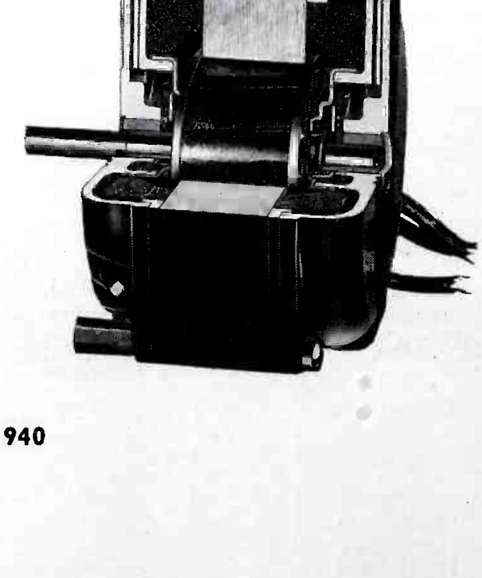
High-frequency transmitters with power outputs ranging from 500 to 3000 watts embodying the Autotune frequency changing device are manufactured by the Collins Radio Co., Cedar Rapids, Iowa. The 231C



Autotune transmitter, shown in the accompanying illustration, is designed for all high-frequency services. Ten frequencies may be selected at random throughout the range of 2500 to 20,000 kc. A special bulletin describing this transmitter in detail may be secured from the above organization.

BODINE MOTOR

This new motor is small in size 2⅜" wide and high, with 1⅝" overall length, excluding the ⅝" long shaft. It weighs less than 1½ lbs. Designed as a capacitor



motor, it can be supplied with three different windings—synchronous capacitor, non-synchronous capacitor, and dynamic braking capacitor. Standard ratings on 60 cycles are, respectively, 1/1500 hp at 1800 rpm, 1/1000 hp at 1700 rpm, and 1/1500 hp at 1200 rpm. Motor input is 8 watts or less. Bodine Electric Co., 2266 W. Ohio St. Chicago, Ill.

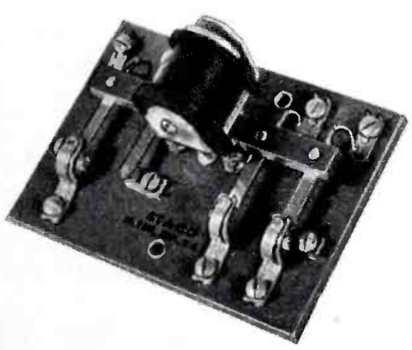
WEATHERPROOF HORN

In the accompanying illustration is shown the Kainer Model W-H-8 horn, constructed for unsheltered outdoor and indoor uses in factories, airports, sound trucks, police and fire cars, stadiums, etc. The bell and housing are spun of heavy

gauge steel alloy. Bell opening 22¾", overall length 17¾", height from base 27". Complete information from Kainer & Co., 763 W. Lexington St., Chicago.

STACO RELAYS

The unit shown in the accompanying illustration is one of the new line of Staco relays designed for radio-frequency and high-voltage application. These units are



low priced and may be used for general control purposes. More information by writing Standard Electrical Products Co., 317 Sibley St., St. Paul, Minn.

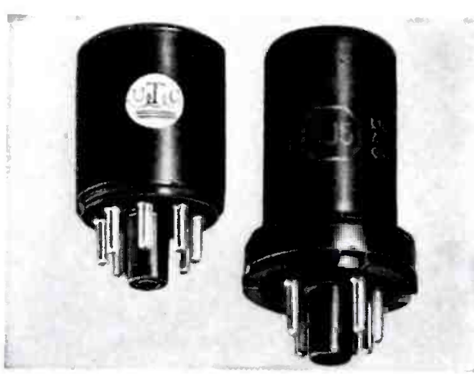
C-D REPLACEMENT CAPACITORS

The Cornell-Dubilier Type EZ replacement capacitors are supplied with both straps and upright mounting feet which can be adapted for spade-bolt mounting, it is said. They are available in single, dual, triple, and quadruple combinations, in a wide variety of capacity and voltage ratings.

The units are specifically designed to enable maintenance of adequate replacements without running up inventory to prohibitive levels, it is said. Additional information may be obtained directly from Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

PLUG-IN TRANSFORMERS

After producing plug-in transformers for three years, United Transformer Corp. announces a complete line of bakelite cased plug-in audio units. These units have identical characteristics to the UTC



Ouncer transformers, and weigh only two ounces. The transformers have standard octal sockets with overall dimensions of 1⅛" diameter—1½" high. United Transformer Corp., 150 Varick St., New York City.

