PRICE FIFTY CENTS

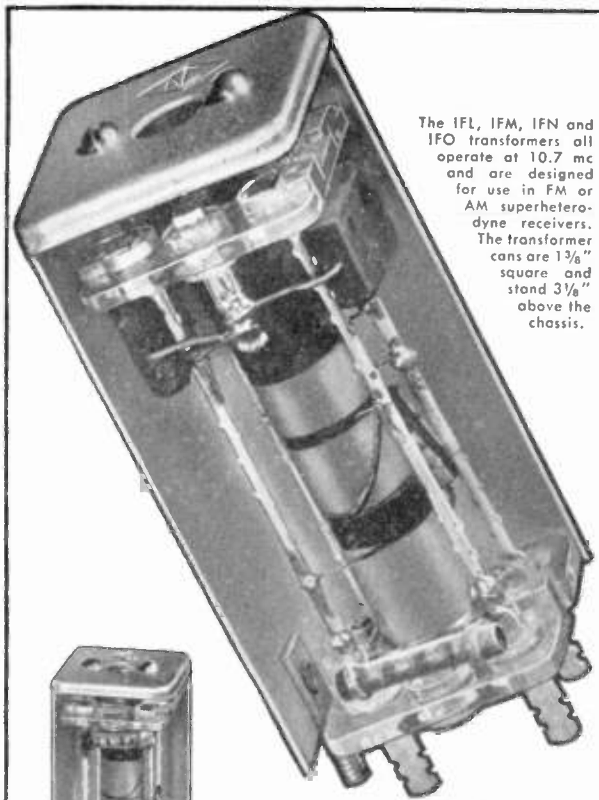
FM AND TELEVISION

AUG. 1947

★ ★ Edited by Milton B. Sleeper ★ ★

REPEAT PERFORMANCE
1935–1947

Why
the *Lock-In* Tube is at home
IN THE AIR!
COMPACT . . . MADE TO FIT SMALL SPACES
This famous Sylvania product is ideal for use in air-borne radio equipment—it's so compact . . . has reduced overall height and weight. Further, it has no top cap connection . . . overhead wires are eliminated.
STAYS PUT IN SOCKET...THROUGH LOCK-IN FEATURE
No matter how rough the air, the tubes in an aircraft's radio will stay in their sockets—if those tubes are *Lock-Ins*. Specially designed "lock-in" locating lug on each tube keeps them in place—assuring firm socket contact.
ULTRA-HIGH FREQUENCIES...HANDLED WITH EASE
Lock-In is *the* tube specifically engineered to more than satisfy the requirements of today's sets, as well as handle ultra-high frequencies with ease! Electrical features include: short, direct connections . . . fewer welded joints—less loss; getter located on top . . . shorts eliminated by separation of getter material from leads. *See Sylvania Distributors or write Radio Division, Emporium, Pa.*
SYLVANIA
ELECTRIC
SYLVANIA
MADE IN U.S.A.
SYLVANIA'S LOCK-IN TUBE...
. . . the radio tube whose electrical and mechanical superiority makes it the ideal choice for equipment in the air, on the road, marine radar, FM and television.
MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS



The IFL, IFM, IFN and IFO transformers all operate at 10.7 mc and are designed for use in FM or AM superheterodyne receivers. The transformer cans are 1 3/8" square and stand 3 1/8" above the chassis.

National
NC
EST. 1914

THE NATIONAL EMBLEM ON PARTS IS YOUR GUARANTEE OF QUALITY

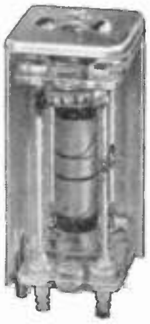
For over 25 years, hams, engineers and radio technicians have agreed that National parts were thoroughly reliable in manufacture and performance.

That reputation is your guarantee of quality when ordering National parts for new equipment.

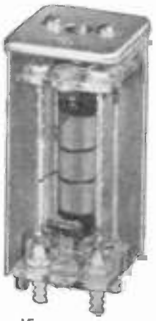
If you need parts that will fit as they're supposed to, that will give you long hard service, then National's your best bet — as any radio veteran can tell you.

Send today for your copy of the new 1947 National catalog, containing over 600 parts.

National Company, Inc.
Dept. No. 14
Malden, Mass.

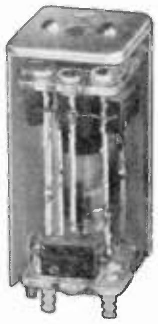


The IFM is an IF transformer with a 150 KC bandwidth at 1.5 db attenuation. Approximate stage gain of 30 is obtained when used with 6SG7 tube. Net Price....$6.45



The IFL discriminator transformer is suitable for use in conventional FM receiver discriminator circuits and is linear over a band of ±100 KC. Net price....$6.90

The IFN is an IF transformer with a 100 KC bandwidth at 1.5 db attenuation. Approximate stage gain of 30 is obtained when used with 6SG7 tube. Net Price....$6.45



The IFO is an FM discriminator transformer of the ratio type and is linear over a band of ±100 KC. Net Price..........$6.98

The HRT is a new plastic tuning knob with a chrome plated appearance circle. The HRT knob fits a 1/4" diameter shaft and is 2 1/8" in diameter. Available in Black or Gray. HRT Knob. Net Price $ .75

The HRS Knobs are a new series of plastic knobs with a 1 3/8" diameter chrome-plated skirt. They all fit 1/4" diameter shafts. Three types are available in Black or Gray.

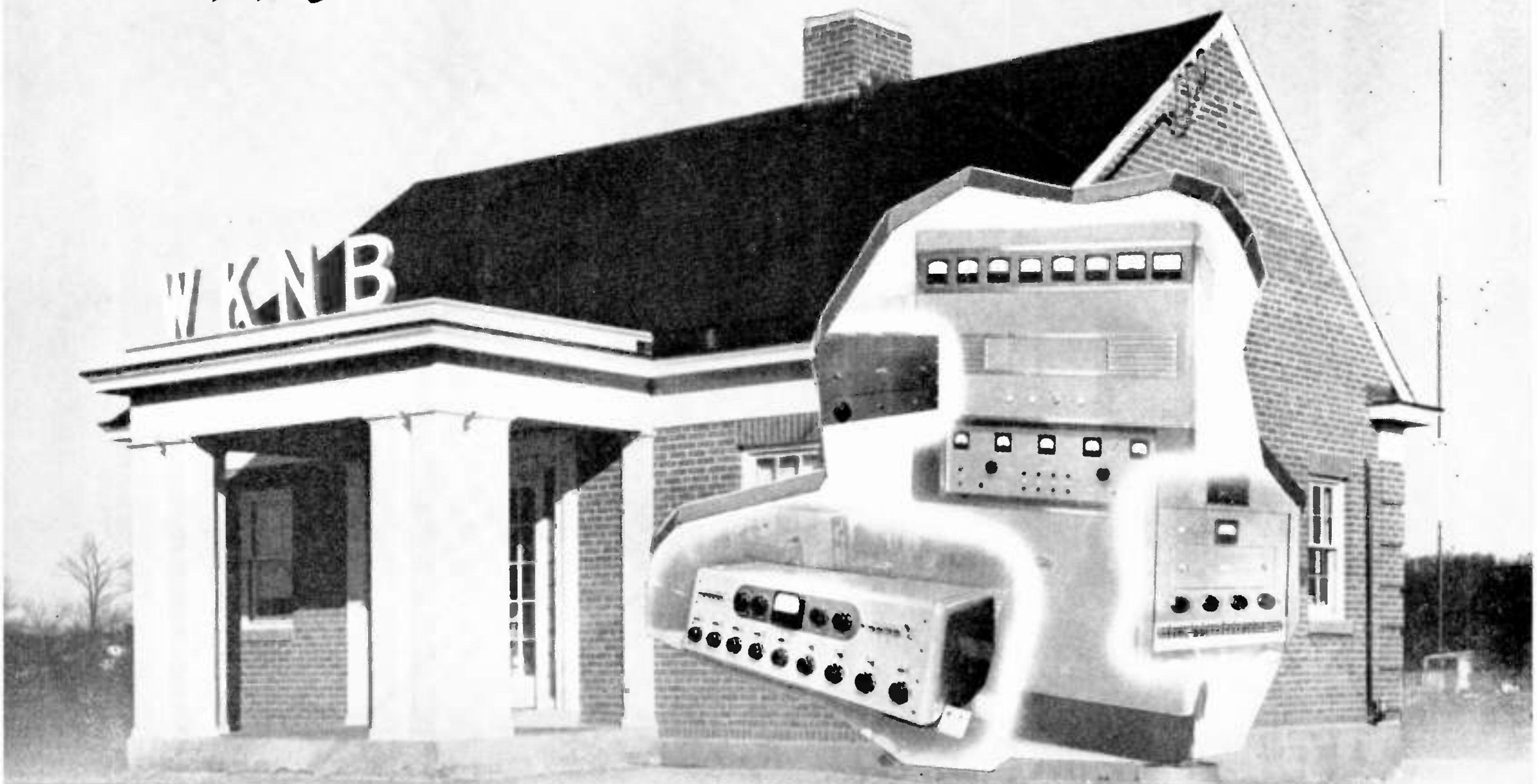
HRS-3 Knob........0-10 through 300° rotation. Net price..........$ .51

HRS-1 Knob....ON-OFF through 30° rotation. Net price...........$ .51

HRS-2 Knob........5-0-5 through 180° rotation. Net price...........$ .51

MAKERS OF LIFETIME RADIO EQUIPMENT

Happy Anniversary, WKNB...



Raytheon equipment installed includes: RM 10 Monitoring Amplifier; RL-10 Limiting Amplifier; RC-10 Studio Console; R9 1000 Watt AM Transmitter.

AND *More Power** TO YOU!

Every day for twelve consecutive months New Britain's WKNB has been operating on the Raytheon equipment shown. Owner and engineers now *know from experience* that Raytheon is truly "the finest in broadcast equipment." Result: When WKNB is ready to use *more power, they will buy their equipment from Raytheon!

Users the country over are enthusiastic about the high fidelity, servicing accessibility and low-cost maintenance of Raytheon AM and FM broadcast equipment. They find it greatly facilitates setting up programs, with operation so simple and logical that errors are cut to a minimum.

Get the facts before you buy. Write for illustrated bulletins and technical data on the complete line of Raytheon Speech Input Equipment and AM and FM Transmitters ranging from 250 to 10,000 watts.

Meet Chris Brauneck . . .

Here's the chap who helped select and procure the Raytheon equipment and associated items for WKNB . . . and, incidentally for many other New England stations. He is typical of the high type Raytheon representatives who are ready to work with *you:*

CHRISTIAN BRAUNECK
1020 Commonwealth Ave.
Boston, Massachusetts
Tel. Aspinwall 6734

HENRY J. GEIST
60 East Forty-Second Street
New York 17, New York
Tel. Murray Hill 2-7440

W. B. TAYLOR
Signal Mountain
Chattanooga, Tennessee
Tel. 8-2487

ADRIAN VAN SANTEN
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Seattle, Washington
Tel. Eliot 6175

COZZENS & FARMER
7475 North Rogers Avenue
Chicago 26, Illinois
Tel. Ambassador 0712

HOWARD D. CRISSEY
414 West Tenth Street
Dallas 8, Texas
Tel. Yale 2-1904

EMILE J. ROME
215 West Seventh Street
Los Angeles, California
Tel. Tucker 7114

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
COMMERCIAL PRODUCTS DIVISION
WALTHAM 54, MASSACHUSETTS
Industrial and Commercial Electronic Equipment, Broadcast Equipment, Tubes and Accessories

Sales offices: Boston, Chattanooga, Chicago, Dallas, Los Angeles, New York, Seattle

FM AND TELEVISION

FORMERLY, FM MAGAZINE and FM RADIO-ELECTRONICS

VOL. 7 | AUGUST, 1947 | NO. 8

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THIS MONTH'S COVER

This photograph of Major Edwin H. Armstrong was taken on June 19th, when he staged an FM demonstration from Alpine, carrying a five-talent program originating at Yonkers, for New York dealers assembled at the Engineering Societies Auditorium. It was there, on November 6, 1935, that he gave the first public FM demonstration, before the IRE, using the same facilities.

Not the least remarkable feature of FM is its success in the face of an already existing, profitable, and accepted method of broadcasting, and its certain progress in eventually replacing the old AM system. This is without parallel in business annals.

Entered as second-class matter, August 22, 1945, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Concord, N. H. Printed in the U. S. A.

MEMBER, AUDIT BUREAU OF CIRCULATIONS

WHAT'S NEW THIS MONTH

1. FM for the Tropics
2. Better Listen First

1. Watching the steady increase in the number of subscriptions coming from foreign countries, we've wondered how long before some of them, particularly in the tropical latitudes, would put FM to use as a means of overcoming natural static interference on AM broadcast frequencies.

This subject finally came up for discussion at the International Telecommunications Conference, now in session at Atlantic City. Several of the delegates, including representatives of the Central and South American republics, asked that high-frequency channels now used for communications traffic be assigned to AM broadcasting. While these higher frequencies are not free from static interference, they are less affected than the regular broadcast band.

For that reason, they are valuable for handling communications traffic. Accordingly, it was suggested that those countries use FM for broadcasting. Their answer was that they had investigated FM before the war, and had been advised that the transmitting range was very limited — so limited, in fact, that it would not meet their needs.

Since, in such a situation, hearing is believing, the FCC arranged a series of FM demonstrations for the delegates at Atlantic City. A receiver was installed there for the reception of Alpine, and connected by a 15,000-cycle telephone line to WBAB. Sixty-five Zenith receivers were presented to the chief delegates, so that they can continue to hear FM programs.

While we shun the rôle of the starry-eyed oracle, we venture to predict that this opportunity to gain first-hand knowledge of FM broadcasting will result in the introduction of the system in many countries. Possibly a deciding factor will be the practicability of wire-less networks, now being demonstrated by the Continental Network. In countries where great forests and mountainous terrain make the cost of maintaining wire lines prohibitive, FM relay broadcasting is the perfect answer.

We shall have some important further news on this subject next month.

2. We still have an over-supply of do-gooders who hear nothing, see nothing, but are prepared to tell all, at every opportunity, about FM. We had an ex-

(CONTINUED ON PAGE 48)

PRODUCTS & LITERATURE

So many new instruments, components, and materials are being brought out that space does not permit us to publish illustrated descriptions of them all. Accordingly, rather than selecting a few each month, we have established this new department of Products & Literature so that a great number of brief descriptions can be published. From these, you can select items which interest you, and send for catalogs or bulletins. We'll appreciate it if you will mention FM and TELEVISION in your requests.

Mike Stand has push-button height adjustment with automatic release and lock. No screw adjustment is used. Height range is 36 to 65 ins. Three 17-in. supporting legs can be removed to make compact package. Net weight 7½ lbs. — Electro-Voice Inc., Buchanan, Mich.

Coaxial Cable Relay provides a remotely controlled single-pole, double-throw switch for changing an antenna from transmitter to receiver. Metal enclosure is proportioned to produce characteristic impedance of 75 ohms. Models are available for use on 6, 12, 24, 32, or 110 volts DC, or 115 or 230 volts, 60 cycles AC. — Type CR10, Signal Engineering & Mfg. Co., 154 W. 14 St., New York 11.

Twin Tweeter for reproducing 2,000 to 15,000 cycles has die-cast double horn for wide dispersion angle. Can be mounted on top of bass speaker, in space 2¾ ins. high by 9½ ins. wide. No dividing network needed. — University Loudspeakers, Inc., 225 F Varick St., New York City.

Special Dry Cells: Of other than standard types, required for unusual applications, will be manufactured by Specialty Battery Company, Madison, Wis. This is a new subsidiary of Ray-O-Vac.

Tube Caps in a series of plain and insulated types for tubes ranging from acorn types up to those .8 in. in diameter for 204 and 851 tubes. The series includes those with enclosed resistors. — Circular A1, Alden Products Co., Brockton, Mass.

Television Receivers including a table model retailing at $349.50, and a consolette with FM and AM reception at $497.50. Both have 10-in. direct-view tubes. — Farnsworth Television & Radio Corp., Ft. Wayne, Ind.

Blower to cool and ventilate vacuum tube equipment delivers 32 cfm. Overall dimensions 5⅛ by 3½ by 3¾ ins. Operates on 115 volts, 60 cycles. Available for prompt delivery. — Small Motors, Inc., 2076-F Elston Avenue, Chicago.

Test Record for checking record changers and coin-operated phonographs. Its purpose is to permit accurate adjustment of the set-down and tripping positions of the pickup. Adjustments can be made quickly because the playing time of the 10-in. record is only 40 seconds. — Walter L. Schott Co., 9306 F Santa Monica Blvd., Beverly Hills, Calif.

Plastic Parts, such as escutcheons, push buttons, and knobs with filled lettering. Produced from mottled Lumarith or clear and colored Lucite by injection molding. Complicated parts are joined with Lucite cement. — G. Felsenthal & Sons, Inc., Chicago.

Miniature Tubes announced by RCA are: 1U5 diode-pentode for portable receivers, similar to the 1S5, but of improved design; 6BJ6 remote-cutoff amplifier pentode for mobile use and for AC-DC FM and AM receivers; 12AL5 high-perveance twin diode. — Technical bulletins, RCA, Harrison, N. J.

VT Voltmeter of low-price, light-weight design for servicemen. Equipped with RF probes rated flat to 120 mc. Has 6 ranges. — Allied Laboratory Instrument, Inc., 355 W. 26 Street, New York.

Studio Recorder for 78 or 33⅓ RPM for all sizes of acetate blanks and flowed-wax masters. Has magnetic head and microscope, with lead screw for any pitch from 80 to 160 lines, in-out or out-in. — Model 523, Fairchild Company, Sound Division, 88-06 Van Wyck Blvd., Jamaica 1, N. Y.

Permanent Magnets are described in a 36-page booklet, giving technical data on characteristics, designs, properties, and applications. — Bulletin FM1, General Electric Company, Metallurgy Div., Pittsfield, Mass.

Butterfly Condensers of 25, 50, and 100 mmf. maximum capacity. Stainless steel shaft and tie rods, rounded aluminum plates, air gap .125 in. — Bulletin F3, Barker & Williamson, Inc., Upper Darby, Pa.

Compensating Ceramics for use in the isolating circuits of FM receivers employing 6SB7's or similar tubes. Compensation characteristics can be controlled in accordance with specifications. — Electrical Reactance Corp., Franklinville, N. Y.

Mercury Vapor Rectifiers, types 866-A/866 and 872-A/872, are designed for average anode current of .25 ampere maximum at peak inverse anode voltage of 10,000, and 1.25 amperes at 10,000 volts respectively. — Eitel-McCullough, Inc., San Bruno, Calif.

Dynamic Microphone for FM broadcast service is rated flat within 2.5 db from 60 to 13,000 cycles. Output is −53 db, with switch selection of 50 to 250 ohms impedance. — Model E-V635, Electro-Voice, Inc., Buchanan, Mich.

Radio Components for distributors are listed in a new 24-page bulletin covering resistors, controls, antennas, pickups, and speakers. — Bulletin ESD-93, General Electric Co., Syracuse, N. Y.

Miniature IF Transformers with molded, powdered iron cores, mounted in cans ¾ in. square by 1⅞ ins. high. Built to precision standards for use where space is at a premium. — Type SM-107, Stanwyck Winding Co., Newburgh, N. Y.

Broadcast Station Equipment is described in data sheets covering phase sampling, Iso-Couplers, tower lighting filters, transmission line supports, and capacitors. — E. F. Johnson Co., Waseca, Minn.

Signal Generator for 140 to 170 mc. features low leakage (approximately .2 microvolt) constant output through the use of feedback, and an output control calibrated in db. Output is independent of plus-or-minus 10% variation in line voltage. — Harvey Radio Laboratories, Inc., 443A Concord Ave., Cambridge 38, Mass.

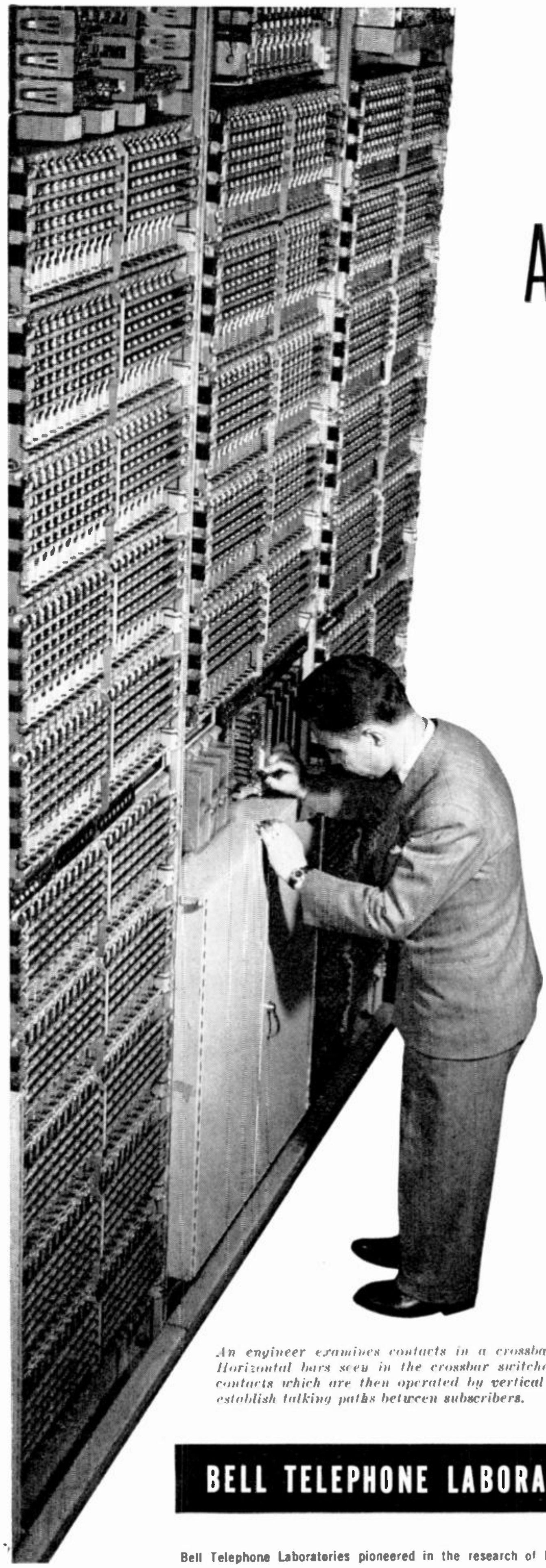
Test Jig for checking oscillator and antenna sections of gang condensers in accordance with RMA standards. Dual modified Schering bridge gives high degree of accuracy, since switching is eliminated. Bridge is sensitive to plus-or-minus .1 mmf. — Airadio, Inc., Stamford, Conn.