MULTI-RANGE AMMETER

Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill., have announced a small a-c multi-range ammeter with built-in current transformer. Known as Micro-Tester Model 280, this instrument provides readings in any of five different ranges, from fractions of an ampere up to 25 amperes. Complete information may be secured from the manufacturer.

AUTOMATIC CUTOUT

An automatic device for autos cuts out the radio, headlights, and other electrical accessories while the starter motor is in operation. This unique device is manufactured by Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago. Additional information may be obtained directly from them.

HOMOCORD RECORDERS

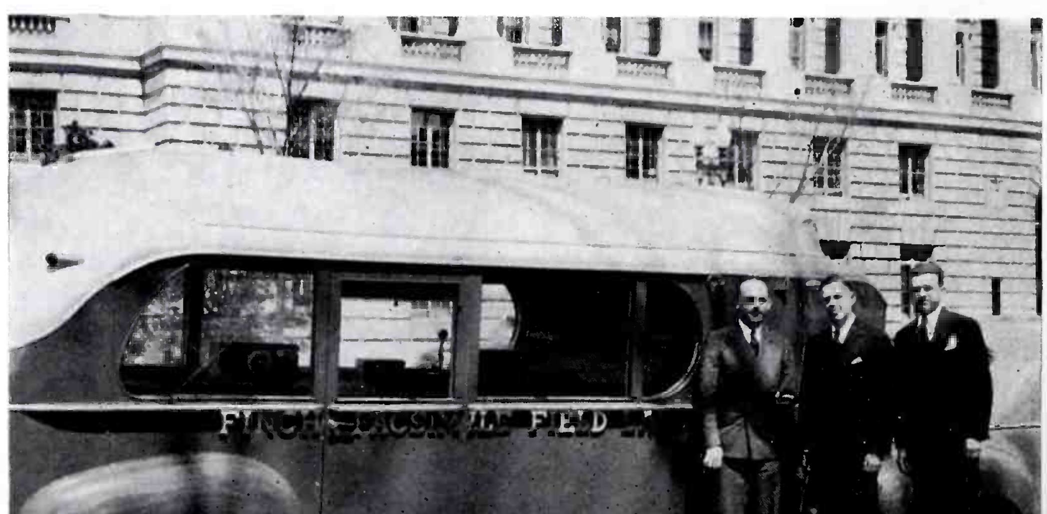
Homocord Manufacturing Co., Inc., 457 W. 45 St., New York City, have introduced three home recording-radio combinations. Model 110 is a table model with a seven-tube superheterodyne. Model 120 is similar but is housed in a console. The console Model 130 also provides automatic record changing facilities.

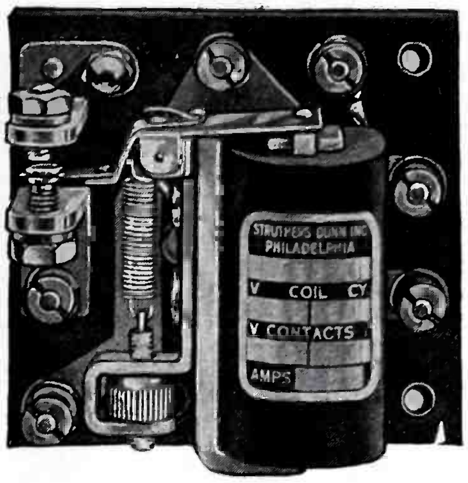
Additional information and prices may be obtained directly from Homocord.

RELAY

New Dunco Type "S" sensitive relays, said to be designed for applications where a high degree of sensitivity must be coupled with high-speed, low-power operation, have

A mobile facsimile laboratory developed by Finch Telecommunications.

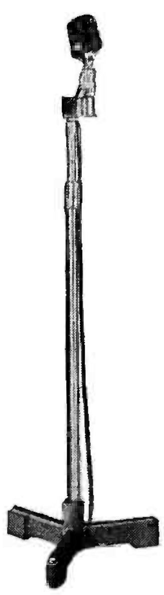




been announced by Struthers Dunn, Inc., 1315 Cherry Street, Philadelphia. The new relays operate on .008 watts, dc, or 0.10 volt-amperes at 60 cycles ac, and will operate on as low as ¼ of rated power where reduced contact pressure is permissible. A descriptive bulletin No. P-243 gives complete data on the units. Write to the manufacturer.

MICROPHONE FLOOR STAND

A new, heavyweight broadcast microphone floor stand is now offered by Shure Brothers. This new Model S510A stand



forms an easily adjusted dependable support. Extra heavy, non-vibrating, large-diameter tubings are employed for rigidity and freedom from noise, it is said. Shure Brothers, 225 W. Huron St., Chicago.

AMERICAN CONDENSER CATALOG

American Condenser Co., 2508 S. Michigan Ave., Chicago, has issued their latest catalog illustrating and describing their line of condenser products. Copies may be obtained directly from them.

SELECTAR TO MAKE RECORDERS

Selectar Mfg. Corp., 30 W. 15 St., New York City, formerly devoted to the manufacture of precision electro-mechanical instruments announce their entry into the professional and home recording field with a complete line of recorders, microphones, pickups, and other accessories. The new Selectar line is built around the Bruno products. William A. Bruno has been retained to direct manufacturing and technical activities of the corporation.

Index to Advertisers

25 YEARS AGO

1915 JUNE 1915

Sun Sat

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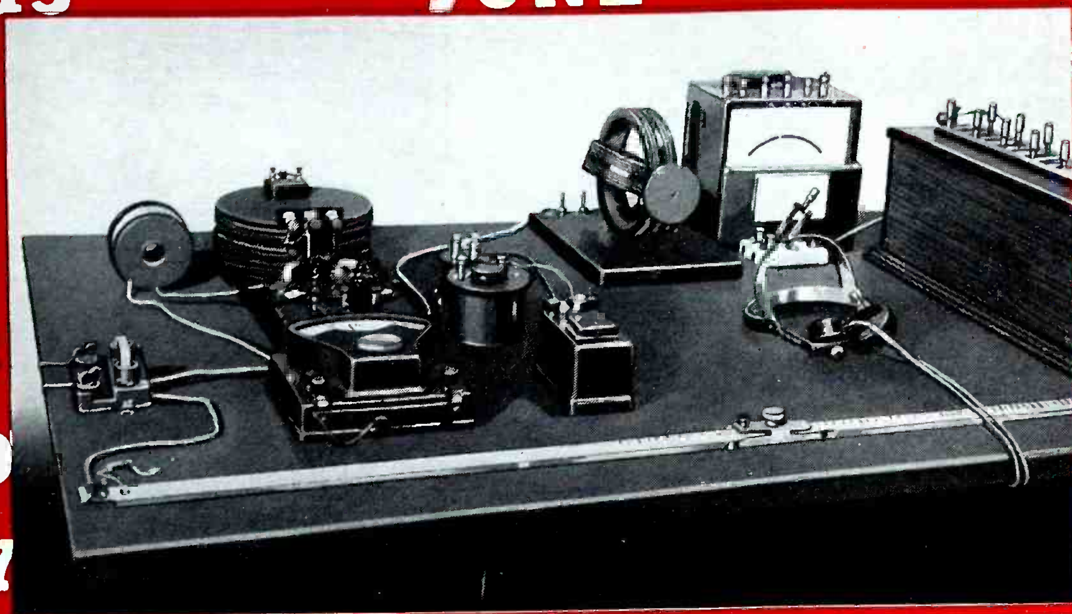
5 12 19 26



1915 ***SKIN-EFFECT RESISTANCE MEASUREMENTS OF CONDUCTORS*** *at radio frequencies up to 100,000 cycles per second. During 1915-1916 important research on this problem was undertaken at one of the leading educational institutions with the equipment shown — the latest then available. Included in the set-up are an Alexanderson r-f alternator delivering 2 kw. at 100,000 cycles, a hot-wire ammeter, adjustable paper condenser, variable air condenser, fixed telephone condenser, single slide-wire, fixed and adjustable inductances, a portable galvanometer, a headset and 1,000-cycle commutator interrupter. These instruments represented the latest developments in the instrumentation field in 1915.*