Text Books in a new pocket size, priced at 99c. The first six volumes of the new series are now ready for distribution to radio engineers, servicemen, and students. — John F. Rider, Inc., 404-F Fourth Ave., New York 16.

Wire Connectors to fasten wire ends to screws, studs, hooks, or insulators. Parallel and ring-tongue types are available. No solder is needed. — Aircraft-Marine Products, Inc., 1612 N. Fourth St., Harrisburg, Pa.

Voltage Controls in the form of variable transformers and automatic voltage regulators are described in a 12-page bulletin, giving mechanical dimensions and characteristic curves. — Bulletin 547-F, Superior Electric Co., Bristol, Conn.

Robomat is the name of a unit which combines an automatic 20-record turnover changer, radio receiver, and paging system for use in public places, ships, and factories. Output is 90 watts. Can be preset for start and stop time. — Eastern Amplifier Corp., 794-F East 140th St., New York.

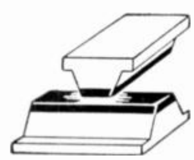


An engineer examines contacts in a crossbar office. Horizontal bars seen in the crossbar switches select contacts which are then operated by vertical bars to establish talking paths between subscribers.

A BILLION ORDERS A DAY

In a large modern telephone office 2,000,000 switch contacts await the orders of your dial to clear a path for your voice. They open and close a billion times a day.

At first, contacts were of platinum—highly resistant to heat and corrosion but costly. Years ago, Bell Laboratories scientists began looking elsewhere, explored the contact properties of other precious metals—gold, silver, palladium and their alloys—and with the Western Electric Company, manufacturing unit of the Bell System, restudied shape, size and method of attachment.



Outcome of this long research is a bar-shaped contact welded to the switch and positioned at right angles to its mate. For most applications, an inexpensive base is capped with precious metal.

Savings from these contacts help keep down the cost of telephone service. This is but one example of how Bell Laboratories serve the public through your Bell Telephone Company.

BELL TELEPHONE LABORATORIES

Bell Telephone Laboratories pioneered in the research of FM radio and television, and is active in developing improvements in both fields today.

ENGINEERING SALES

Permoflux: Is now producing a complete line of speakers, transformers, pickups, and microphones for sale through jobbers. These items are being manufactured at the Chicago plant, 4900 W. Grand Avenue, and in California at 236 S. Verdugo Road, Glendale.

Collins: Has completed a new national sales setup under Russ Remaker, with offices in Orlando, Fla., Dayton, Memphis, Omaha, and Dallas, in addition to existing offices in New York and Los Angeles.

Motorola: Robert F. Davis has been appointed communications field engineer for Colorado and Kansas. He will make his headquarters in Denver.

RCA: Jack M. Williams, a 20-year RCA veteran, has been made advertising manager of the RCA Victor home set division. He was formerly manager of record advertising.

GE: New sales manager for G.E. television transmitter equipment is A. F. Wild. He has been employed in engineering and sales work at G.E. since 1937.

S-C: Keith J. Ackley has joined Stromberg-Carlson as district merchandiser for New England and northeastern New York.

Motorola: Vernon S. Anderson, formerly broadcast sales engineer for Raytheon, has joined Motorola as communications field engineer in northern Illinois.

Philadelphia: Harry F. Mickel, after 21 years with RCA, has resigned as manager of the communications equipment section to join Raymond Rosen, 32nd and Walnut Streets, Philadelphia, where he is engineering sales manager of their radio engineering products division.

Smith: Herman H. Smith, manufacturers of radio hardware at 405–44th Street, Brooklyn 20, have appointed Land-C-Air Sales, Inc., 14 Pearl Street, New York, as eastern representatives, and Henry M. Krueger, 990 Fulton Street, San Francisco, as representatives in northern California.

Collins: West coast sales for Collins broadcast division are now under Jerry P. Dieus, Los Angeles, and southeastern sales under Edmund J. Aleks, Orlando, Fla.

More Broadcasting Stations . . .

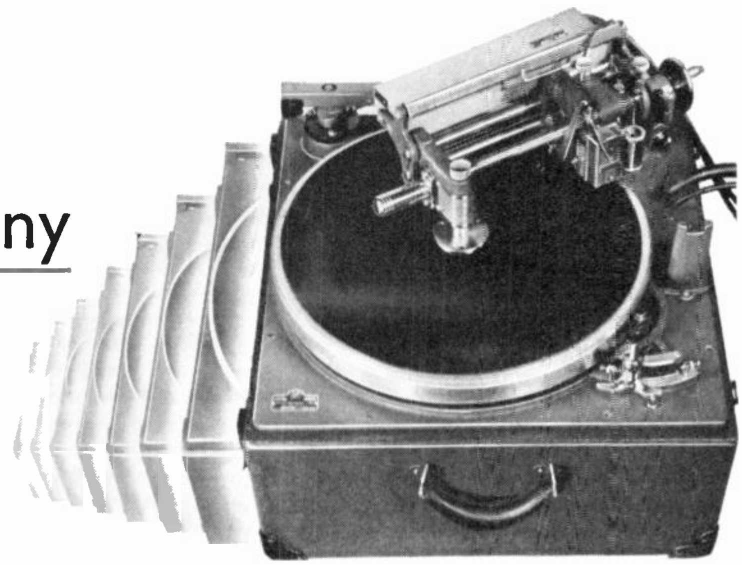
1947

. . . for more years . . .

. . . have used more

Presto 6 N's than any

other recorder



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Walter P. Downs, Ltd., in Canada

World's largest manufacturer of instantaneous sound recording equipment and discs


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TYPE E
MICA CAPACITOR


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SANGAMO
CAPACITORS
MICA
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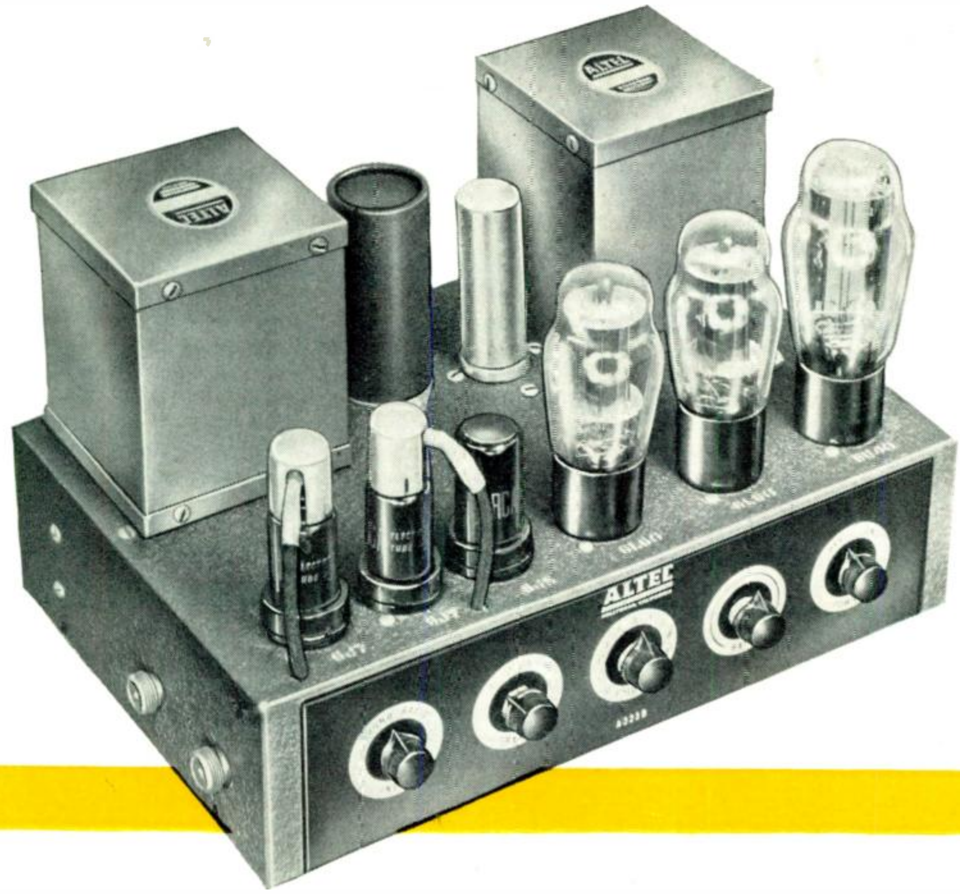

Capable of realizing the full resources of the new professional FM tuners

. . . and linking their superior performance to the industry's first-choice speaker*

The final link in the chain of high-quality reproduction has now been forged: a power amplifier which brings out the final degree of excellence of performance of the new professional-quality tuners, and of the two-way multi-cellular speaker which has become the standard of the broadcasting, recording, and motion picture industries, the Altec Lansing Duplex speaker.

Salient characteristics of the New Altec Lansing A-323B Amplifier are:

1. Flat frequency response—within 1 db from 20 cycles to 20,000 cycles.
2. Full 15 watt power output within 1db from 35 cycles to 12,000 cycles.
3. Two inputs. One low gain from radio tuner, and one high gain with built-in equalization to operate direct from the new General Electric Variable Reluctance or the new Pickering Cartridge Pickup.
4. For record reproduction, stepped low pass filter which gives sharp cut-off of noise frequencies yet allows full reproduction of useable high frequencies
5. Adjustable base boost.
6. Hum balancing potentiometer to eliminate the necessity of careful selecting of tubes for quiet operation.

The Altec Lansing A-323B Amplifier was designed with a particular view to its use in high-quality music reproduction systems in which the electrical elements—tuner, amplifier, record player, and speaker—are either wholly concealed in the interior structure of the room, or partly concealed in furniture already in harmony with the interior scheme.

The noteworthy trend, among fastidious, musical-minded home lovers, toward built-in music systems which eliminate non-functional radio "furniture"—and thus eliminate the inevitable problem of assimilating "big sets" into modern decorator-influenced interiors, is becoming increasingly apparent; this trend highlights the importance of the new Altec Lansing amplifier and the Duplex multicellular speaker in the advanced planning in the FM field.

*The Altec Lansing Duplex Loudspeaker

The Altec Lansing loudspeaker is the only speaker which in actual performance has been found capable of reproducing the full frequency and dynamic ranges, and without distortion, all the characteristics of sound of which the frequency modulation method of radio transmission is capable. The high efficiency, and the resultant damping, causes the Altec Lansing Duplex loudspeaker to follow accurately every variation in the signal wave form, without contributing the spurious sounds that result from intermodulation and poor transit characteristics common to ordinary speakers.

ALTEC LANSING CORPORATION

250 W. 57th St., N.Y. 19, N.Y. 1161 N. Vine St., Hollywood 38, Calif.

available now . . .

MEISSNER AM and AM-FM TUNERS

For Superlative Reception

Designed for use wherever exceptionally high fidelity reception is desired, the new postwar Meissner AM and AM-FM Tuners are now available for your most exacting requirements. Both of these new precision designed components cover the broadcast band from 527 to 1620 kc. and the AM-FM Tuner also covers the FM band from 88 to 108 mc. At 105-125 volts, 50-60 cycles, power consumption is 80 watts for the AM-FM Tuner and 60 watts for the AM Tuner. See these quality units at your jobbers today or write for complete specifications to the address below;

CHECK THESE OUTSTANDING FEATURES

Frequency response of Tuners is flat within ±2 db from 30 to 15,000 cycles! Bass control provides 10 db boost at 40 cycles; treble control varies response from +12 db to −14 db at 10,000 cycles. Volume control has automatic bass compensation circuit to match the bass characteristic of the human ear.

Sensitivity of the Tuners is less than 10 microvolts. Selectivity for AM signals may be made either "broad" or "sharp". Output of the Tuners is 8 volts at the high-impedance terminals and .75 volts at the 500 ohm terminals. Hum level is 60 db below output. Phonograph input terminals are provided so that Tuner and its amplifier may be used with a record player. Any antenna with single lead-in wire can be used for AM signals. FM section designed for an antenna having a balanced 300 ohm transmission line.

AM-FM Tuner Tube complement; 9003 R. F. Amplifier; 6BE6 oscillator converter; 2-9003 I. F. Amplifiers; (456 kc); 6AL5 detector for AM section. For the FM section; 6AG5 R. F. Amplifier; 6C4 oscillator; 6AG5 converter; 3-6AG5 I. F. Amplifiers (10.7 mc.) 2-9001 limiters and 6AL5 detector. Two 6C4's are used for audio amplifiers, a 6U5/6G5 for tuning indicator and 5Y3GT/G for rectifier.

AM Tuner Tube complement; 6BA6; 6BE6; 2-6BA6; 6AL5; 2-6C4; 5Y3GT/G and 6U5/6G5.

Meissner

ELECTRONIC DISTRIBUTOR AND INDUSTRIAL SALES DEPARTMENT

MAGUIRE INDUSTRIES, INC.

936 N. MICHIGAN AVE., CHICAGO 11, ILLINOIS

EXPORT ADDRESS: SCHEEL INTERNATIONAL
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NOW – A SIXTY-FIVE WATT

EIMAC TETRODE

TYPE 4-65A

- *Hard Glass*
- *Non-Emitting Grids*
- *Instant Heating Filament*
- *Low Drive*
- *Low Voltage*
- *Low Feed-Thru Capacitance*
- *Low Cost*

$14.50

TYPE 4-65A

ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	6.0 v
Current	3.5 amp
Grid-Screen Amp. Factor (Av.)	5
Direct Inter-Electrode Capacitances (average)	
Grid-Plate	0.08 µuf
Input	8.0 µuf
Output	2.1 µuf

TYPICAL OPERATION

Class C Telegraphy or FM Telephony
(Key Down Conditions, 1 Tube)

D-C Plate voltage	400	1000	2000	v
D-C Screen voltage	250	250	250	v
D-C Grid voltage	–40	–50	–70	v
D-C Plate current	100	125	125	ma
D-C Screen current	40	37	35	ma
D-C Grid current	13	16	16	ma
Peak R-F grid input voltage	135	155	180	v
Driving power (approx)	1.8	2.5	2.9	w
Screen dissipation	10.0	9.2	8.8	w
Plate power input	40	125	250	w
Plate dissipation	12	30	50	w
Plate power output	28	95	200	w

THE ANSWER TO THE TRANSMITTER-MAN'S PRAYER

Available now, type 4-65A is a small radiation cooled, instant heating tetrode. Devoid of internal insulating hardware, the 4-65A was designed as a transmitting tube . . . not a blown-up receiving tube. This rugged new Eimac tetrode really performs at low voltage, and its instant heating thoriated tungsten filament makes it ideally suited for mobile installations. The 4-65A operates well into the VHF, beyond the 160-Mc. band, and is capable of delivering relatively high-power with a plate voltage range from 400 to 3000 volts. As do other Eimac tetrodes, type 4-65A embodies the inherent characteristics of low grid drive, low feed-thru capacitance, and general stability of operation.

Type 4-65A's versatility of operation is demonstrated in the adjacent data showing typical operation at 400, 1000, and 2000 volts. Additional data on the 4-65A are now available, write direct.

EITEL-McCULLOUGH, Inc.
1771 San Mateo Ave., San Bruno, California

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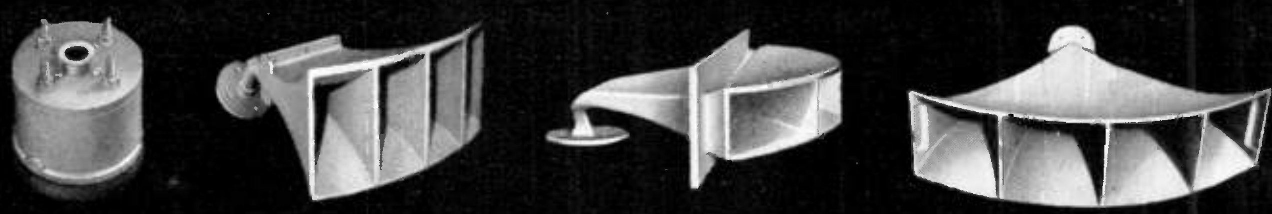

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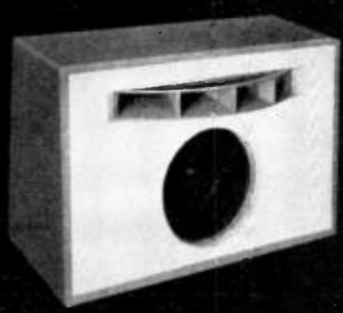
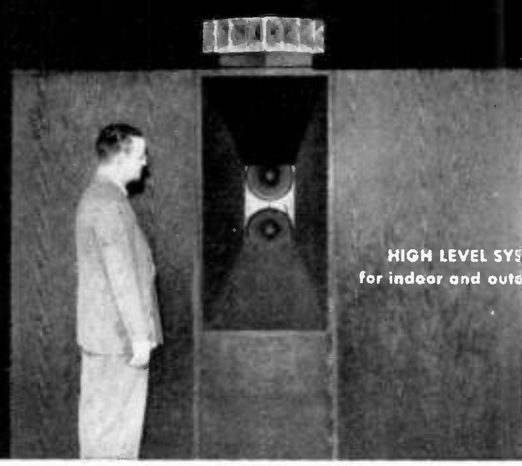


757A—dual unit system.



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755A 8" direct radiator	8 watts	70-13,000	4 ohms	70°	81.5 db above 10^{-16} watts per sq. cm. at 8 watts input	Speaker—4½ lbs.	Dia.—8⅜" Depth—3⅛" Baffle Hole Dia.—7"	2 cu. ft.	Width—16" Height—21" Top Depth—9⅛" Bottom Depth—12"
756A 10" direct radiator	20 watts	65-10,000	4 ohms	60°	89.5 db above 10^{-16} watts per sq. cm. at 20 watts input	Speaker—10 lbs.	Dia.—10⅜" Depth—3⅛" Baffle Hole Dia.—$8\frac{13}{16}$"	2½ cu. ft.	Width—19" Height—22" Top Depth—8⅛" Bottom Depth—$11\frac{13}{16}$"
728B 12" direct radiator	30 watts	60-10,000	4 ohms	50°	93.5 db above 10^{-16} watts per sq. cm. at 30 watts input	Speaker—17 lbs.	Dia.—$12\frac{11}{32}$" Depth—$3\frac{25}{32}$" Baffle Hole Dia.—11"	3 cu. ft.	Width—21" Height—23⅜" Top Depth—9⅛" Bottom Depth—12⅜"
754A 12" direct radiator	15 watts	60-10,000	4 ohms	50°	94 db above 10^{-16} watts per sq. cm. at 15 watts input	Speaker—17 lbs.	Dia.—$12\frac{11}{32}$" Depth—3⅞" Baffle Hole Dia.—11"	3 cu. ft.	—
754B 12" direct radiator (outdoor type)	50 watts	60-10,000	4 ohms	50°	94 db above 10^{-16} watts per sq. cm. at 50 watts input	Speaker—17 lbs.	Dia.—$12\frac{11}{32}$" Depth—3⅞" Baffle Hole Dia.—11"	2½ cu. ft.	—
757A 2 unit system	30 watts	60-15,000	4 ohms	90°	93 db above 10^{-16} watts per sq. cm. at 30 watts input	82 lbs. including cabinet	Composed of 1-728B low frequency unit and 1-713C high frequency receiver with KS-12027 horn	Enclosure furnished with system	Width—30½" Height—20" Top Depth—11⅛" Bottom Depth—13⅛"
713B high frequency receiver	25 watts	With horns KS-12024-5-7 800-10,000	4 ohms	(See specifications for horns)	With KS-12024—100 db KS-12025— 98 db KS-12027— 97 db	8 lbs.	Dia.—$4\frac{5}{16}$" Depth—4⅛"	—	—
713C high frequency receiver	25 watts	With horns KS-12024-5-7 800-15,000	4 ohms	(See specifications for horns)	With KS-12024—97 db KS-12025—95 db KS-12027—94 db	8 lbs.	Dia.—$4\frac{5}{16}$" Depth—4⅛"	—	—
KS-12027 high frequency horn	—	With 713C Receiver 800-15,000	—	90° horizontal 90° vertical	—	10 lbs.	Length—13½" Width—$19\frac{3}{16}$" Height—$2\frac{9}{16}$"	—	—
KS-12024 high frequency horn	—	With 713C Receiver 800-15,000	—	50° horizontal 40° vertical	—	7 lbs.	Length—16½" Width—$13\frac{5}{16}$" Height—6⅜"	—	—
KS-12025 high frequency horn	—	With 713C Receiver 800-15,000	—	80° horizontal 40° vertical	—	12 lbs.	Length—19" Width—$23\frac{21}{32}$" Height—6⅜"	—	—
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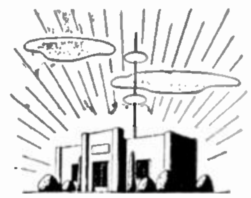

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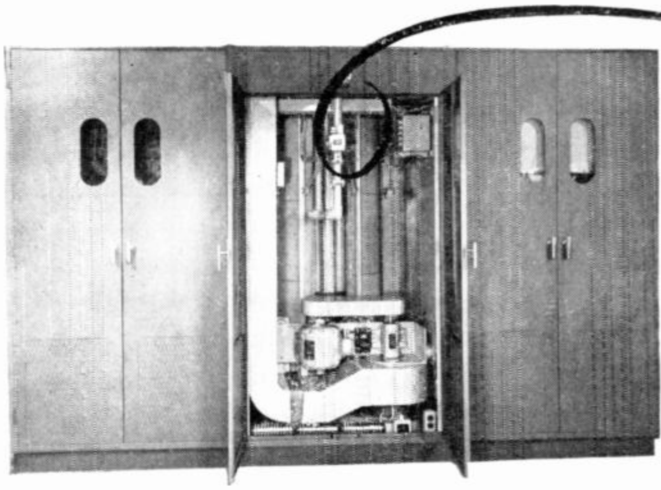

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It gives you for the first time...

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The MONITOR (B), located within the transmitter, registers on front panel meter the power in kilowatts actually going into the transmission line at any time, *no matter what the standing wave ratio on the line.*

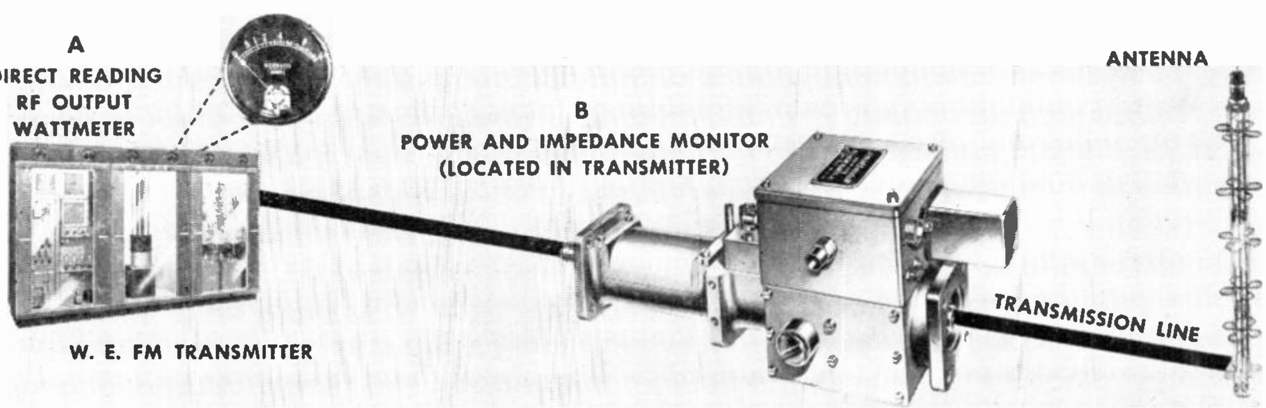
The FRONT PANEL METER (A), connected to the Monitor, provides direct readings of output power and reflected power in kilowatts. Also gives a simple means for determining standing wave ratio at any time, *while the transmitter is in operation.*

The new Monitor is supplied as standard equipment with Western Electric FM transmitters of 3 kw and higher powers.

Write for literature describing in detail the operation of the new Power and Impedance Monitor. Address your request to Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y., or see your local Graybar Broadcast Representative.

Distributed by Graybar

— QUALITY COUNTS —



BELL SYSTEM SEES FM NETWORK DEMAND

Telephone Companies Ready to Provide Circuits to Meet FM Growth, but Must Know Broadcasters' Needs Before Installing Terminal Equipment

BY L. G. WOODFORD *

THE rapid growth in the number of Frequency Modulation broadcasting stations — from only 18 five years ago to the 245 reported in operation in July of this year — indicates a probable eventual need for extensive network facilities for FM broadcasters. Besides the stations in operation in July, there were 638 more reported with either construction permits or conditional grants, plus 151 for which construction permits had been requested. Therefore, as of that date, there was a grand total of 1,034 operating and potential FM broadcasting stations — or about three-fourths the number of AM stations in operation.

Recognizing that the job of the telephone companies is to provide the best possible service for all who want it, the Bell System, in designing telephone plant, aims at a flexibility which permits its wire facilities to fill a variety of requirements. Thus, many of the System's existing channels of communication are adaptable to the transmission of telephone conversations, teletype messages, radio programs, telephotographs and, in certain cases, television.

In general, radio broadcasters are now using transmission facilities with an upper frequency range of 3,500 or 5,000 cycles, and, in a few cases, 8,000 cycles, depending on the individual requirements. With the development of networks for FM broadcasters, however, there may be a demand for long-haul transmission facilities carrying up to 15,000 cycles.

Beginning as long ago as 1933, the Bell System carried on extensive experiments in anticipation of filling such needs. These tests have demonstrated conclusively that the System is well able to furnish 15,000-cycle transmission for commercial use. Today the experimental stage is behind us.

The telephone companies' long experience in the broadcast transmission field provides further assurance that their existing nationwide wire networks — including coaxial cable — can be readily adapted to the needs of FM broadcasters within a reasonable period of time after receipt of orders for network facilities. It is important, however, that prospective network operators give the telephone companies adequate advance notice of their plans to allow time for the installation of the special terminal equipment needed to provide suitable program circuits. Although Bell engineers are preparing this special equipment for manufacture, it is not felt that quantity production of it ought to be undertaken at this time in the absence of sufficient orders from broadcasters.

> **T**O GIVE a proper perspective on network rates, here are some figures from the record which should be considered in evaluating the costs of high-fidelity FM program distribution:
>
> In 1926, the year that AM network broadcasting started, the rate for a 5,000-cycle line was $7.00 per route mile per month. Today, rates are determined on an air line basis. Route mile distances are 40% longer than an air line distance. Therefore, the 1926 rate must be adjusted to $9.80 in order to compare it with present-day rates.
>
> Now, 5,000-cycle lines cost $6.00 per airline mile per month. This represents a rate reduction of 40% since 1926, in spite of the fact that a dollar bought a great deal more then than it does now!
>
> In 1926, each AM station paid $4,000 per year for its connection to the network. The present charge is $900. The cost to FM stations may be $1,500.
>
> These facts indicate that rates of $12.00 per mile per month for 15,000-cycle lines, and $125 for the station connection will offer no financial obstacle to high-fidelity FM networks. Moreover, it is reasonable to expect a substantial reduction in these charges as soon as 15,000-cycle nets are in operation on a national basis. — EDITOR.

Also, long distance lines are still overloaded in many sections of the country and under these circumstances it is not planned to divert broad-band channels to set up networks prior to the time they are requested. However, construction of new facilities is proceeding rapidly; as additional broad-band systems are installed for telephone purposes, the potential facilities for FM broadcasters' networks are being steadily increased.

When FM broadcasters feel it is time to establish networks, there is some question also whether 15,000-cycle channels actually will be desired at the outset. In order to be in a position to meet whatever future needs may develop, the telephone companies are canvassing all FM stations, construction permit holders, and applicants to learn the demand for high-fidelity network facilities. While there has been no evidence of demand in previous years for high-fidelity circuits, nevertheless the Bell System is keeping informed as to current new demands and the probable future network needs of FM broadcasters.

It is interesting to note that, in answer to inquiries from the telephone companies, some FM broadcasters have indicated that their network requirements would be well served initially by the 5,000 or 8,000-cycle quality now offered in the tariffs.

When 8,000-cycle network facilities are provided, their monthly cost, as stated in the tariffs, is $8 per mile and $125 per station connected for 16 hours a day. This compares with $6 per mile and $75 per station connected for 5,000-cycle service, the type generally used today for commercial AM networks. No tariffs have yet been filed with the Federal Communications Commission for 15,000-cycle program channels. Tentative rate proposals, however, contemplate monthly charges of about twice the 5,000-cycle rates.

While intercity networks for FM broadcasters are still in the formative stage, there has been a substantial growth in short-haul 15,000-cycle transmission facilities provided to connect FM stations with detached transmitters. A recent survey of 137 operating FM stations showed that 79 studio-transmitter links were being furnished by telephone company wire facilities. Seven others were provided by the broadcasters themselves, while 51 FM stations had their studios and transmitters in the same building, making such outside circuits unnecessary. In addition, 15,000-cycle circuits enabling FM studios to be connected with local pickup points have been available for some time.

Channels provided by telephone companies for short-haul circuits such as these are supplied by regular telephone lines adapted for program use. Where the distance covered exceeds 8 to 10 miles, the installation of special amplifying equipment or loading systems is sometimes required.

As indicated above, terminal equipment which will adapt the expanding broad-band carrier facilities for 15,000-cycle intercity transmission is ready for manufacture. Volume production of such equipment and the adaptation of wire circuits for FM purposes will depend on the extent of demand for high fidelity network facilities. But whatever the future network needs of FM broadcasters may be, the Bell System will be able to fill them.

---

* General Manager, Long Lines Department, American Telephone & Telegraph Co., 233 Broadway, New York 7, N. Y.

MAJOR EDWIN H. ARMSTRONG GAVE THE NEW YORK DEALERS THE MOST EFFECTIVE KIND OF SALES TALK: THE OPPORTUNITY TO HEAR LIVE-TALENT FM RECEPTION

FOREWORD

THE Engineering Societies Auditorium in New York City has witnessed some dramatic presentations of progress in the arts and sciences, but none has equalled the occasion when, on June 19th, Major Edwin H. Armstrong repeated the demonstration of FM reception that he first gave on November 6, 1935.

At the first demonstration, radio engineers listened with unconcealed skepticism to the performance of an experimental receiver, frankly and obviously the product of a research laboratory.

When, nearly 12 years later, he repeated the demonstration in the same auditorium, the audience of more than 700 New York dealers came to learn about the performance of a system which has become a nation-wide public service, and they listened to reception from commercial, production equipment.

And it is interesting to note that, although the war years interrupted the initial progress of FM broadcasting, not even the total disruption of the radio industry served to stop the swing to this new system that began in 1939, when the first FM stations went on the air.

The following address was delivered by Mortimer H. Fogel, one of the long-established radio dealers in New York City and master of ceremonies when the Dealers' Group of the Electrical & Gas Association of New York played host to Major Armstrong.

Mr. Fogel's remarks are of particular significance because he summarized the attitude of aggressive retailers toward FM as a means of bringing back the profits which, in 1939, were brought down to the vanishing point by the introduction of $9.95 AM receivers.

FM DEMONSTRATIONS: 1935, '47

Concerning the Changes That FM Broadcasting Has Brought to the Business of Selling Home Radio Receivers

BY MORTIMER H. FOGEL*

THOSE of you who know me, and many of you do, know that this is not the first time I have championed the cause of the retailers. But although I can recall many a meeting of the retailers of this New York area, never can I recall a meeting that meant so much to so many. And as for my own participation in past meetings, never can I recall one that gave me so much pleasure, or so much cause for enthusiasm.

My enthusiasm for FM dates back to 1935, when I heard the first demonstration of Frequency Modulation reception at the November meeting of the Institute of Radio Engineers in this very auditorium. FM at that time was a sassy young upstart in this industry of ours, suddenly come upon us without warning of any kind. I recall that the audience was spellbound. Few realized that what was taking place would make radio history, yet most of those present suspected the magnitude of what was being described and demonstrated to them. Their answer was not long in coming. It started slowly at first. Then, gradually gathering momentum, like a tidal wave, obstacles were swept from its path until at this very minute FM is ready to engulf the entire country with its crystal clear reception.

Before we proceed with our meeting, let me assure you that we are not here tonight for fun, nor to waste your good time. This is a business meeting. We are here tonight to learn at first hand of new wonders that are within our reach. If we grasp the full meaning of these new wonders to our business as radio dealers, we can work with greater effectiveness because of the knowledge we shall have gained.

It is just about two years since the war ended, and during these past two years the experts have been telling us at every opportunity that we have been heading toward that ethereal will-o'-the-wisp state of affairs called "normal."

* Mortimer H. Fogel Co., 92 Liberty Street, N. Y. City

NATHANIEL NORMAN BUILT THE KLIPSCH SPEAKER USED AT THE DEMONSTRATION

If there is a goal or an objective we are trying to reach that will in fact be a normal condition, I hope we never get there. The very term "normal" connotes such a complete finality, such a state of inertia in terms of business, that in my mind if we did get back to normal we would stagnate and wither at our very business roots. This normal business makes me feel that we are looking backwards, ready to pattern our future after some particular period in the past.

Now, rather than work toward a goal which does not exist in fact, I for one want to work toward a goal of change, and I don't mean change as in money, but constant and everlasting changes that will advance business. I want to work for changes that will correct old abuses, changes that will solve our problems as they arise and, most of all, creative changes that will open new avenues of business for us, and for services to our customers.

This meeting tonight is a change in the very fullest sense, as I refer to it. It is a change because probably for the first time in many years, if not in the entire history of our industry, all segments of the industry have coöperated unstintingly with us for the purpose of this meeting. And I want to say now that this meeting is but the first step in a new program of progress for New York Dealers' Group. This is an evening that will long be remembered by every one of you as the forerunner of a new spirit of coöperation between ourselves, the radio dealers, and our partners in business: the distributors, the manufacturers, and the men of science in the laboratories. So this meeting represents a change in terms of coöperation for our mutual benefit.

OFF STAGE, FRANK GUNTHER, FOREGROUND, AND GORDON RUSSELL HANDLED RECEPTION, CHALKED UP NOTICE TO MAJOR ARMSTRONG THAT ALPINE WAS READY

In addition, this meeting represents a change that is designed to correct an industry problem. That problem is ignorance — ignorance on our part of the greatest and most fundamental development in the history of all radio — and I mean FM.

I could go on and on for the rest of the evening describing the benefits of throwing off the old ideas and the old procedures and prejudices, for thinking in terms of the new problems will bring us new success as surely as God gave us a man who could find the secret of eliminating static.

There are those who will tell you that success in business is due to luck or getting the breaks. To my mind that is pure bunk. I have long believed that the very essence of business is a challenge, a constant challenge to our ability and to our ingenuity to work out each day's problems as they arise. But ability and ingenuity are no longer enough for, make no mistake, the technical problems we will be facing within a year or two and maybe sooner will make the prewar days seem like a picnic by comparison. A knowledge of prices and discounts is not enough.

It is with the coming of technical problems in mind that I have discussed the value of changes as opposed to a return to normal as our outlook for the future. If, individually and collectively, we set our sights high, aiming for the top with vigorous, alert minds, we will build a standard of progress for our industry second to none. Failure to appreciate the value of the advancements of the radio art and their services to our customers is to invite chaos, and quickly. The wheels of the radio industry are turning faster than ever now, and they will be turning still faster and faster in an ever-rising crescendo that is accelerating the obsolescence of prewar products and prewar sales methods.

The purpose of this meeting is to bring you the full and complete story of FM — its origin, its advantages, its effect upon your business, its progress to date, and its importance to your future. Whether you realize it or not at this minute, FM is here to stay as a vital and compelling part of your business. If you will make use of the knowledge you will gain here tonight, you cannot fail to benefit in your business for you will learn much about selling the radio of tomorrow, and I mean FM.

The first step in building increased profits from the retail radio business is to shift our sales effort from conventional sets of small unit price to the new FM models carrying price tags that make our work worthwhile.

The first essential to the intelligent, effective promotion of FM is an understanding of what it can mean in greater enjoyment to our customers. So we are going to have a demonstration of live-talent FM reception. The program will originate at the home of C. R. Runyan, Jr., in Yonkers. It will be beamed to Alpine, and transmitted to us from there. This reproduces the conditions of the first public demonstration of FM broadcasting, staged in this auditorium almost 12 years ago. Then, the equipment was the product of the research laboratory. Now, we shall hear reception on standard, commercial equipment. The demonstration will be conducted by the man who, in the intervening years, has probably done more for our industry through basic, fundamental, scientific research than any other person in the world, past or present — a man whose concrete accomplishments defy comparison. We owe much to him. His words carry the power of authority, for he is the Father of FM — He is Major Armstrong!

INEXPENSIVE "STARTER" MODELS ARE INTRODUCING MANY LISTENERS TO FM. LEFT: SWITCH ON ELECTRONICS MODEL IS FOR BUILT-IN OR EXTERNAL AMPLIFIER & SPEAKER. RIGHT: PILOT FM TUNER OPERATES THROUGH ANY AM SET

SET DESIGNS ARE CHANGING

Emphasis Is Shifting to the Audio Amplifier and Reproducer

BY MILTON B. SLEEPER

DRAW up around the cracker barrel, and let's settle down for another bull session. This time it has to do with a fundamental change in radio sets that will make present designs very, very obsolete.

We ought to have an FM receiver with a good audio end and speaker to bring in some live talent during this session. It would help to clarify some of the points we are going to discuss. On the other hand, FM reception on a 15,000-cycle system is so compelling that we'd probably drop the discussion and just listen to the program.

If you've heard that kind of FM, you will agree with what we're going to say. But if your listening has been limited to the stuff that some stations are still grinding out from records, you may have decided that 15,000 cycles is the bunk, and high-fidelity FM just a promotion gag. Don't go away, though. If that is your opinion, we shan't try to convince you otherwise. Some day, you'll hear the real thing, and then you will join the chorus of those who are demanding: "We want more live-talent FM programs!"

Now, to get down to the text of our one-item agenda: The day of the conventional cabinet radio sets is already passing.

That observation is not a prophecy. It's an accomplished fact. Oh, cabinet radios, both table types and consoles, will be made for some time to come. But the miserable little squeak-box that talks and sings through its nose, and the awkward floor models with their swinging doors and hinged tops are definitely on their way out. The only exceptions will be table models as second sets for children, and for use in bedrooms and kitchens.

Maybe you, too, have seen this coming. If not, let's take a look at what has been going on:

During the first 20-odd years of broadcasting, cabinets were designed to conceal the machinery of the radio receiver, and the dimensions of the machinery were shrunk and modified to facilitate concealment.

Manufacturers considered the tuner the most important part of a radio set because it brought in the stations. The amplifier and speaker were merely adjuncts necessary to make the signals audible. Whether they were good or bad made very little difference, but it was necessary that they be cheap in price. Considerations of fidelity were purely personal and academic because of the 5,000-cycle limitation imposed by network lines, and the narrow-band tuning required in receivers to minimize adjacent-channel interference.

And, as if that were not enough to make the use of good amplifiers and speakers unjustified, there was, and still is on AM, an over-riding layer of background noise, interference, and static to ruin high-fidelity reception even if it were otherwise possible.

Now, note this carefully: That was the situation until 1939, when regular FM broadcasting came on the air.

FM reduced the status of the tuner to that of a mere station-selecting device — the means of feeding programs into the audio system. The important part of an FM receiver is the amplifier and speaker. This is true both as to cost and mechanical dimensions. In fact, the RADIO cabinet has become the SPEAKER cabinet, generally with room provided for the amplifier. And since it is so much easier to design attractive and simple cabinets to house only the speaker and amplifier, both the tuner and the record player are being squeezed out into inconspicuous, separate units.

There, in this simple statement, you have the picture of the revolution in design that has come upon our industry.

You don't agree? Perhaps you haven't had the opportunity to hear much good reproduction of live-talent FM broadcasting.

You say that FM stations are only transmitting low-fidelity records? That may be true of the stations in your area, but give them time. They'll catch up with the others.

People don't want high-fidelity, anyway? Now, are you sure that what they didn't like really was high-fidelity? Or was it reproduction from a $2 amplifier feeding a 6-in. speaker?

Let's nail down that last point right now. The miserable little amplifiers in AM sets are good enough to make the kind of speech and music the public has come to accept as "radio reception," but that's all they are meant to do.

Distortionless reproduction of perfect signals calls for a near-perfect audio system. This means an amplifier costing $50 to $125, and a speaker at $150 to $450, depending upon the degree of near-perfect reproduction required at a given installation.

And how much for a tuner to drive that audio system? That is a relative matter, too. It is related to individual taste and means. But it doesn't alter the principle underlying our discussion.

For people who have expensive phonograph combinations with fairly good audio ends, if they don't want to spend much money to add FM reception, there are low-price tuners. They might be called "starters," because they give listeners a chance to become acquainted with the advantages of FM, even though they do not provide the full benefits.

Those who want to hear more and more distant stations with better noise suppression, must pay a higher price, of course. They will probably want special amplifiers and speakers, too.

As time goes on, and additional FM stations come on the air with an increasing amount of live-talent programs, listeners will become more critical of their reception, and there will be a growing demand for FM installations comparable in performance to a fine piano, and nearly as high in price.

Maybe you think this won't happen. Perhaps your experience tells you that there is no broad foundation to support a market for sets priced above $49.95, and that cabinet styles aren't going to change. Well, there's a lot to be said on that subject. Let's go into it at our next session around the cracker barrel.

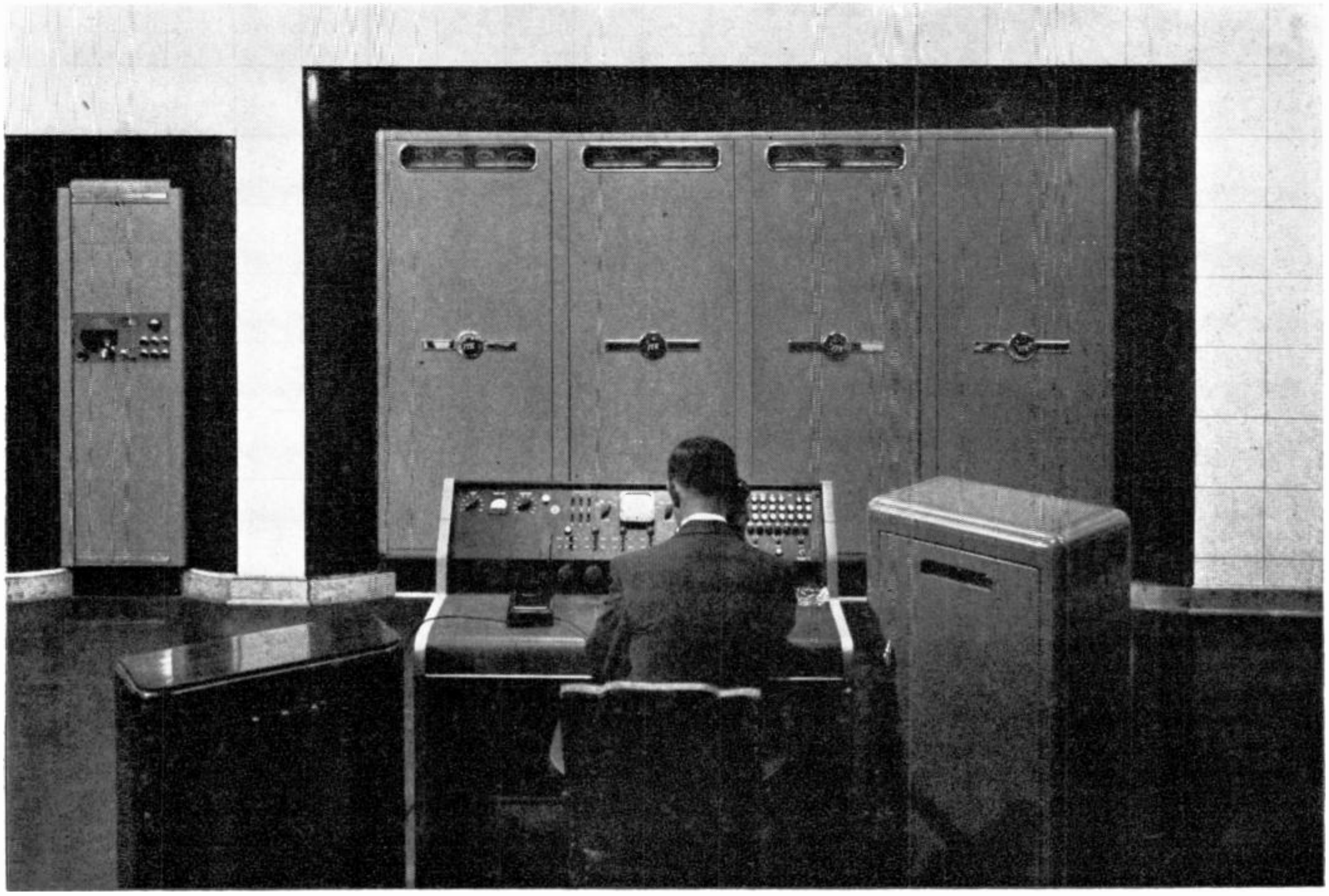


FIG. 1. THE 10-KW. FEDERAL FM TRANSMITTER IS SET INTO THE WALL OF THE ENGINEER'S OFFICE, FACING THE CONSOLE

THE 48.6-KW. INSTALLATION AT WMRC-FM

An Account of the Planning, Installation, and Operation of a High-Power FM Station

BY W. ENNIS BRAY*

THE planning and construction of WMRC-FM has caused many a headache, but now that the transmitter is on the air with a 9-hour schedule 7 days a week, its performance is ample justification for all the effort our staff put into it.