1940 JUNE 1940

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1940 ***TWENTY-FIVE YEARS LATER*** *the same measurements can be duplicated with this equipment at frequencies up to 1,000,000 cycles per second and with accuracies far in excess of those possible in 1915. Included are General Radio Type 516-C Radio Frequency Bridge, Type 684-A Modulated Oscillator, Type 619-E Heterodyne Detector, Type 663 Resistors and a headset. Before 1940 has gone by, G-R instruments will probably be available to extend the frequency range of these measurements to 10,000,000 cycles!*

GENERAL RADIO COMPANY celebrates its 25th Anniversary this month. The twenty-fifth year in the life of most companies or persons is not particularly significant; but in the radio and electronic measuring-apparatus field twenty-five years takes one practically back to the beginning. General Radio is probably the oldest company of its kind in the world. It has been continuously engaged (under the same name, with the same directing head and with the same managerial policy) in the design, manufacture and sale of precision electrical laboratory apparatus for use at communication frequencies. General Radio instruments have always kept abreast of the developments in the electronic art and its apparatus has in no small measure contributed to the ease with which further developments have been and are possible.

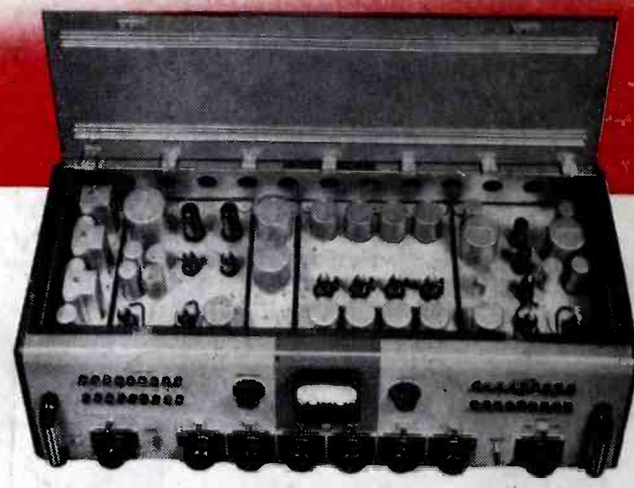
The extent of diversification in the manufacture of its apparatus is always surprising to persons not long familiar with General Radio. G-R instruments are in use throughout the entire world in the leading laboratories, factories and commercial organizations.

If you are interested in electrical measuring equipment at audio or radio frequencies, you should familiarize yourself in detail with G-R products. Write for a copy of Catalog K. Address 30 State Street, Cambridge, Mass.

GENERAL RADIO COMPANY

COMPACT...FLEXIBLE...ECONOMICAL!

RCA 76-BI



Consolette Speech Input System... with Interlocked Push-Button Switching

HIGH FIDELITY... unexcelled flexibility... in a modern, *complete* speech input system, ideal for one and two studios! That's the RCA 76-B1, for simultaneous broadcasting and auditioning—with push-button control for more circuit *combinations* with simpler switching operations.

Monitoring, auditioning, cueing, and talk-back are all under push-button control. The high-fidelity program channel affords 6 mixer controls—4 microphone pre-amplifier input channels with switching control for as many as 6 microphones. Location of control knobs and correct slope of panel give greatest visibility and ease of control. High power output to line and loudspeakers. Hinged top and chassis mounting for instant accessibility of parts.

And all at a price that even the smallest station can afford! Get the facts on RCA 76-B1—write today for complete data.

No Other Consolette System offers Push-Button Flexibility plus All These Features!

- ★ Independent Auditioning and Program Channels
- ★ Talk-back facilities for two studios and remote lines
- ★ Emergency Amplifier and Power Supply
- ★ 6 Step-by-step Mixers—Dual Turntable Faders
- ★ 6 Remote Inputs—Push-Button Cueing Control
- ★ New Illuminated Scale VU Meter
- ★ Two Line Repeating Transformers
- ★ Plate Current Meter and Relay Power Supply
- ★ Attractive Appearance–Two-Tone Umber Grey Finish

There is an RCA tube for every purpose in broadcasting.

Use RCA radio tubes in your station for finer performance.

RCA **Broadcast Equipment**

RCA Manufacturing Company, Inc., Camden, N. J. • A Service of the Radio Corporation of America

New York: 1270 Sixth Ave. Chicago: 589 E. Illinois St. Atlanta: 530 Citizens & Southern Bank Bldg. Dallas: Santa Fe Bldg. San Francisco: 170 Ninth St. Hollywood: 1016 N. Sycamore Av