From this experience, Mr. R. A. Jolley, our president and treasurer, will probably tell you if you ask him about going into FM: "First, get an accurate estimate of the cost. Then, if you are prepared to spend twice that much, go ahead."

Actually, we did better than that. Our estimated cost of $75,000 climbed to $125,000 by the time the installation was completed. I might add that, with a less capable chief engineer, this final figure would have run up considerably more.

Still, this investment is far less than that required for a 50-kw. AM transmitter, giving far less primary coverage.

¼ KW. AM VS. 50 KW. FM

THIS ARTICLE, by the General Manager of WMRC and WMRC-FM, is of particular interest to AM broadcasters because it tells the story of a local AM station whose owners had the means and the vision to step up into big-time operation, but were limited by their position in the over-crowded AM band.

Now, with almost 50 kw. radiated on FM, this station has a potential audience far beyond anything that can be offered by an AM competitor. (WMRC-FM is now preparing to file for increased power to 75 kw.)

The only remaining task is to build the fact of FM coverage into a numerically competitive audience. How long will it take? Perhaps two years. Perhaps less than that, because the experience of listening to FM is such highly effective sales promotion for FM receivers.

With FM set production gaining steadily (now approximately equal in dollar volume to AM sets) the principal controlling factor in building an FM audience is the character of the programming.

Why Go into FM? ★ Just in case some of my fellow broadcasters have the idea that our going into FM was a matter of looking for trouble, let me explain our situation:

When the Textile Broadcasting Company filed its AM application with the FCC in 1940, the best assignment obtainable was 250 watts full time on 1490 kc. Nevertheless, after the usual initial struggle, the station prospered. But we weren't satisfied to continue on a local basis. We had proved that we were performing a valuable public service in an area that was developing industrially at a rapid rate. And we wanted more coverage.

Looking back, it is clear that our decision to enter FM was a smarter move than we realized then, for just a few months ago a station on our AM frequency was authorized in Ashville, N. C., 58 miles away by air line!

Now, as we plot the coverage of our FM transmitter from reports of regular, dependable reception, we find that it exceeds

*General Manager, WMRC and WMRC-FM, Greenville, S. C.

R. A. JOLLEY, SUCCESSFUL AND RESPECTED BUSINESS MAN, PUT BLUE CHIPS ON FM

the primary area of any 50-kw. AM station. That, by the way, has been done with only 37 kw. effective radiation from our antenna for, while the erection of the 8-bay structure was completed some time ago, we were using only 4 bays at first. The plumbing for connecting the other 4 bays was delayed, and we are only now up to our full power of 48.6 kw.

Meanwhile, as a result of the great amount of FM activity in this part of the South, the leading dealers are doing an enthusiastic promotion job on FM receivers. Those we have interviewed have been unanimous in saying that they are refusing to buy any straight AM receivers retailing at more than $24.95 to $29.95!

It's a very comforting feeling to know that we are doing a major job in developing the new FM audience, and that by the time we have gained adequate experience with all the new techniques involved, the audience will be large enough to assure commercial operation on a profitable basis.

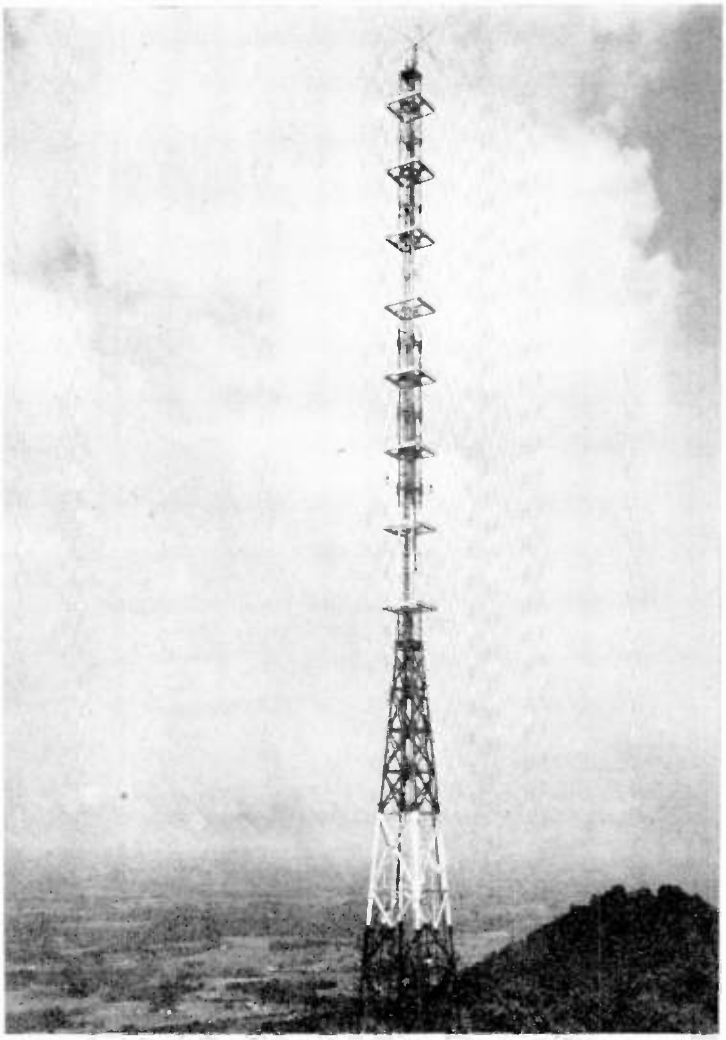
The occasion of our inaugural ceremonies on July 13th, when WMRC-FM held its official open house for the public, was a definite indication of interest in our new activities. Over 2,000 people drove up Paris Mountain to get their first view of our transmitter, and to hear FM reception over the monitor speakers. Our local dealers felt the effect of this in an immediate increase in calls for FM sets. Incidentally, all the publicity that we have built up around our FM activities has strengthened our competitive situation on AM business, and has done much to set the groundwork for selling FM time. That will be discussed in the second part of this article.

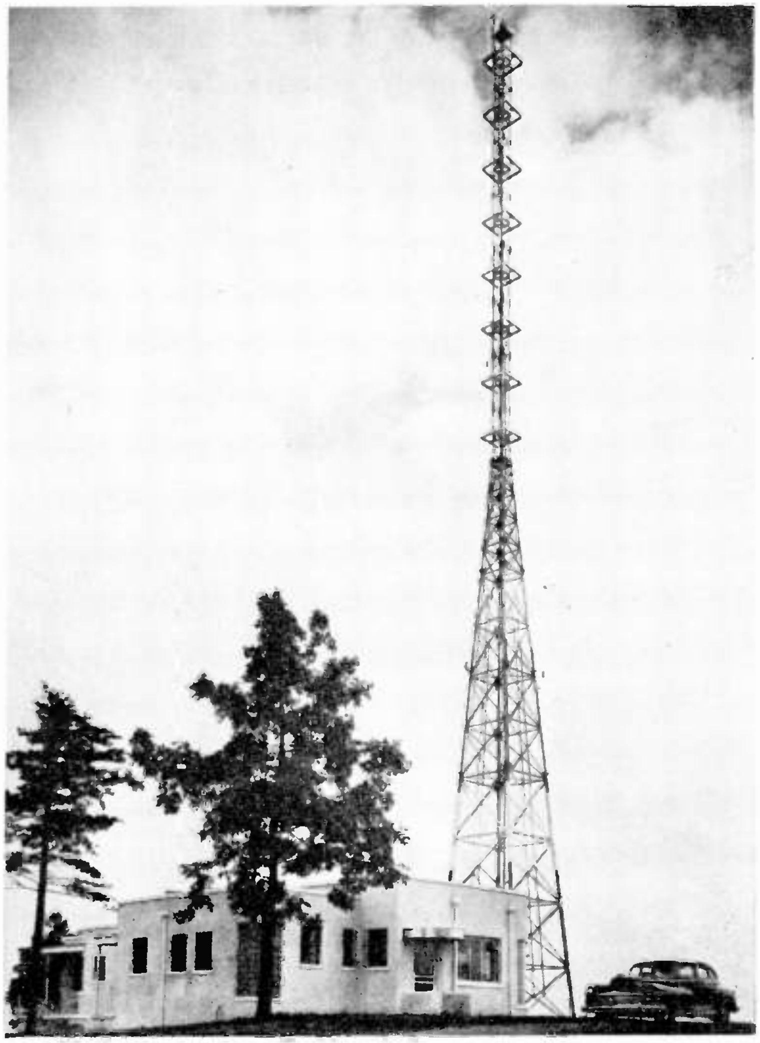
I said we had many headaches by the time WMRC-FM went on the air. Actually, they were the normal concomitants of a venture into something completely new and strange, further complicated by the problems of building anything under present conditions.

Now that we have gone through the experience of building an FM station, many of the answers over which we struggled so hard seem very obvious. Perhaps some of them will help others who are just starting out, or are still trying to decide upon taking the first decisive steps.

Transmitter Site ★ Our first discussion of FM started in 1943. Having determined on a course of action, we placed our order for a 10-kw. Federal FM transmitter, with an 8-bay antenna, and got our construction permit on November 12, 1946. We met the FCC's requirement of 6 months

FIG. 2. VIEW OF THE 8-BAY FEDERAL SQUARE-LOOP ANTENNA FROM NEARBY FOREST RANGER'S TOWER. FIG. 3. VIEW FROM GROUND





time to the day, putting the transmitter in operation on May 12, 1947.

In our area, the top of Paris Mountain was a logical choice because it is the only elevation that stands up well above the surrounding terrain. You can see this from the accompanying illustration. It is 6½ miles air line from downtown Greenville, and is 2,047 ft. above sea level. A good road had been built to a point near the 128 acres which we purchased.

However, there was no electric power up the Mountain. After a consultation with officials of the local electric company, it was agreed that they would run the lines without cost to us if we could secure the right of way. The property owners were very coöperative, and the arrangements were made without any charges except at one section where the line had to go up a very steep bank. The owner of that property asked $500 because, he said, "This is the only chance I'll ever have to get anything out of that land. It's so steep that it's no good for anything except to run wires over it." We paid him!

The work of building the road to the summit and clearing the land involved no complications, except that we did it during the winter months. Fortunately, we had very little trouble from extreme weather conditions. Water was available in ample supply a short distance down the mountain. We piped it up to a much larger tank than is needed for the station because we expect that a part of our land will be sold later as sites for new homes. Mr. Jolley himself will probably build the first one up there.

While we were making the necessary preparations on the Mountain, two other projects were under way on paper. These were the design of the transmitter building and the tower.

Antenna Tower ★ We had placed our order well in advance for a 10-kw. Federal transmitter, and an 8-bay, square-loop antenna, a combination that assured us of our authorized effective radiation of 48.6 kw. With the advice of Federal engineers, we arrived at the general specifications for the tower and arrangement of the coaxial lines.

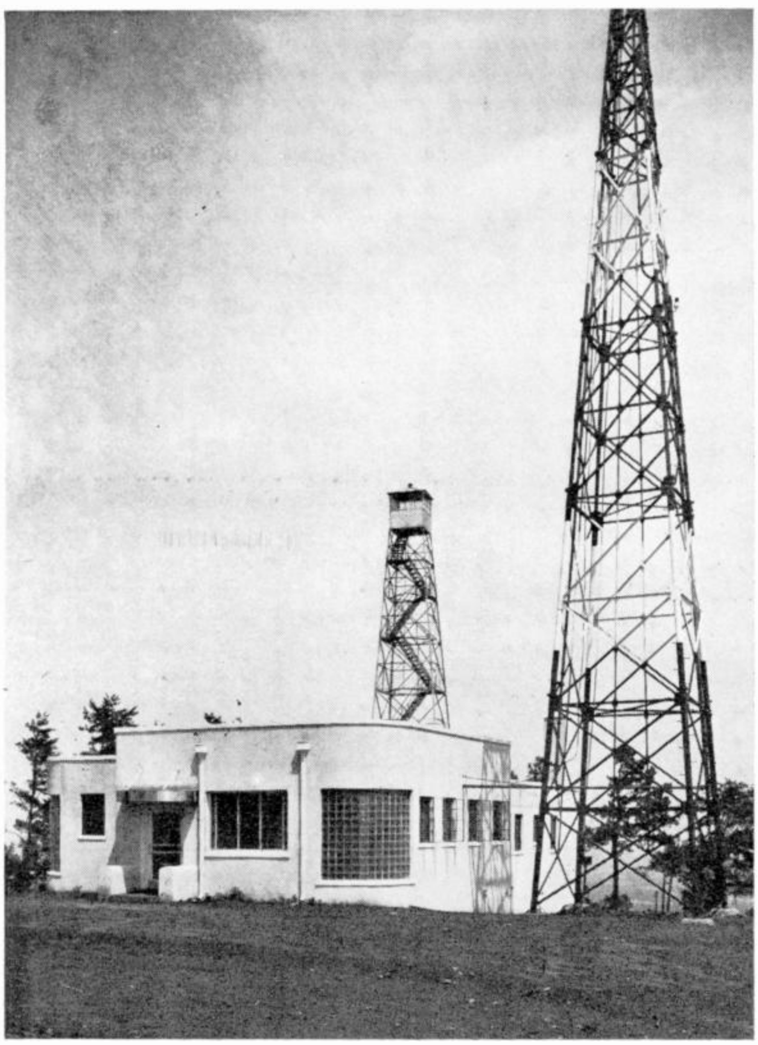
They called for a supporting structure 88 ft. high, with a 77-ft. mast to carry the square loops. All the details are shown in Figs. 2 to 5 and 8.

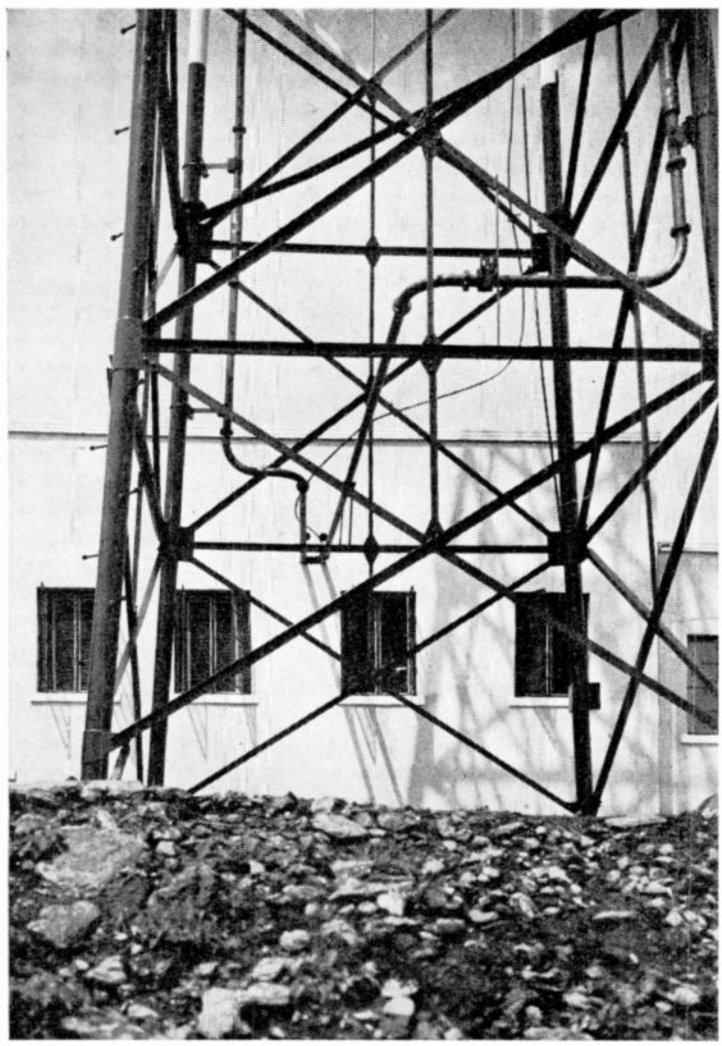
We had it fabricated locally by the Greenville Steel Company, and another local concern, the Conway Construction

THE AUTHOR SMILES OVER THE ENTHUSIASTIC REPORT OF ANOTHER FM LISTENER

Company, handled the erection. There were no unusual problems or difficulties other than delays which consumed extra time that ran into extra expense. The four concrete piers go down 12 ft. into solid rock and, with the ample factors of safety allowed, we expect the antenna to

FIGS. 4 AND 5. CLOSE-UP VIEWS OF THE TOWER CONSTRUCTION SHOW THE SIMPLE ARRANGEMENT OF THE TWO COAXIAL LINES





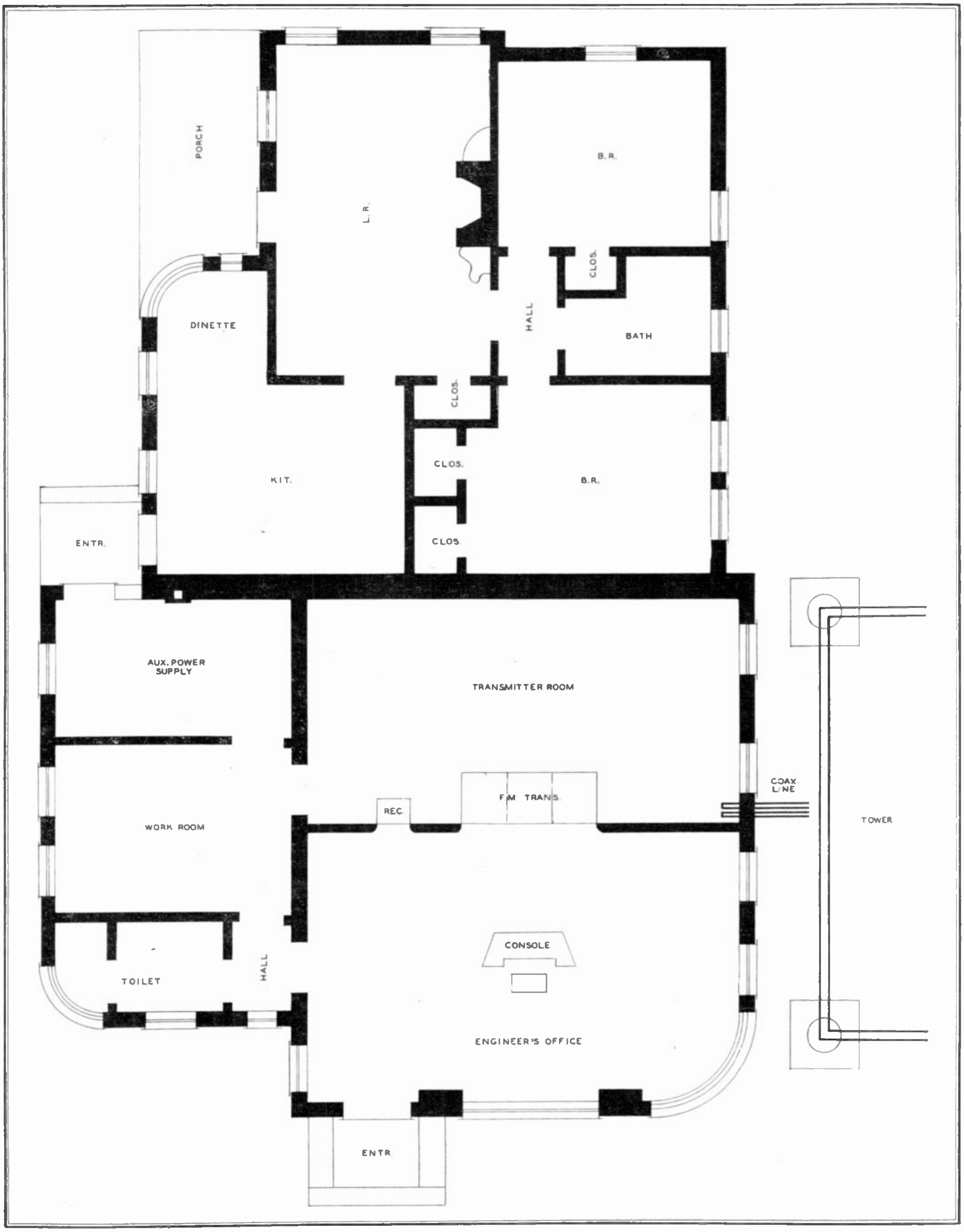


FIG. 6. PLAN DRAWING OF THE TRANSMITTER FACILITIES AND COMFORTABLE QUARTERS FOR THE CHIEF ENGINEER AND HIS FAMILY

withstand any storms or ice load that might develop under the most extreme conditions.

We have provided de-icing units in the loops, to eliminate that hazard, anyway. Also, if you look closely in Fig. 2, you will see rods pointing down toward the corners of each loop. These are to relieve the corner insulators from the accumulation of ice. The coaxial lines, as Fig. 5 shows, were easy to install. Each line feeds 4 bays. There is no exposed plumbing to be affected by winter conditions and the proximity of the tower to the transmitter brings the length of the lines down to an irreducible minimum. The simple phasing section is in the transmitter room.

In addition to our FM antenna, the tower also supports the receiving antenna for our studio-transmitter relay receiver, and an antenna for a county communications transmitter which is installed in our building.

Transmitter Building ★ Fig. 6 presents a plan drawing of the transmitter building, which includes accommodations for George Tate, our chief engineer, and his family.

In this manner, we solved one housing problem, and made it possible for our chief engineer to carry out his official duties in a convenient and agreeable manner. Since the road up the Mountain is open all year 'round, social, school, and marketing problems are met without difficulty by the Tate family.

As the plan indicates, the building is divided into two sections by a lateral fire wall, with the transmitting facilities at the front, and living quarters at the rear.

The control console, at the center of the engineer's office, faces the front panels of the transmitter. This layout can be seen in Fig. 1. At the left is the metal cabinet that houses the relay receiver, a Hallicrafters model with a slightly modified output.

Ample working space is provided in the transmitter room, behind the transmitter cabinets. In order to absorb the sound from the blowers, we covered the walls and ceiling of the transmitter room with acoustic blocks. That had the effect of reducing the noise level in the engineer's office. Also, because the summer temperature on the Mountain sometimes runs high, we found it necessary to install an exhaust fan in the transmitter room. That was the only auxiliary cooling means we found necessary. The simplicity of install-

GEORGE TATE, CHIEF ENGINEER OF GREENVILLE STATIONS WMRC AND WMRC-FM

ing a transmitter equipped with air-cooled tubes certainly has much to recommend it.

In case you wonder at not seeing any evidence of a frequency monitor, it should be explained that, like several other items, it hasn't been delivered yet. Even now, we are still minus quite a number of things that are necessary, but not immediately essential to the operation of the transmitter. They are coming in slowly. In the meantime, we have got our station up to full power, and that is what is most important right now!

Off at the left of the engineer's office is a shop fitted with benches and such tools as are needed for maintenance and repair. Also, it provides space for the storage and use of test instruments. This is a most necessary adjunct to a transmitter, particularly in these times when so much special equipment can be built in much less time than it can be bought in assembled form.

Behind the shop is space for an engine-driven generator to serve an auxiliary power supply in case the line up the Mountain fails. This unit is not shown in the illustrations for the reason that, at this time of writing, it is being set up. When the installation has been finished, the operation of the power supply will be fully automatic. If the line fails, the engine will start immediately, and the generator will be cut over to the transmitter in a matter of a few seconds. This source of current will also take care of the electric lights.

Power Lines ★ The power line up the Mountain delivers 13,000 volts. This is stepped down to 220 volts, 3-phase, and 220 and 110 volts single-phase. Transformers are set up on poles, as shown in Fig. 7, from which the operating voltages are brought to a control panel in the building. This simplifies the wiring, and keeps the 13,000-volt supply away from the transmitter installation.

Part 2 of Mr. Bray's article will discuss the WMRC-FM S-T relay, studios, personnel, programming, and coverage. This will appear in our September issue.

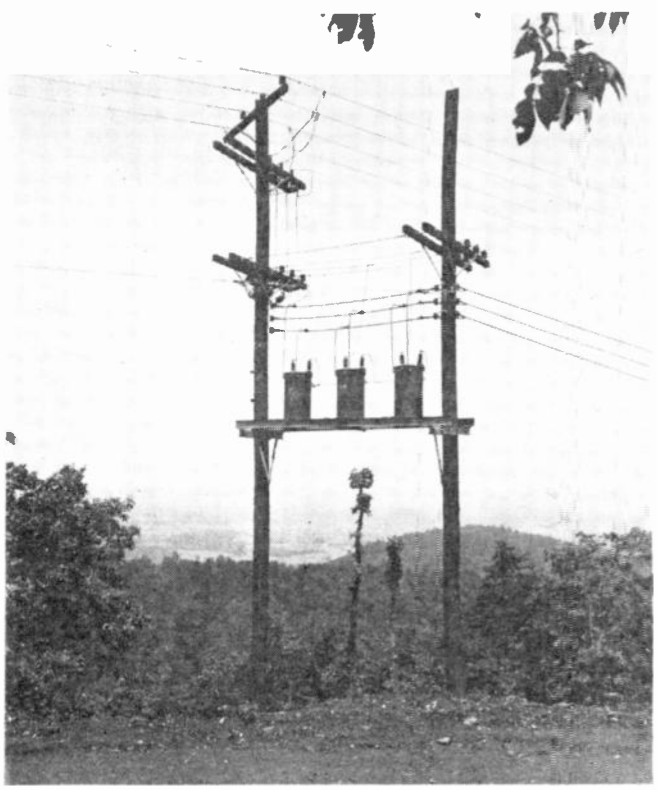


FIG. 7. LINE VOLTAGE IS STEPPED DOWN BEFORE IT ENTERS THE BUILDING. FIG. 8. VIEW OF THE BUILDING FROM THE LEFT

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

Sign of the Times: That the market for FM receivers has already grown to national proportions is indicated by the receiver models listed in the new Montgomery Ward catalog. While the spring-summer catalog listed only 2 FM-AM models, the new issue shows 5. AM models range from table types at $15.95 to $37.95, a console at $72.95, and a phono combination at $136.95. FM-AM models start with a console at $124.95, and run up to "Ward's newest and finest" phono combination at $239.95.

WFMZ: Penn-Allen Broadcasting Company, Allentown, Pa., dedicated FM station WFMZ at a very elaborate ceremony on July 30th.

Added Plant: Insuline Corporation of America has added an annex of 25,000 sq. ft. to its plant at 19th Avenue and 36th Street, Long Island City, N. Y. It will be devoted to the production of automobile antennas.

Too Bad: WOR, according to a recent news release, not only has the means for creating 12,083 different sound effects, but a soundman so skilled that he can make "the sound of a man running with his feet, fire a pistol with one hand, knock the body over with his elbow, spin the cop's tommy gun record with his other hand and give blasts on his police whistle with his mouth." Now, WOR should have an FM station on the air, to give realism to all those sounds.

WBZ-FM: Boston station operated by Westinghouse has changed to its new frequency of 92.9 mc., but will continue on low-band at 46.7 mc. New schedule runs from 3:00 to 10:00 P.M.

Stanley Bracken: Former vice president of Western Electric has succeeded Clarence G. Stoll as president. Mr. Stoll, after 44 years with Western, and president since 1940, has retired.

Sold: Assets of Isolantite, Inc., manufacturers of ceramic insulation at Belleville, N. J., have been bought for $295,000 by Sidney Hollaender, president of Ever Ready Label Corporation, 141 E. 25th Street, New York City.

FM Antennas: Probably the most widely-publicized of recent articles concerning FM was John Carl Morgan's "Don't Blame FM — Put up an Antenna!" It was published in the May, 1947 issue of *FM* and TELEVISION. Since then, reprints have been distributed by Majestic, Stewart-Warner, Ward Products, several set jobbers, and nearly a score of broadcast stations.

New York-Schenectady Relay: G.E. is operating a 1-way microwave relay in the 2,000-mc. region to carry television programs from New York City to Schenectady. The first hop is 55 miles to Beacon Mountain, then 55 miles to Round Top Mountain, 29 miles to the Helderbergs, and finally 14 miles to the studio at Schenectady.

Television-Facsimile Combination: WFIC Philadelphia plans to be on the air this fall with both television and facsimile, and will offer the combination service to sponsors. Facsimile rates will give consideration to the number of home recorders and those installed for public viewing, since a Bureau of Traffic Engineering survey discloses that bulletin board recorders at 10 strategic locations in Philadelphia would have a potential readership of 952,000 persons in 12 hours.

Public Phones on Trains: Chesapeake & Ohio has applied to FCC for authority to install public toll telephones on two of its trains running between Washington, D. C. and Cincinnati. Plan is to use induction system.

New York Harbor: New York Central is speeding operations of its 24 tugs by use of newly-installed G.E. 2-way FM equipment, supplied by General Railway Signal Company. Antenna for the fixed station is on a 218-ft. grain elevator at Weehauken.

San Francisco Meeting: IRE and the West Coast Electronic Manufacturers' Association will join forces at an exhibit and technical conference on September 24 to 26. Further information can be obtained from WCEMA Secretary Noel Eldred, 395 Page Mill Road, Palo Alto, California.

New Receivers: The 1948 Westinghouse line will include FM-AM models ranging from an 8-tube table set at $99.95, an 11-tube console at $187.50, up to a phono combination at $600. Prices are still tentative.

Broadcast Employment: FCC figures just released show 34,831 employees in U. S. broadcast stations in February, 1947, up 18% from October, 1945. Total included 30,100 full-time staff employees, and 4,731 non-staff program employees.

Coaxial Cable: Withdrawal of tariffs previously filed for intercity television transmission by coaxial cable is generally accepted as indication that this service can be handled to better advantage by radio relays.

KOAD: FM station at Omaha has celebrated its first anniversary. During the past year, distributors' figures show 3,000 FM sets sold in the Omaha area.

Robert K. Dixon: Former engineer at Submarine Signal and an old-timer in the broadcasting field is the new production manager of broadcast equipment at Raytheon in Waltham, Mass.

Television for Apartment Houses: Some of the best television brains believe that the answer to television reception in apartment houses is not to be found in piping antenna connections to each tenant, but in transmitters of higher power. Reason: while the equipment involved is not expensive, labor and material costs for the wiring are prohibitive.

Non-Interfering Diathermy Equipment: First certificate of approval from FCC for diathermy equipment has been issued to Raytheon Manufacturing Company, Waltham, Mass. New unit operates on 2,450 mc.

Dr. A. Senauke: Retiring president of Amperex Electronic Corporation has become chairman of the board. He is succeeded as president by Nicolas Anton, formerly vice president in charge of manufacturing.

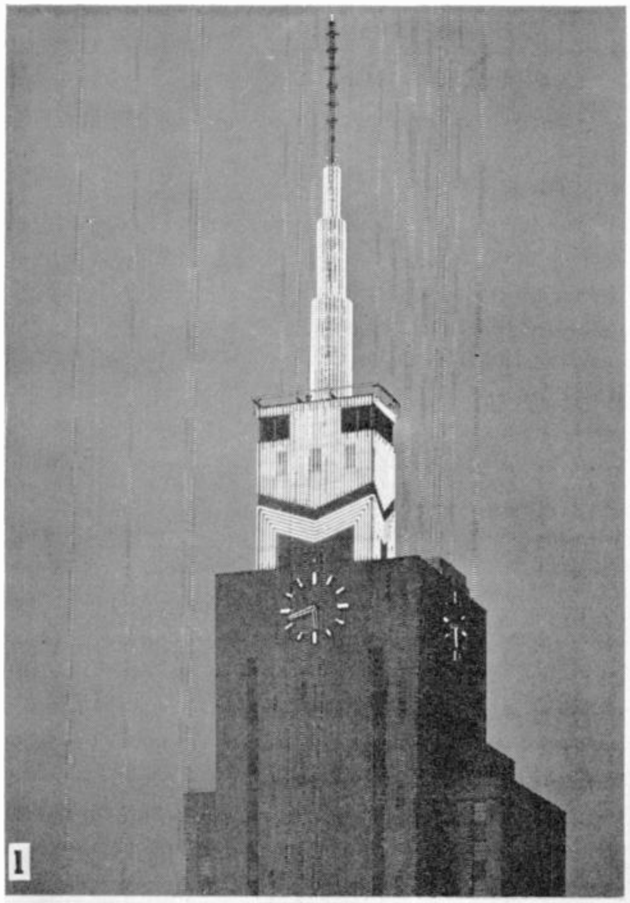
WFRO-FM: Effective June 30, WFRO-FM, Fremont, Ohio, increased its broadcast schedule to 75 hours per week. Schedule is now 11:30 A.M. to 10:00 P.M. weekdays, and 10:00 A.M. to 10:00 P.M. Sundays.

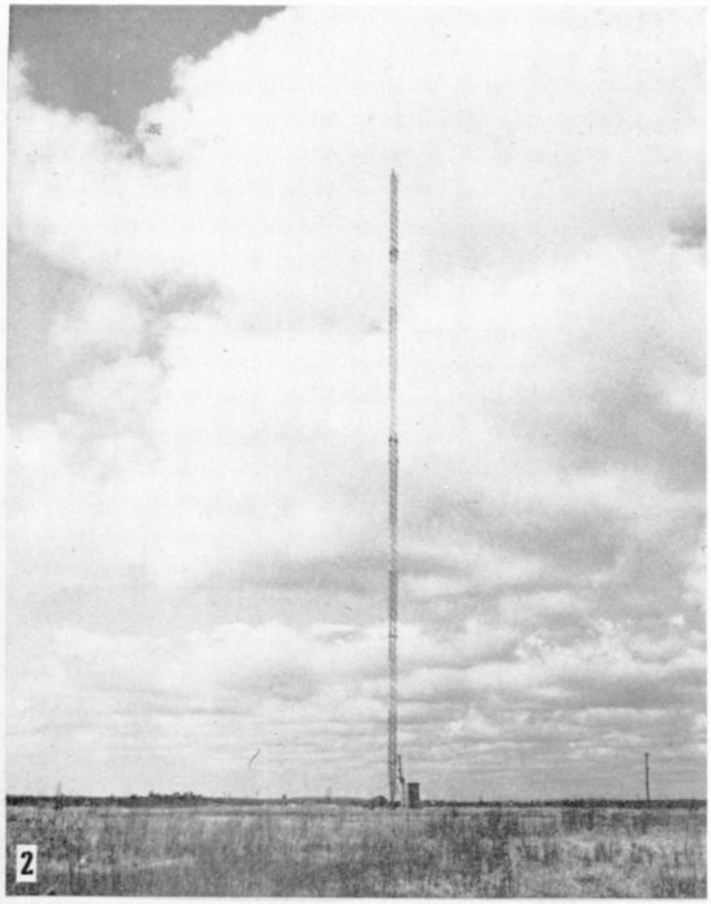
2nd FM Net: Everett Dillard's second FM station, KOZY at Kansas City, is getting another live talen FM netsork started. First program was carried to WIBW-FM, Topeka, on Sunday, June 29, at 8:30 PM. KOZY will also carry WIBW-FM shows. If this initial operation expands as fast as the Continental Net, it will soon include a considerable number of stations.

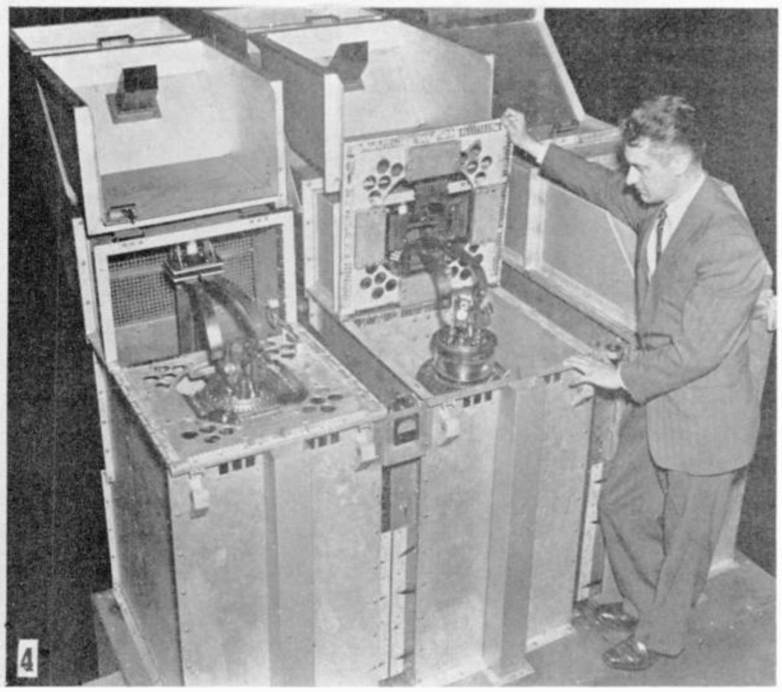
More FM Channels: First expression of FMA thinking on additional FM broadcast bands was contained in testimony by executive director Bill Bailey before the Senate subcommittee hearing on the White Bill: "we request that the Congress authorize the Commission to add another 20 or 30 FM channels to the present band, below and contiguous to 88-mc."

FMA Convention: Will be held September 12 and 13, at Hotel Roosevelt, New York City. This date precedes the NAB Conference at Atlantic City, scheduled for September 15 to 18.

WNLC-FM: Now on interim operation, is erecting a 226-ft. tower at Raymond Hill, Conn., a 602-ft elevation between New London and Norwich. Operation on full power of 20 kw. is scheduled for the first of 1948.





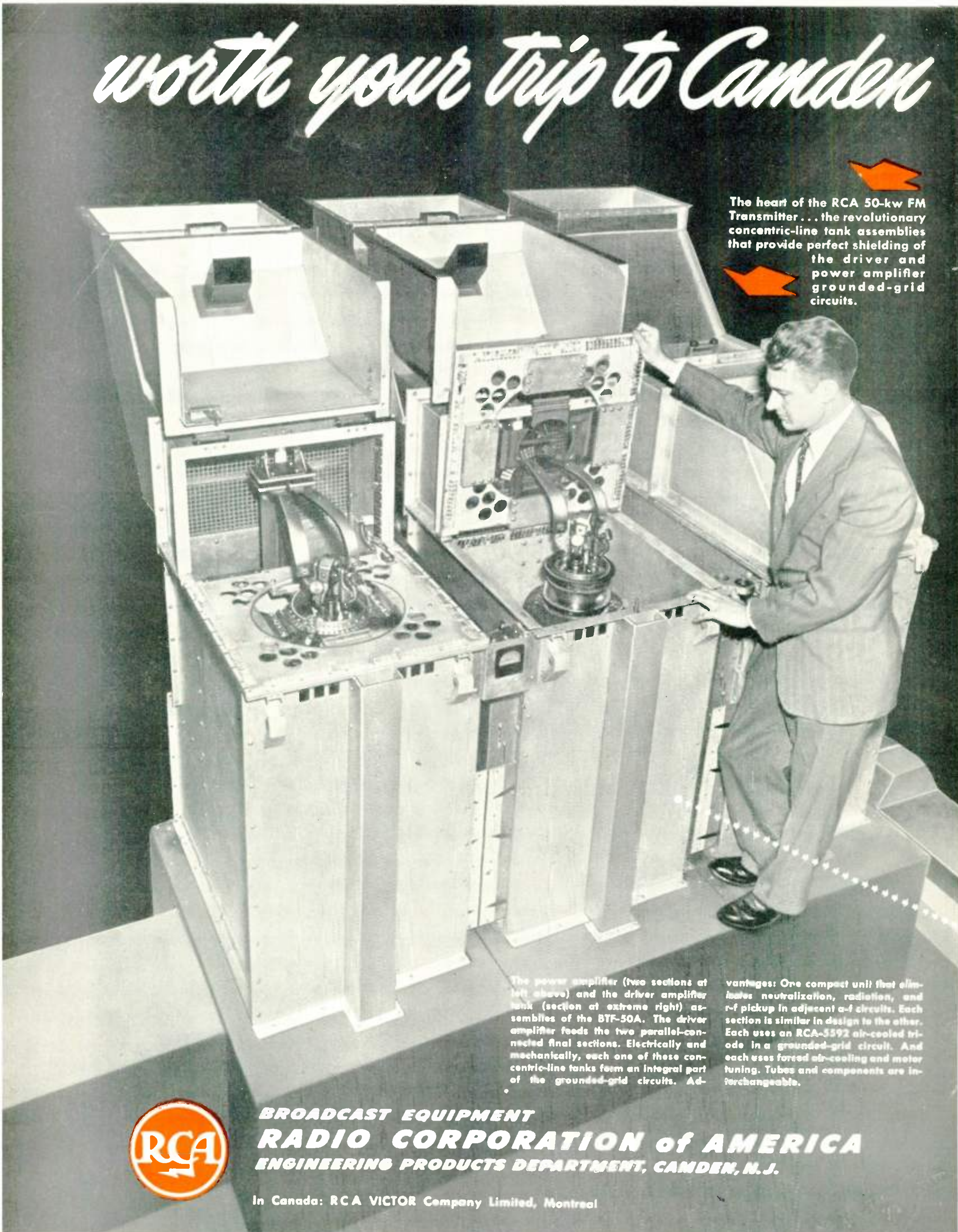


NEWS PICTURES

1 Station KERA-FM has made a striking display of their 8-bay Cloverleaf antenna on the Mercantile National Bank Building, Dallas, Texas. The first FM antenna completed in the Ft. Worth-Dallas area, it is now radiating 14 kw., and will be up to full rated power of 43 kw. early this fall. KERA-FM is owned by the *Dallas Morning News.*

2 Ontario-Minnesota Pulp and Paper Company, Ltd., the Canadian subsidiary of the Minnesota and Ontario Paper Company, is directing huge lumbering operations by FM communications. This illustration shows the 300-ft. tower at the Ft. Frances mill, counterpart of another 93 miles away at the Kenora mill, on the Lake-of-the-Woods. In the whole system there are 2 smaller fixed stations, working with 9 radio-equipped camps. FM is used not only to control movement of equipment, food, medicines, crews, and timber, but for such safety services as to dispatch boats to men who become isolated by storms. A detailed description of this system will appear in a forthcoming issue of *FM* AND TELEVISION.

(CONCLUDED ON PAGE 56)


worth your trip to Camden
The heart of the RCA 50-kw FM Transmitter . . . the revolutionary concentric-line tank assemblies that provide perfect shielding of the driver and power amplifier grounded-grid circuits.
The power amplifier (two sections at left above) and the driver amplifier tank (section at extreme right) assemblies of the BTF-50A. The driver amplifier feeds the two parallel-connected final sections. Electrically and mechanically, each one of these concentric-line tanks form an integral part of the grounded-grid circuits. Advantages: One compact unit that eliminates neutralization, radiation, and r-f pickup in adjacent a-f circuits. Each section is similar in design to the other. Each uses an RCA-5592 air-cooled triode in a grounded-grid circuit. And each uses forced air-cooling and motor tuning. Tubes and components are interchangeable.
RCA
BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.
In Canada: RCA VICTOR Company Limited, Montreal

to see it in action!

50 KILOWATTS OF FM POWER

The BTF-50A...now operating at full output on 108 mc

Broadcast station engineers who have watched the BTF-50A in operation put their arms around it . . . so to speak. No wonder, either. Because it handles easier than any other high-power transmitter they have ever seen . . . and it's as reliable as a powerhouse.

Here are some of its features.

Grounded-grid amplifiers and simplified single-ended r-f circuits (operating class C) insure high stability of operation and easy tuning. The Direct FM exciter produces high-fidelity frequency modulation simply and directly . . . has lower distortion than other methods . . . uses fewer tubes. Total BTF-50A tube complement, 42 tubes: 14 r-f, 2 a-f, 10 rectifier and 16 regulator and control . . . the smallest number of tubes, we believe, of any transmitter of similar rating. Of these, only 26 can seriously affect your carrier because the regulator-control tubes cannot contribute to transmitter outages. And as for spares, you need stock *only 14 different types.*

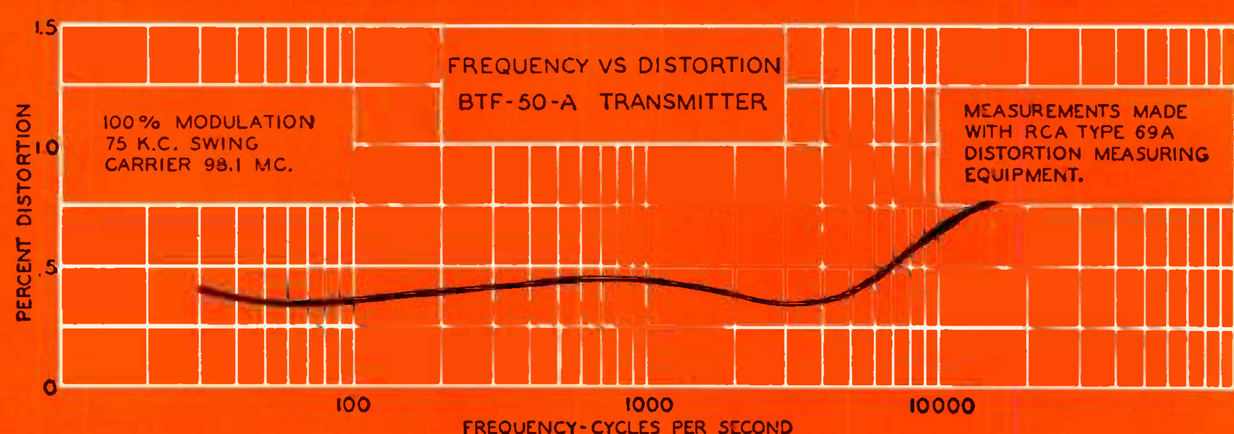
Other important design advantages include: Centralized power and control units, air-cooled tubes throughout, walk-in construction, only one high-voltage power supply . . . with spare-tube switching, and emergency cut-back with hi-lo power switching that isolates the 50-kw final amplifier for emergency 8-kw operation. Two blowers, operating independently, supply forced-air for the high- and low-power amplifiers . . . assure program continuity during emergency operation.

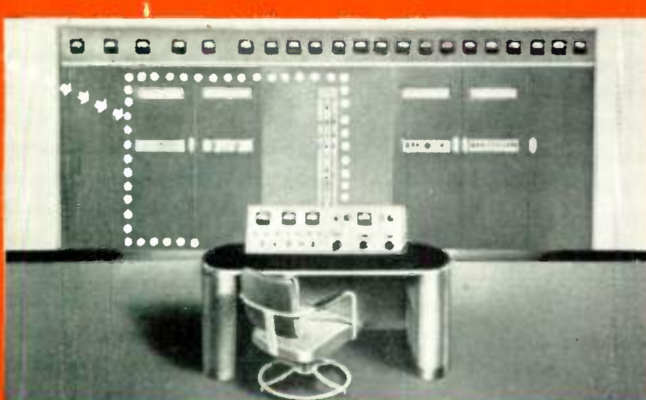
Here is a functionally styled 50-kw FM transmitter that will fit any type of station layout. It's compact enough to move in a standard passenger elevator . . . ideal for installing in office buildings. It's flexible. And it's economical to set up. Make sure you overlook none of its electrical and mechanical features when you inspect it in operation at Camden. Ask your RCA broadcast sales engineer to arrange your trip, or write Dept. 25-H.

• • • • •

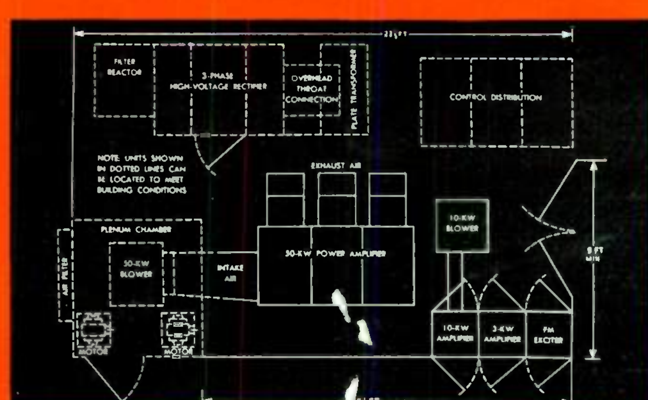
Production of the BTF-50A is progressing steadily to give you the earliest transmitter delivery possible.

Program fidelity that pleases audiences. Less than 1% output distortion between 30 and 15,000 cycles.





Smartly styled, the BTF-50A incorporates a unified front-panel design with centrally located control strips and flush-mounted controls. White dotted lines indicate the position (behind the front panel) of the concentric line 50-kw amplifier. Right-hand panel sections contain the 3- and 10-kw amplifiers and Direct FM exciter.



A typical floor layout for the BTF-50A. Additional equipments provided with the transmitter, but not mounted within the units are: pre-emphasis network, harmonic attenuator, transmission-line monitor, and a console which provides for audio and transmitter control. Write to nearest RCA sales office for details on various suggested floor plan arrangements.

FIG. 1. OPERATING POSITION, WESTERN MARYLAND'S YARD OFFICE, PORT COVINGTON

FM INCREASES TERMINAL EFFICIENCY 10 PERCENT

Facts and Figures on the Use of Radio Communications at the Second Largest Eastern Seaport

BY JOHN M. SITTON*

J. A. ABBOTT, Superintendent of the Hagerstown Division of the Western Maryland Railway, has definite ideas about the value of FM radio communications in freight terminal operations, and they are based on facts. Furthermore, he doesn't mind talking about them. Not all railroad people are willing or able to tell how much money is saved by adding radio as a supplement to existing communications. Mr. Abbott, however, when asked for his opinion of the train radio installation at Port Covington Terminal, answered quickly and definitely. His words were: "We like it. It saves us time and money, and has made our over-all terminal operation at least 10% more efficient."

Now that shipping facilities are at a premium, and shippers across the country are crying for faster terminal operation to get goods on the ships, the Western Maryland Railway has the answer, and that answer is FM communications.

Just how radio is used to quicken service to shippers, and how the complicated handling problems of a busy railroad yard are geared to the marine activities of the second busiest port in the country is an interesting story. Here is Mr. Abbott's story, as related to the writer:

Activities at Port Covington ★ Port Covington Terminal, Fig. 2, is located along the Patapsco River in Baltimore Harbor, adjacent to Hanover and McComas Streets, and is served by a 35 ft. channel. It is made up of the following facilities.

1. MERCHANDISE PIERS: There are four modern merchandise piers, with a combined floor area of 470,000 sq. ft., 3 of the piers being 2-story structures with large-capacity elevators and covered bridges connecting the second floors, together with gantry cranes, cargo masts, and double track aprons.

2. COAL PIER: Capable of transferring a car of coal a minute, with minimum breakage.

3. BULK CARGO PIER: Equipped with cantilever gantry crane for transferring ore and other bulk freight between ships and cars.

4. GRAIN ELEVATOR: Capacity 4,000,000 bushels, equipped with modern facilities for handling grain between cars and vessels.

5. BERTHING SPACE: For 23 ocean-going ships, such as shown in Fig. 3.

6. WAREHOUSES: 125,000 sq. ft. of warehouse space.

7. MISCELLANEOUS: Port Covington terminal also includes a locomotive repair shop, engine house, car repair yards, track scales, and two car-float bridges.

The floats vary in capacity from 10 cars to 22 cars. We have a heavy trade with Sparrows Point and Canton. By using our own floats, delivery of cars to these points is sometimes reduced by 10 or 12 hours over direct rail delivery.

To summarize the large volume of shipping handled by our combined facilities at Port Covington, here are some statistics on the monthly volume: 1) grain unloaded to elevators, 2287 cars or 4,364,000 bushels, 2) coal and coke, 6821 cars or 355,450 gross tons, 3) merchandise for export, 1500 cars, 4) ore unloaded, 40,000 tons, 5) car float operation, 5000 cars.

Use of Radio ★ Of course, the entire operation is geared to providing better service to shippers, and to achieve more economical operation. Radio communication, since we have begun its use at Port Covington, has proved its value over and over again in daily service. A conservative estimate gives us approximately 10% increase in the efficiency of radio-equipped rolling stock over non-radio switch engines. Substantially more than this figure is save in some typical yard and terminal operations. There are spectacular reductions in the need for engines to double-back or to wait at remote areas because of order changes. The facility which radio affords in allowing order changes to be made enroute is of incalculable value.

Operations at Port Covington are on a 24-hour basis, which makes increased demands on the dependability and ruggedness of equipment. Dollar-wise, the saving with radio is substantial enough, but when we consider the added safety of operation of radio-equipped switch engines, the convenience and the faster service to customers, and the many intangibles that accrue from improved operation, radio proves to be a "must" in modern yard and terminal operation.

The Port Covington 2-way system makes use of standard Bendix train radio equipment, consisting of a receiver and a transmitter in one enclosed unit, and a power supply. Figs. 4 and 5 show one of the locomotives, and a close-up of the antenna and radio installation. The same type of equipment is installed at the fixed station. Out of a total of 10 locomotives in use at Port Covington, 7 are diesel switch engines, and 5 of these are radio-equipped. In addition, we have a launch provided with radio. The fixed headquarters antenna is located atop a 200-ft. grain elevator, with remote operation provided at the yardmaster's office, Fig. 1.

These facilities allow the yardmaster to keep in close touch with crews working in any part of the terminal, and outside areas as well. Some points are normally hard to reach on foot, and are not available by telephone. With the complex system of switches in the yard and terminal, delivery of a change order issued to an engineer at a remote area used to be difficult and time-consuming. Now, in case of the old, non-radio engines, by sending the order to a nearby radio-equipped locomotive, double use can be made of the new system. This relay type of operation

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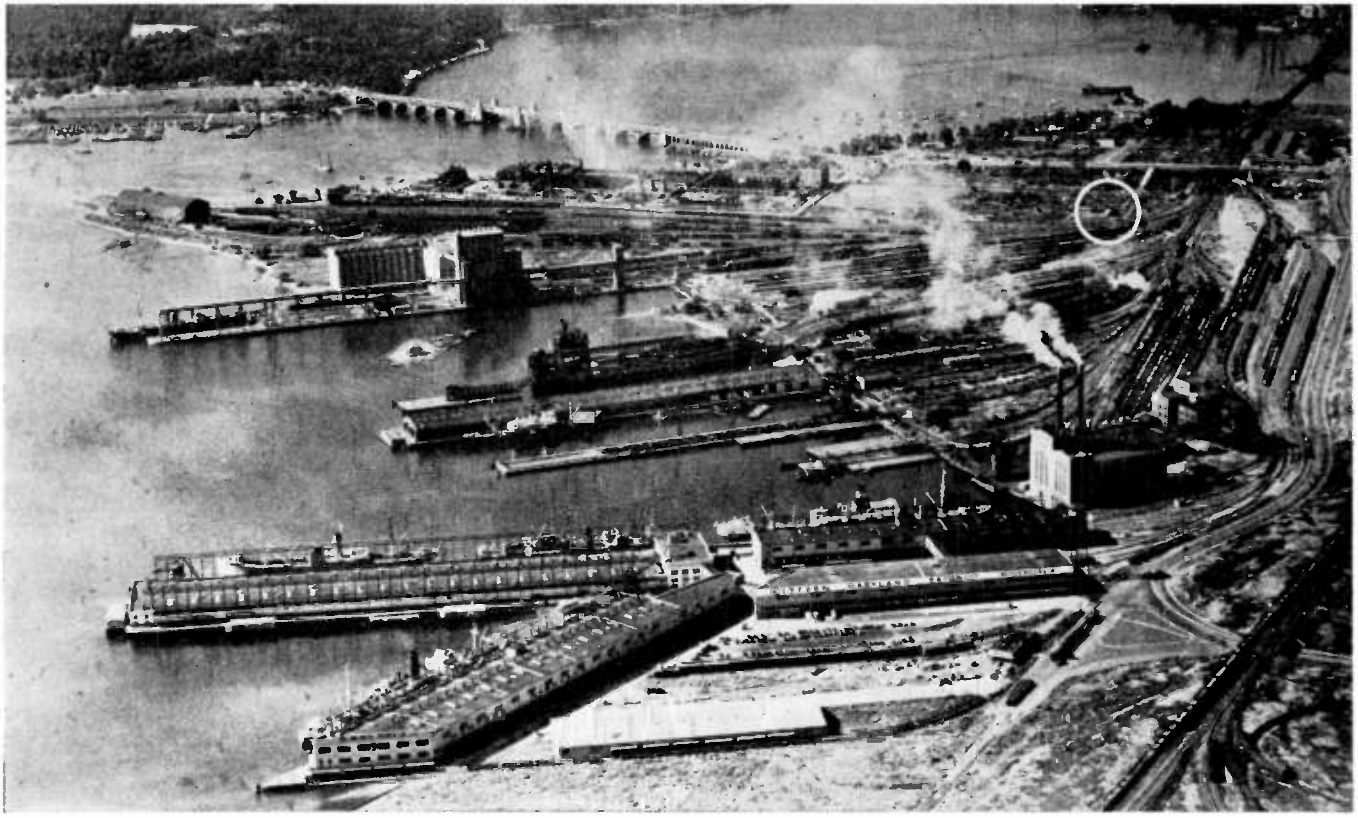


FIG. 2. PORT COVINGTON TERMINAL, BALTIMORE. CIRCLE INDICATES THE YARD OFFICE AND RADIO CONTROL POINT

is used only on rare occasions, however.

The Western Maryland radio installation and maintenance is under the direction of K. L. Muse, superintendent of communication. His maintenance schedule requires routine inspection of the equipment once each month when the diesels are routed to the shop. The Bendix installation has proved highly satisfactory from both the operational and maintenance angles. Operating personnel, from the switching crews to the yardmasters, express enthusiasm for the radio as an added communications tool, because it makes their jobs easier, and eliminates uncertainties.

Right now, the Port of Baltimore is increasing its volume of shipments to devastated Europe, and the advantages of radio-communications are reflected in increased turnover. With a port the size of Baltimore, speed and economy in handling freight traffic are of utmost importance. Large volume is literally the lifeblood of the port. It has been estimated that the export and import volume for March 1947 was 29% more than the same month a year ago. And it is no secret that radio communication has given this yard a definite advantage.

Considering the importance[1] of the harbor of Baltimore, and of the Western Maryland's Port Covington Terminal, it is understandable that we constantly seek ways of minimizing delays in operation. As soon as FM train radio had proved to be practicable, we began to plan for its use.

Cost of Installation ★ As every railroad man knows, it is difficult to arrive at an exact figure, dollar-wise, of the savings per day for each diesel switcher. However, it can be said that radio allows complete flexibility of operation. Since instantaneous change orders can be given to keep each switch engine occupied constantly, radio eliminates all lost motion and wasted time ordinarily consumed in layovers when the engineer is otherwise out of touch with the yardmaster.

[1] The port of Baltimore is second only to New York in export-import activity. Actually, on several occasions last year it was ahead of New York. It is closer geographically to the mid-west than any other eastern port.

FIG. 3. RADIO COMMUNICATIONS PERMIT INSTANT COORDINATION IN SHIP-SIDE LOADING AND UNLOADING OF CARGO

Previously, I had given a summary of our total monthly operation in terms of volume. The annual savings in using radio-equipped engines can be quickly inferred. The cost of the 2-way radio equipment, including a total of 6 mobile stations, a fixed station, and spare equipment was approximately $12,700. A conservative estimate of the increase in over-all efficiency clearly indicates that our radio paid for itself in a relatively short time. However, the profit to shippers in accelerated service is a plus value that cannot be estimated. Another intangible value accruing from radio operation is the pride which the operating personnel take in this new facility. They like to use the radio, and they have come to depend on it. It makes their jobs easier and saves countless steps throughout the day and night.

Personnel Reaction ★ At first, this aspect of radio communication was an unknown quantity. We were not sure how the men would react, and whether they would learn quickly to use radio communication efficiently. Our worries in this respect soon proved to be unfounded. They took to radio like ducks to water. Recently, one of the engineers came into the office and volunteered: "It's none of my business, but I've got a suggestion to make about the radio-telephone. When the engines are put over on the ash-track, the radio ought to be turned off so as to save current." Also, he said that when he started a trick he always called in to the yardmaster and reported that he was ready to go. Ordinarily the yardmaster had initiated the calls. These two practical suggestions were soon translated into operating rules and are now standard radio practice.

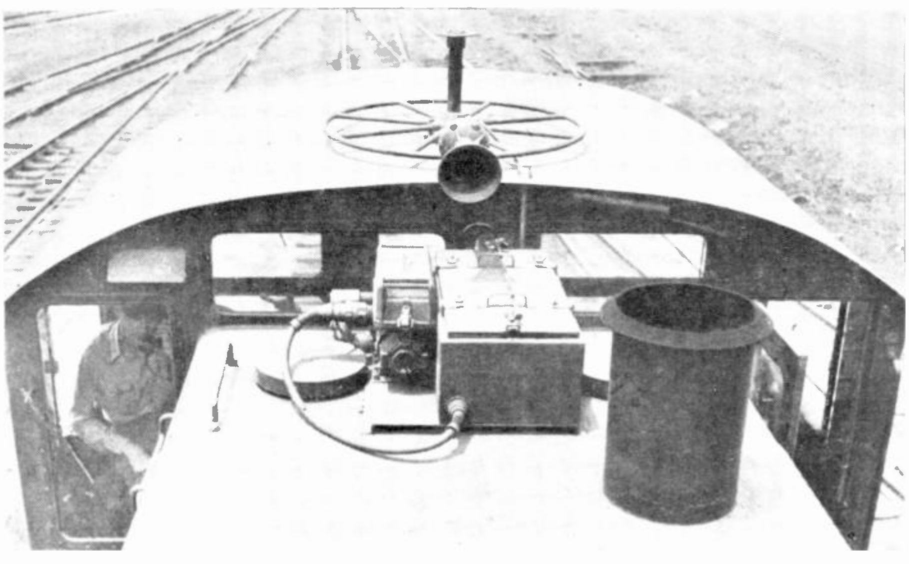


FIG. 5. BENDIX WAGON WHEEL ANTENNA, POWER SUPPLY, AND RADIO UNIT ON LOCOMOTIVE CAB

One of the features of our system may prove advantageous in other railroad installations. The radio operates with "cross-channel" communication. That is, two channels are used, one for fixed station transmission to the engines, and the other for the mobile units to talk back to the fixed station. This means that the locomotives cannot talk to each other except by relay through the yardmaster. Conversely, however, the yardmaster is able to talk directly to all of the engines. The purpose of this cross-channel communication is to eliminate the possibility of unnecessary talk between engine crews. Needless to say, this type of operation is quite satisfactory, as it is virtually impossible for operating crews to use the radio for any purpose other than company business.

Value of Radio Communications ★ To illustrate the savings effected by the use of radio, here are some specific examples drawn from actual operating experience: The night shuttle switch engine starts from the Hillen Yard, across the city from Port Covington. When the conductor starts this trick, he calls the yardmaster at Port Covington, to line up his work. In following this routine procedure, he can furnish the yardmaster with the consist of his train, no matter where the engine is located. This use of the radio operation has saved from 1 to 3 hours on numerous occasions, and the exchange of information makes it possible to get in a lot of extra switching, since the train crews are under constant supervision by the yardmaster, no matter where the individual engines are located, within range of the system.

FIG. 4. ONE OF THE DIESEL ENGINES EQUIPPED FOR RADIO, AT PORT COVINGTON, MD.

The towing launch, known as L-2, is also equipped with two-way radio. It serves to coördinate switching operations with the arrival of car floats, lighters, and scows at the various piers and shipsides. The saving which results from this type of operation cannot be estimated, but the economy in added efficiency is sometimes astounding. In the old days, the launch had to lay off-shore until someone who would relay a message passed within shouting distance. It was equally difficult to get a message to the launch. The craft could not, of course, be left unattended while a telephone call was made from a land station.

Here is another example of the value of radio communications: Two cars of oil were to be loaded on a vessel waiting at one of the piers. A mistake occurred in switching the cars. Under ordinary circumstances, the ship would have had to sail without the oil, or its departure would have been delayed. Either contingency would have been unfortunate, and the loss to both the shipper and to ourselves would have been appreciable. With radio, the yardmaster merely picked up the telephone handset, contacted the shuttle engine working outside the terminal, and alerted him to look for the car numbers. In the meantime, also by radio, the yardmaster was able to send out an engine to bring the cars to the pier as soon as they were located. As a result, the oil was at the pier in ample time.

These specific instances could be multiplied so many times during each month's operations that, looking back, it is hard to see how we got along without the radio-telephone system. It would be impossible for us to go back to the old methods of communications now.

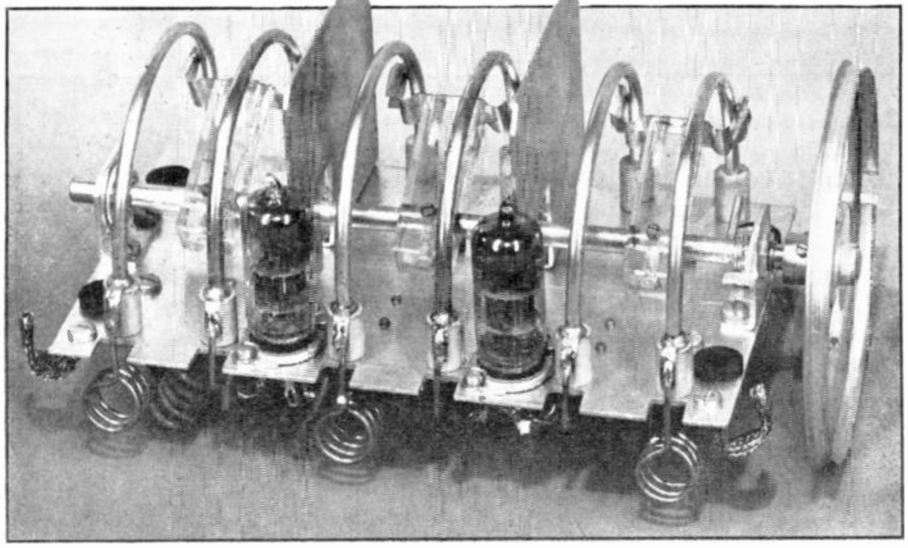


FIG. 2. THE TUNING CIRCUITS ARE ASSEMBLED AS AN INDEPENDENT MECHANICAL UNIT

TUNING WITHOUT CONDENSERS

Resonant Lines Are Used to Improve Mechanical Design

BY FRED E. BERHLEY*

THE ever-increasing number of FM stations on the air, and the spiraling demand for high-quality FM reception are a challenge to the ingenuity of circuit engineers who must steer a course between very cheap designs of such poor performance that dealers are coming to recognize them as spurious models, and FM receivers which are too high in price for the mass market at this time.

It was with the middle course in mind that our engineers at Approved Electronic Instrument Corporation designed the unit shown in Fig. 1.

First of all, it employs a tuned RF stage with one limiter and a discriminator, giving high sensitivity and effective static reduction. These assure reception that does full justice to FM broadcasting. Then, a simplified mechanical and electrical design was developed which reduces manufacturing costs and yet assures high stability and freedom from drift.

This tuner contains all the controls required for operation, but it does not have an audio amplifier. Thus it can be connected to a special amplifier and speaker, or to the audio system of an existing AM set. In either case, the tuner will provide excellent fidelity within the limits of the amplifier and speaker used with it.

RF Section ★ The superheterodyne circuit employed in this tuner follows the Armstrong method of reception. However, the RF section, comprising the RF stage, mixer, and oscillator, deviates from the conventional types of variable capacitor-inductance combinations by the complete absence of a variable condenser. Instead, a new and novel form of RF front end has been developed. Fig. 2 shows the heart of this tuner in detail.

The RF section consists of 3 high-*Q* resonant lines, terminating in small end-inductances, providing frequency coverage from 88 to 108 mc. with 180° rotation of the shorting bars. Semi-fixed, temperature-compensated silver ceramics in circuit with the resonant lines and end-inductances constitute the total LC of the circuits.

This combination allows for an exceptional high-*Q* circuit design, with excellent frequency stability and sensitivity. The mechanical construction of the RF section is such as to give complete freedom from microphonics encountered with variable capacitors when used at high frequencies.

The lines are constructed from brass tubing 5/32 in. outside diameter, with a silver overlay .005 in. thick. The shorting contacts are formed from .007 in. phosphor bronze, with a .005-in. silver overlay. Although much more expensive than plating, silver overlay was chosen for reasons of wearing qualities and low-resistance contact surface. The shorting contacts are mounted on lucite bars, fastened to a common shaft, to form a single control rotatable over 180°. With the 4-in. drive drum attached to the tuning shaft, a tuning ratio of 16 to 1 is obtained with a pointer travel of 6 ins.

The whole front end is mounted on rubber. Full use of the new miniature tubes is made, with a 6AG5 as an RF amplifier and a 6J6 dual triode serving as combination mixer-oscillator. The oscillator operates at 10.7 mc. below the signal frequency.

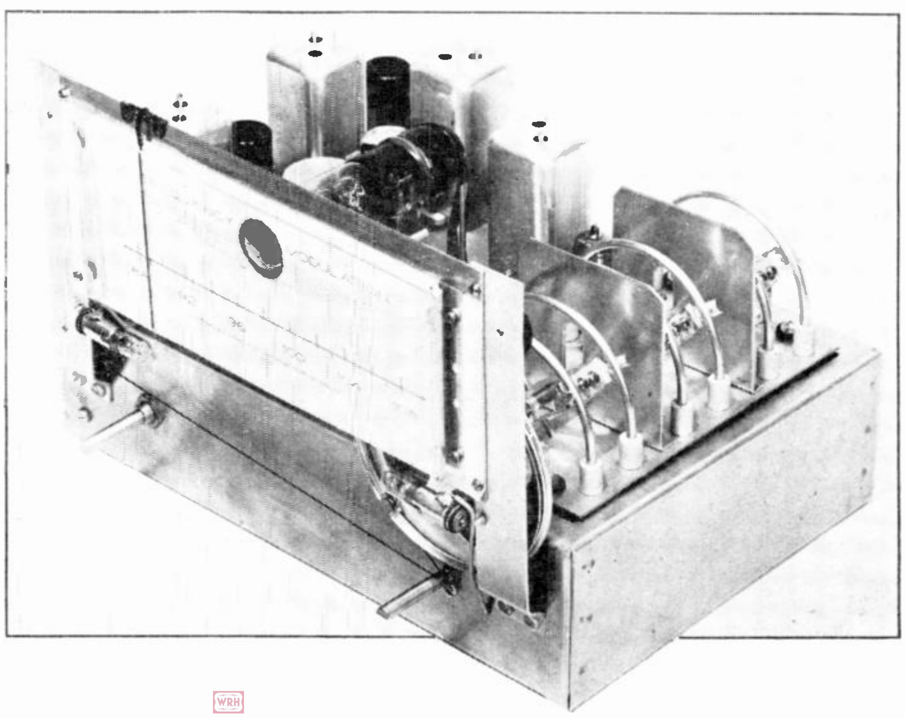
IF Section ★ Following the mixer are two IF stages operating at a center frequency of 10.7 mc. into a single limiter stage which, in turn, feeds a standard discriminator. All IF transformers are wound on low-loss ceramic, ground accurately as to diameter. Special iron cores are used that reach their peak *Q* value at 10.7 mc. The fixed ceramic capacitors are of the compensating type. Wave-shape tests have shown these transformers to possess excellent symmetry and stability. Figs. 3 and 4 show the characteristic curves of the IF and discriminator transformers.

Carefully chosen LC ratios with high *Q* maintained during production of these transformers result in high adjacent channel attenuation.

Audio Amplifier ★ For full enjoyment of high quality reception, an amplifier having a response flat within 2 db. from 50 to 15,000 cycles should be used with a correspondingly good speaker.

No power connection need be made from the amplifier to the tuner. A good ground

FIG. 1. RESONANT LINES REQUIRE NO MORE SPACE THAN A CONVENTIONAL CONDENSER



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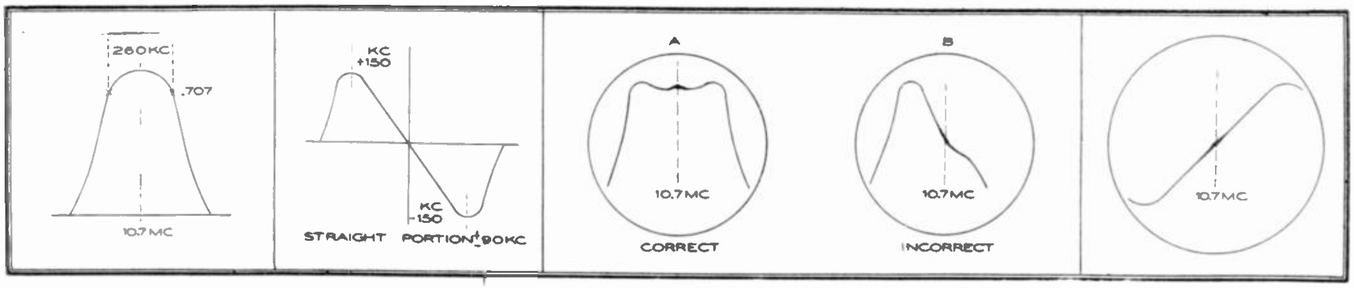


FIGS. 3 AND 4. IF AND DISCRIMINATOR CHARACTERISTICS. FIG. 5. CORRECT AND INCORRECT IF ALIGNMENT, SHOWING MARKER PIP. FIG. 6. CORRECT ADJUSTMENT OF DISCRIMINATOR AS SEEN ON OSCILLOSCOPE

connection must be provided, and a shielded lead from the tuner output to the amplifier input in order to avoid hum pickup. Hum level measured across the output of the tuner is −70 db. below average rms output.

IF Alignment ★ The center frequency of the IF amplifier is 10.7 mc. Due to overcoupling of the IF transformers, a bandwidth of about 150 kc. can be expected, of the double humped variety. While it is possible to align the IF amplifier with an ordinary AM signal generator and meter for maximum response, it does not follow that this method produces the correct alignment for proper bandpass characteristics.

A much more efficient and time-saving procedure is the visual method, requiring a frequency-modulated signal generator, an oscilloscope and, for double-check purposes, a deviation meter connected across the discriminator output. The meter should be a DC, VTVM zero-center type, calibrated 3-0-3 volts. The frequency-modulated signal generator must be capable of sweeping through a range of about 10.5 to 10.9 mc. in sawtooth fashion, with a possible adjustment for contraction or expansion of the total sweep width.

A simultaneously generated sweep voltage is necessary for horizontal deflection of the oscilloscope. A good AM signal generator with a wide spread around 10.7 mc. completes the total test instruments necessary for proper IF amplifier alignment.

Using the visual method, the sweep-voltage output of the FM signal generator must be connected to the horizontal deflection input of the oscilloscope. The controls of the scope should be so adjusted that the trace covers almost the full width of the screen. Connect the vertical deflection input of the oscilloscope across the grid return resistor of the limiter stage and, with the output of the FM signal generator applied to the grid of the second IF stage, adjust the generator to sweep from about 10.5 to 10.9 mc.

Due to grid rectification action of the limiter stage, a signal corresponding to the amplitude response of the preceding circuits is then available and, by careful adjustment of the oscilloscope controls, a picture of the response curve will be visible on the screen. Never apply more generator voltage than required to produce a good image.

In order to insure correct center-frequency setting, it is necessary to apply a marker frequency, conveniently obtained from the standard AM signal generator, unmodulated, and applied in parallel with the sweep frequency generator. Isolate the output of the AM generator by means of a small mica condenser. The generator should have sufficient RF voltage output to produce a small marker pip superimposed upon the response curve trace. The result is illustrated in Fig. 5.

With the AM generator set to exactly 10.7 mc. observe the position of the marker pip. If the pip falls in the center of the response curve, the alignment to follow consists of equalizing the peaks on either side of the marker pip by means of the iron core adjustment screws protruding from the top of the IF transformers.

If the AM generator possesses a good frequency spread around 10.7 mc., the marker pip can be used to measure actual

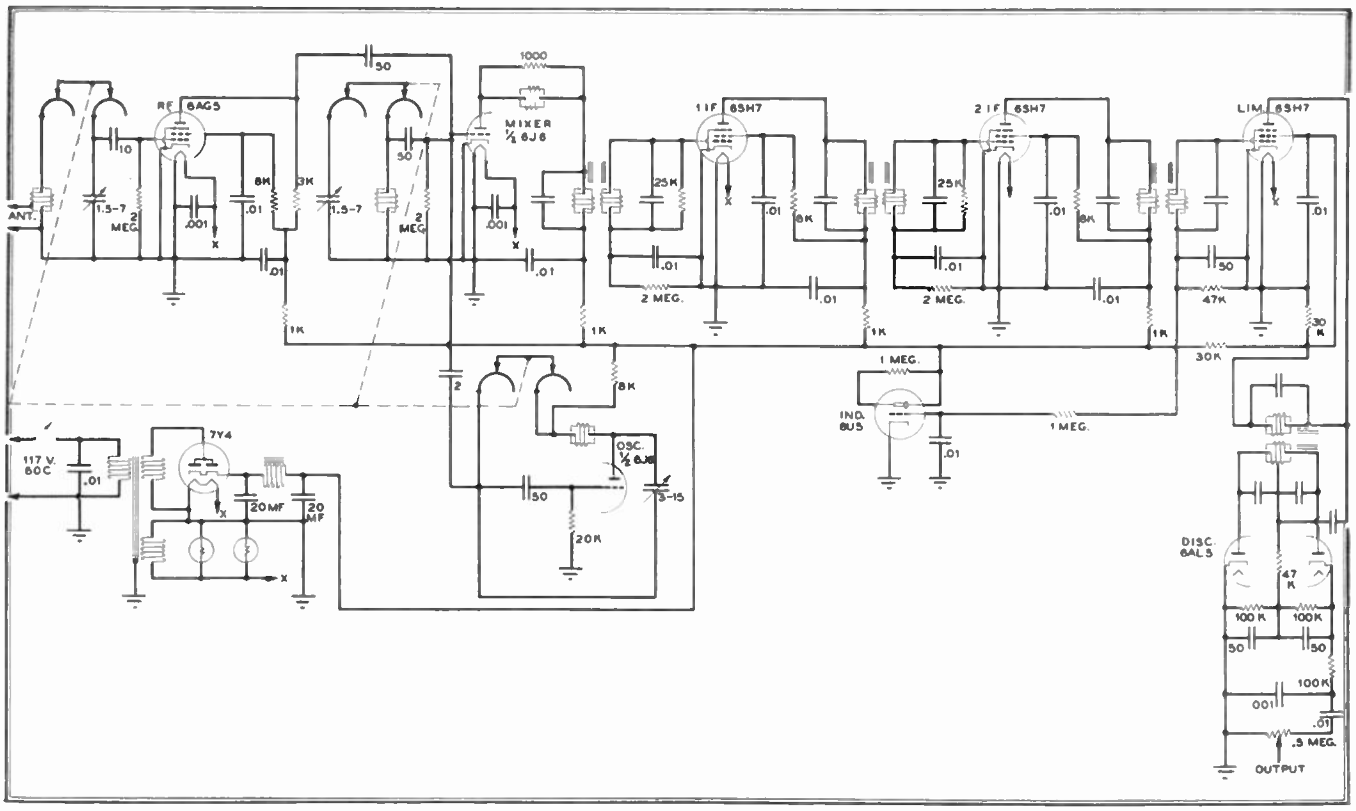


FIG. 7. COMPLETE SCHEMATIC OF TUNER. RESONANT LINES ARE INDICATED BY PAIRS OF SEMI-CIRCLES WITH GANGED CONTACTS

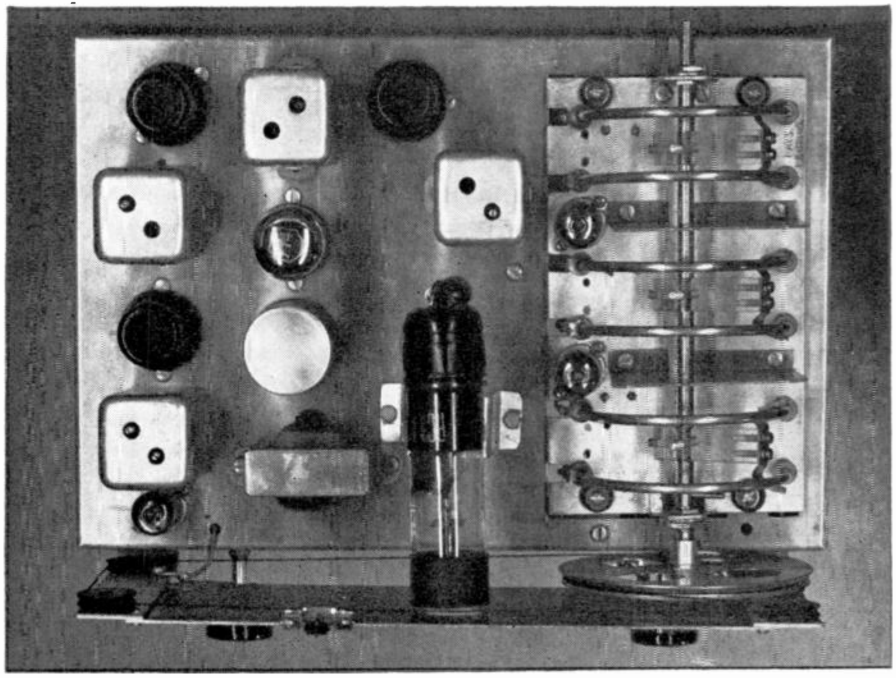


FIG. 8. TOP VIEW SHOWS SIMPLICITY OF THE SHOCK-MOUNTED TUNING ASSEMBLY

band width, by slowly changing the frequency of the signal generator to either side of center frequency, noting where the pip begins to slide off the center of either hump, and adding both frequency differences from center frequency. This equals the total bandwidth. A correct alignment pattern is shown in Fig. 5 A. Greater amplitude of the pattern indicates higher gain. Therefore, all adjustments must be based not only upon symmetry but gain as well.

The generators, both AM and FM, should then be shifted to the grid of the preceding stage, and the foregoing procedure repeated. It will be necessary to reduce the output of the generators, due to the gain of the added stage. When this stage has been properly aligned, the signal generators should be connected to the grid of the 6J6 mixer tube, where the oscillator voltage is injected. The 6J6 tube is a dual triode, of which half is used as a mixer with the other half employed as an oscillator. During the alignment of the first IF transformer, the oscillator should be made inoperative by disconnecting the B+ oscillator lead.

The next step is to align the first IF transformer. The pattern appearing on the screen is then a picture of the over-all response of the complete IF amplifier, and should be symmetrical with the highest possible amplitude for maximum gain.

Discriminator Alignment ★ The alignment of the discriminator is comparatively easy. The output of the FM signal generator is applied to the grid of the limiter tube, and the 10.7 mc. output of the AM generator fed to the same point. The vertical input of the oscilloscope must be connected across the discriminator output, with the ground side of the scope to the grounded side of the discriminator. The controls of the scope should be adjusted for the best image possible, with a minimum of signal generator voltage applied to the grid of the limiter. Symmetry must be obtained around the 10.7 mc. marker pip, with linear response above and below the marker pip. A correct discriminator pattern is shown in Fig. 6.

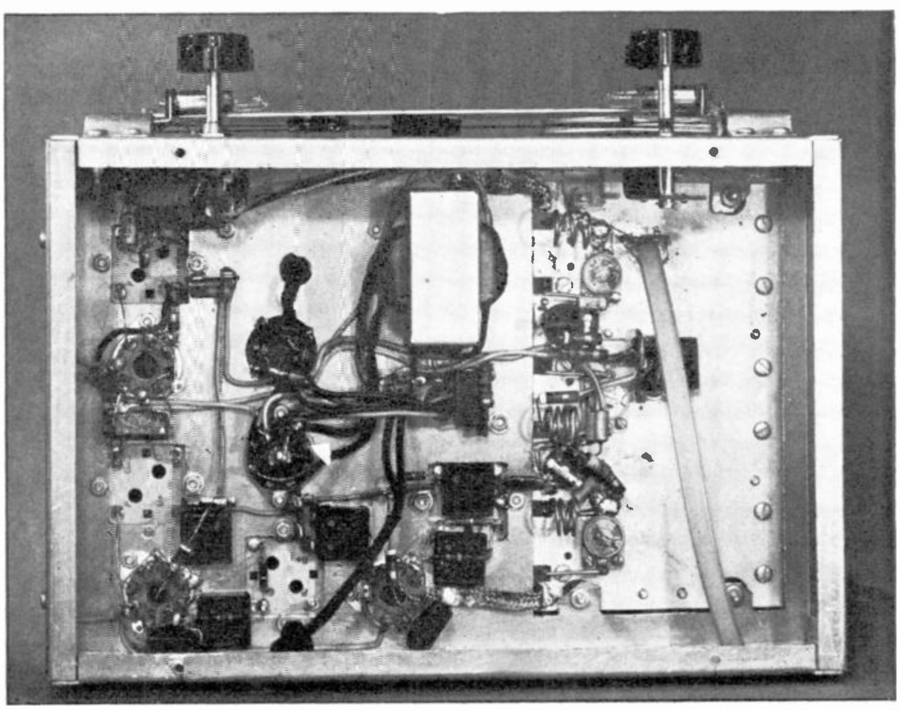
The adjustment of the primary of the discriminator transformer controls the linearity of the discriminator curve. If meter alignment is preferred, or no oscilloscope is available, a simple DC vacuum-tube voltmeter, preferable one having a 3–0–3 scale, should be connected across the discriminator output. A frequency of 10.7 mc. from an AM signal generator is fed to the grid of the limiter stage. If the meter reads off center, the secondary of the discriminator must be adjusted until the meter reads 0 volts. Next, change the generator frequency in equal steps above and below 10.7 mc., and note the voltage read on the meter. Readings should increase linearly on either side of the 10.7-mc. center frequency. Checks and rechecks with simultaneous adjustment of the discriminator primary may be necessary before a curve is obtained that resembles the pattern in Fig. 6.

RF Front End Alignment ★ To align the RF section of the tuner, the following equipment is required: a signal generator with a frequency coverage of 88–108 mc. and preferable on fundamentals, and a DC vacuum-tube voltmeter with a low scale reading of about 3 volts or a DC meter having at least 20,000 ohms-per-volt. The meter should be connected across the grid return resistor of the limiter stage. The output of the generator is then applied to the input of the tuner with the frequency set to 108 mc. and the tuner dial indicator set to read 108 mc. also. Adjust the semi-fixed capacitor of the oscillator until the meter indicates maximum voltage.

If the meter tends to read off scale, reduce the RF input voltage and hold the meter reading to about 2 volts average. The oscillator has been designed to operate at 10.7 mc. lower than signal frequency, and proper setting of the oscillator can be checked with a small absorption type wave-meter. At resonance, a large dip or increase in voltage reading will be noticed. The next adjustment consists of tuning the antenna and mixer stages for maximum response.

The generator should then be shifted to 90 mc. and the dial indicator to the same frequency. With a non-conducting rod, adjust the oscillator inductance until the meter again reads maximum voltage. A small adjustment of the oscillator inductance at 90 mc. may show up as a large frequency deviation at 108 mc. due to the inter-relationship of L to C. It may be necessary to repeat the alignment procedure several times before good tracking is finally obtained. With a perfectly aligned tuner, tracking error should never be more than 3 db. This completes the aligning procedure.

FIG. 9. UNDER SIDE OF CHASSIS IS NOTABLY CLEAN IN DESIGN AND ARRANGEMENT



TELEVISION HANDBOOK

CHAPTER 3—Primary Components of Equipment

Part 1: Pattern Generators, Iconoscopes

BY MADISON CAWEIN

A NUMBER of camera tubes exist for use in television. Each of these tubes has its own special application, each has certain excellencies, and each has its limitations. Several types of these tubes will be discussed here, both from the theoretical and practical standpoint, in an attempt to present a good working foundation for camera-tube usage in the television art.

There are also a number of advanced types of pick-up tubes under development in various laboratories. These will not be discussed since they have not been finalized at this time of writing, and any description of them might lead to confusion.

A great deal of ingenuity has been applied to the development of photo-electric eyes, and many electron principles have been put into use for this important item of the television system. Despite the fact that various tubes are based on different principles, all pick-up tubes have one fundamental characteristic in common: they depend for operation on the conversion of an optical image, in which the light intensity varies from picture element to picture element, into an electrical image which is created by the agency of the photo-electric effect.

There is one type of electrical picture-generator which does not depend upon an optical image. These generators are termed *pattern generators*, and were created for the purpose of generating a fixed pattern with which to test a television system. These will be discussed first.

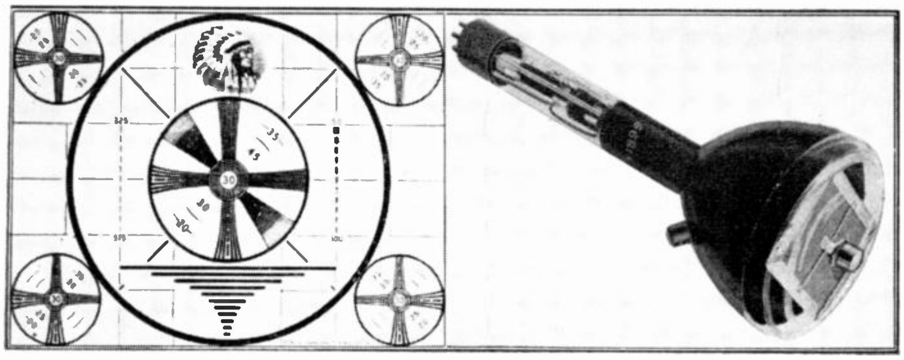


FIG. 37. THE TYPE 1899 MONOSCOPE TUBE, AND THE PATTERN IT GENERATES

1. Pattern Generators ★ Perhaps the best known pattern generator is the monoscope. This tube is produced in two types, a low-resolution type which is a 3-in. tube bearing the designation 1898, and a 5-in. high-resolution type bearing the designation 1899. Only the high-resolution type will be discussed in this article because this is the tube which is in most common usage and is most useful for television tests.

The 1899 tube is shown in Fig. 37. The tube consists essentially of a glass envelope containing an electron gun at one end and a metal plate at the other end. A pattern, Fig. 37, is etched in black on the bright metal plate. The bright portions of this plate are secondary-emissive, while the black portions, which are carbonized, are secondary-emission-suppressive.

The operation of the monoscope depends upon the emission of secondary electrons from the pattern surface. This surface is scanned by an electron beam generated in the electron gun. Scanning is by means of magnetic fields in the high-resolution tube, the deflection coils being quite similar to those used for magnetic deflection of an ordinary cathode-ray-tube. Electrostatic deflection is used in type 1898 in a manner practically identical to that employed for small oscilloscope tubes.

The electron beam is focused on the target plate, from the bright portions of which it knocks out secondary electrons. Each primary electron generates several secondary electrons on these bright areas. The secondaries flow to the second anode so that the bright areas of the pattern are charged positively. The secondary emission ratio of the carbonized pattern is less than unity, so that the electron beam when it strikes these dark areas flows into them and charges them negatively. The generation of a monoscope signal will be better understood by reference to Fig. 38 which shows a monoscope schematic diagram.

It is general practice to ground the pattern plate of the monoscope, which plate serves as the output-signal electrode and is connected directly to the grid of the first video amplifier, as shown in Fig. 38. Since secondary electrons flow away from the signal plate in the bright areas of the pattern, and since primary electrons flow into the signal plate in the dark areas of the pattern, the polarity of the signal generated by the monoscope is such that black is negative on the first video amplifier grid. The peak-to-peak value of the pattern-electrode signal-current is approximately 2 microamperes, so that a signal voltage can be developed at the first video amplifier grid in the order of a few millivolts, depending upon the size of the load resistor. In the circuit shown in Fig. 38 this load resistor is 4,100 ohms. It is possible to get between 5 and 10 millivolts input to the first video amplifier, depending upon the adjustments of beam currents. The more intense this current, the greater will be the pattern-electrode current. The beam current is usually slightly greater, about 30%, than the output-signal current.

It is usual practice to operate the monoscope with the pattern electrode at ground potential in order to avoid undesirable pick-up of extraneous signals, including hum, at the first video amplifier grid. Adjustment of output signal level is made by means of the control of the grid voltage as shown. Since the cathode and grid of the monoscope are operated about 1,000 volts below ground potential, it is necessary to use a transformer with a high-voltage heater winding for supplying the heater-power to this tube. The focusing adjustment is by means of an electrostatic potential applied to the focusing electrode. The order of magnitude of this potential with respect to the cathode is about the same as that of the pattern electrode. The collector electrode is operated slightly positive with respect to the pattern electrode in order to collect the emitted secondaries.

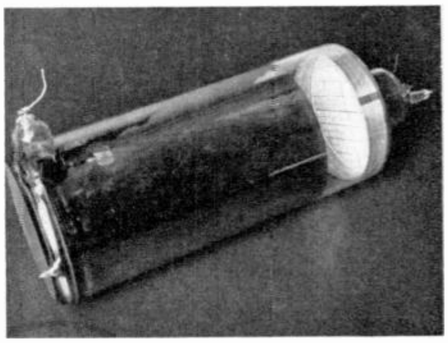
The resolution capability of the monoscope is approximately 500 lines, but it is possible, with proper adjustments, to obtain television pictures with 800-line resolution from some tubes. In general, higher resolution will be obtained with lower orders of beam current and signal output.

The pattern of the monoscope is designed to check the resolution of a television system in both horizontal and vertical dimensions. Linearity of the deflection systems can be checked by means of the square-block diagram in the pattern, and resolution may be checked in the corners as well as in the center of the picture. Both low-frequency and high-frequency phase distortion, or transients in the video amplifier, can be checked by means of the horizontal bars and the small vertical wedges to either side of the central pattern. Poor phase-response manifests itself as white streaks following the black bars and wedges. An experienced operator can determine the approximate frequency at which phase distortion is occurring by calculating of the frequency band required to produce the number of lines of resolution corresponding to the bars and wedges.

There is one other type of pattern generator which will be discussed. This is the so-called pattern dissector shown in Fig. 39. This tube is primarily for use in checking the geometric distortion in the focusing-coil systems of a dissector channel. It can be used also to check resolution of the focus coil system, but does not have as elaborate a pattern for this purpose as the monoscope has.

This tube works on an entirely different principle from that of the monoscope. It consists essentially of a glass envelope with a photo-surface at one end and a fluorescent-screen collector at the other end. The photo-surface has etched upon it a carbon pattern of the photo-emission-suppressive type. The photo-sensitivity of the pattern electrode is sensitive to infra-red. A flat-field projector with red or infra-red filters is used to illuminate the photo-cathode through the window which is coated with a transparent film of fluorescent material. Photo-electrons are generated on the white areas of the cathode while none is generated on the blackened portions of the pattern. An extended electron image of this pattern is formed in the space inside the tube and caused to impinge on the fluorescent screen by means of the potential existing between this screen and the cathode. This potential is of the order of a few hundred volts, and is sufficient to cause the fluorescent screen to glow. The focusing current is adjusted for sharpest focus of the pattern appearing on the screen.

Geometric distortions of the focusing-coil system for the extended image are studied by this means, particularly in reference to the S-distortion which usually accompanies the magnetic focusing of an extended electron-image. Magnification of the pattern can be studied also in this manner. This point will be clearer after a discussion of the operation of the image dissector in a later section.



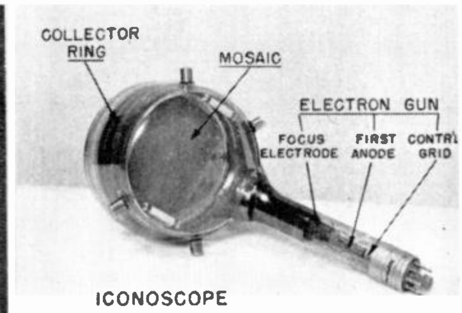


FIG. 39, LEFT: PATTERN DISSECTOR TUBE. FIG. 40, RIGHT: ICONOSCOPE CAMERA TUBE

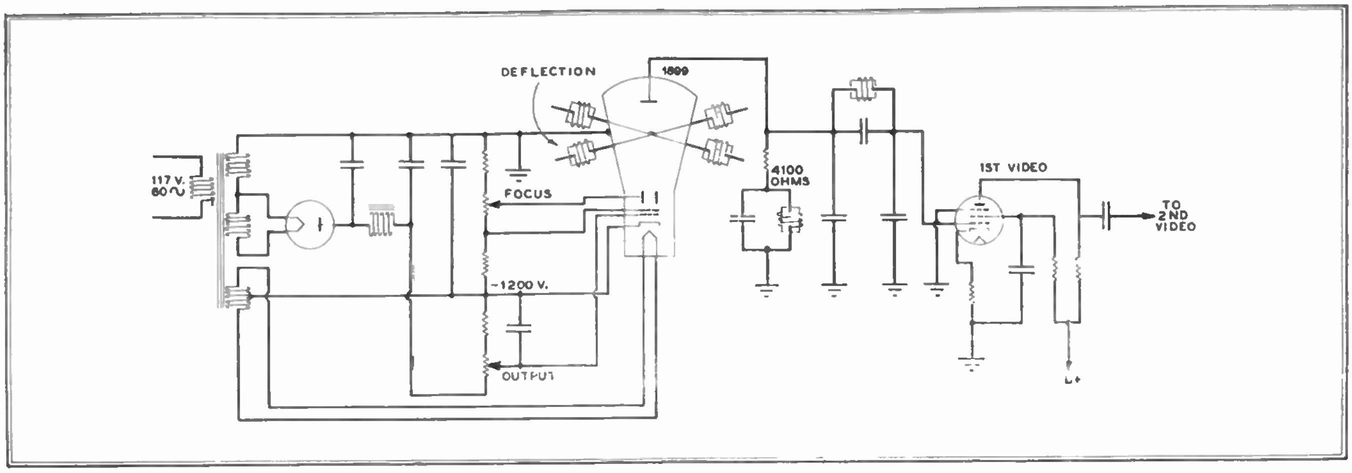


FIG. 38. SCHEMATIC DIAGRAM FOR THE MONOSCOPE TUBE, USED TO CHECK THE PERFORMANCE OF TELEVISION RECEIVERS

2. Pick-up Tubes ★ (1.0) *The Iconoscope:* The iconoscope is at the present time the most generally used television pick-up tube for studio work. It is being replaced by newer tubes, such as the orthicon and the image orthicon. In spite of this fact, many studios still use the iconoscope, and it is necessary that all television engineers understand the theory and application of this type of tube in order to acquire competence in the television art.

(1.1) *Description:* A photograph of the iconoscope is shown in Fig. 40, and a schematic circuit is shown in Fig. 41. There are two types of iconoscopes in general usage today. These are known as types 1848 and 1850-A. It is general practice for most studios to use the 1850-A, which is the larger tube. It is possible, however, to obtain very excellent resolution and generally good results with the smaller 1848 which lends itself, therefore, to less cumbersome studio camera design. Tubes of the 1848 variety have been produced with capabilities of 1,000 lines of resolution.

The operation of the iconoscope is quite similar to that of the monoscope except that a photo-electric mosaic is substituted for the secondary-emissive pattern-electrode of the monoscope. This photo-sensitive mosaic consists of an area of tiny photocells deposited on a mica plate, backed up by a metal film that constitutes the output-signal electrode. Each photo-sensitive island of the mosaic is considerably less than .001 in. in diameter, and constitutes a small condenser by virtue of its capacitance through the mica to the output signal plate behind the mica. Connection to the photo-electric island is made by means of the electron beam which scans, or commutates, the islands, under the influence of the deflecting fields.

Each island is well-insulated from all of the others. A slight amount of leakage does sometimes exist between these islands due to the particles of free caesium deposited on the mica during the photo-sensitizing process in manufacturing the tube. Generally this leakage is quite low in value, however, and does not disrupt the operation of the tube. This operation is briefly as follows: 1) A light image is projected on the mosaic, 2) photo-electrons leave the photo-sensitive islands and flow to the collector so that each island charges up to a potential depending upon the light intensity of that portion of the image which illuminates it, 3) the negative, commutating, scanning beam discharges the positive, photo-electric charge accumulated, and 4) the discharge current which is capacitively coupled to the signal-output plate generates an electrical signal for each island contacted, as the electron beam commutates these islands in succession during the scanning process.

The action of the iconoscope is not quite as simple as outlined above. For a better understanding it will be instructive to examine the theoretical factors involved.

(1.2) *Theoretical factors:* Consider the mosaic as a voltage generator in series with the load impedance and the internal dynamic impedance of the iconoscope, as shown in Fig. 42. Sensitivity will be expressed in output volts, per lumen of input, per square centimeter.

The maximum *theoretical sensitivity* of the iconoscope depends upon the following factors:

A. *The voltage of the generator*, which is the difference between the negative equilibrium potential of the mosaic and the positive stopping potential of photo-electrons from caesium-oxide-silver, in the visible spectrum.

B. *The internal dynamic impedance of mosaic to collector*, which is dependent upon velocity of secondaries, pattern of illumination, beam-current magnitude, proximity of collector and mosaic, space charge, and the photo-sensitivity of caesium-oxide-silver.

C. *The output impedance*, which depends upon the frequency band required, or available, for reproduction of the image. This, in turn, depends upon the physiology of the human eye, and upon the television scanning standards.

The maximum *practical sensitivity* of the iconoscope is obtained by evaluating these three factors involved in the theoretical sensitivity.

It is hoped that the following analysis will prove of some advantage to the student, although analyses on this subject are often unsatisfactory, except as pointers to indicate processes.

(1.21) *Theoretical sensitivity of the iconoscope:* To compute the theoretical sensitivity of the iconoscope, consider a mosaic of picture elements, or insulated islands of photoelectric materials, scanned by an electron beam. The scanning beam commutates these elements cyclically in a given order, depending upon the television system of standards used. It might be thought that since the beam is composed of negative electricity, it would charge the elements negatively, but this is not necessarily true.

Since the secondary emission ratio of caesium-oxide-silver is greater than unity for all the practical values of beam velocities exceeding 10 volts (400- to 1,000-volt beams are used in practice), the action of the scanning beam is to charge the elementary islands positively. This positive charge occurs because a secondary current composed of 8 or 10 times the number of the incoming electrons leaves each element, due to secondary emission, during the passage of the scanning beam. Such action produces a deficiency of electrons, or of negative charges, on the mosaic elements. See Fig. 43.

The average velocity of the major portion of these departing secondaries is about 3 volts, as shown in Fig. 44. That is, the stopping potential at which the electron will fall back upon the mosaic element is at approximately 3 volts. When the elements have charged up to this potential with respect to the collector electrode (2nd anode), all other secondaries which leave the element will return to it. Thus, *+3 volts is the positive equilibrium potential of a caesium-oxide-silver mosaic element* in an iconoscope. This fact has been checked experimentally.[1]

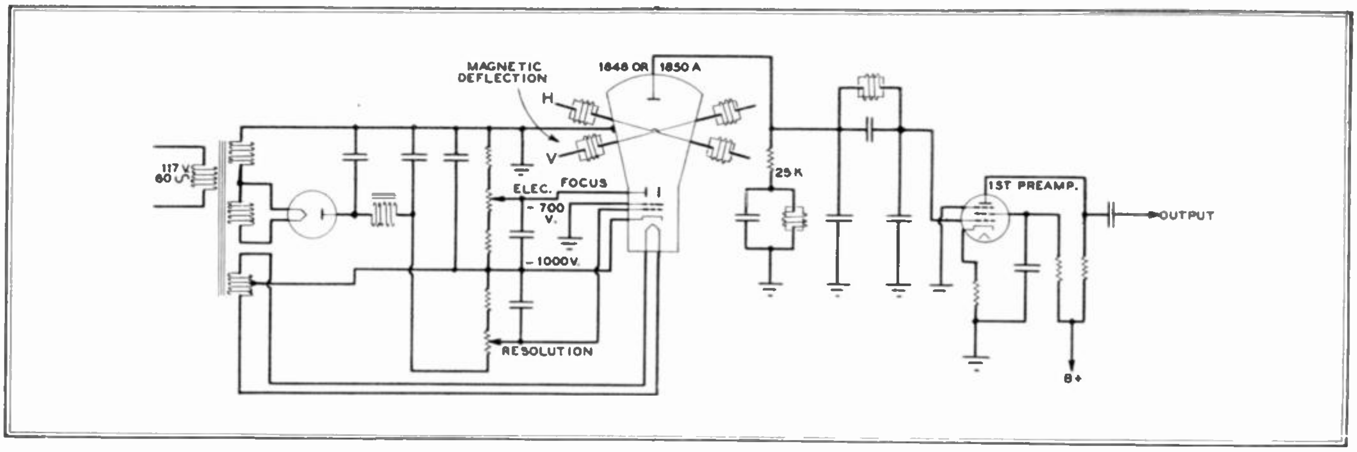


FIG. 41. SCHEMATIC DIAGRAM FOR THE TYPE 1848 OR 1850-A ICONOSCOPE. ADDITIONAL PREAMPLIFIERS ARE BUILT INTO CAMERA

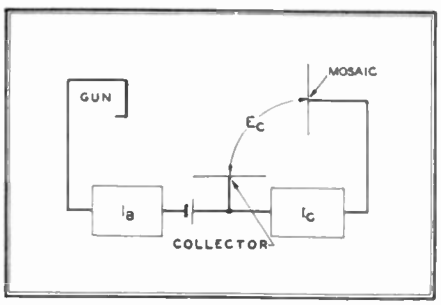


FIG. 42. ELEMENTS OF THE ICONOSCOPE

CONCLUSION I: *The action of the scanning beam is to drive the mosaic elements to their positive equilibrium potential.*

(1.22) *Photo-Emission:* When light falls on a mosaic element, photo-electrons are emitted. The velocity of the electrons emitted is dependent upon the frequency of the incident light. The threshold frequency of light to which the surface is photo-sensitive (which determines the work-function in Einstein's photo-electric equation) is 2.7×10^{14} cycles (11000 angstrom units) for Cs-O-Ag. The maximum velocity of a photo-electron from this substance depends upon the spectral cut-off of transmission for the light source, which may be through glass, film, or other material in the optical system. This is usually within the photo-sensitivity limit of Cs-O-Ag, since the latter lies within the ultra violet region. The spectral response is shown in Fig. 45.

Where scenes in direct sunlight are being scanned, the transmission cut-off of the glass lenses and windows is the limiting factor. This occurs at about 3,500 angstrom units, at which wavelength the peak sensitivity of Cs-O-Ag occurs. A tungsten source at 2,870 degrees Kelvin has a cut-off wavelength of radiation at about 4,000 angstrom units. This becomes a limitation on the velocity of photo-electrons when such a source is used.

The stopping potential of photo-electrons can be computed from Einstein's equation:

$$V = h\,(f-f_0)\ e. \qquad (6.0)$$

Here: V = stopping potential in e.m.u.

[1] "Television" by Zworykin & Morton, p. 280. John Wiley & Sons, Inc., New York.

f_0 = threshold frequency of photo-emission

f = frequency of incident light

$h = 6.61 \times 10^{-27}$ erg secs. = Planck's constant

$e = 1.6 \times 10^{-20}$ e.m.u.

Computation from this equation shows that the stopping potentials of photo-electrons are graduated from zero volts for infra-red light of wavelength λ =

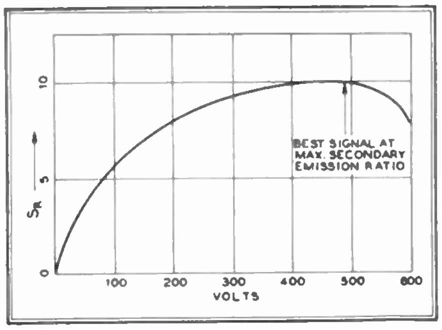


FIG. 43. CAESIUM-OXIDE-SILVER EMISSION

11,000 A° up to +2.6 volts for ultra-violet light (3500 A°).

This means that a photo-electron which is born of infra-red light and Cs-O-Ag cannot be collected by a conductor unless the potential of that conductor is greater than zero with respect to the photo-electric emitter. Likewise, one born of the ultra-violet cannot be collected after the potential of the emitter has risen to +2.6 volts with respect to the collector.

The implications of the preceding paragraphs are summarized as:

Conclusion II: *Mosaic elements in a storage-type tube, driven to positive equilibrium-potential by a scanning beam, and kept at this potential by an efficient collector which collects 100% of the emitted photo-electrons, can never be charged by photo-electric emission agencies alone*, because the positive equilibrium-potential due to scanning occurs at +3 volts, which is greater than the stopping potential for photo-electrons over the region of the visible spectrum. Thus, there would be no output signal from such a tube, either in darkness or in light.

(1.23) *Redistribution.* If the collector electrode were sufficiently close to each of the mosaic islands, all of the secondary electrons either would flow to the collector, or would fall back on the island from which they were emitted. Fortunately, however, the collectors are not 100% efficient. About 75% of the emitted electrons fall back to the positively-charged mosaic elements, and charge these elements negatively to a potential of approximately −1.0 volt (this figure was experimentally determined by Zworykin).[2] Actually, since the secondary electrons have a stopping potential of +3 volts, it is obscure why they do not redistribute the charge on the mosaic elements to a value of −3.0 volts.

This falling-back process is called redistribution, and sometimes manifests itself as shading in the reproduced picture. It is to be remarked that the negative equilibrium potential of −1.0 volt, caused by redistribution, is probably a function of element size, scanning speed, beam current, and illumination. Any wandering of the equilibrium potential will cause a wandering in the black level of the video-signal output.

After the scanning beam has passed, then, the mosaic elements are quickly brought to negative equilibrium by a rain of low-velocity secondaries and photo-electrons, through a redistribution process. Light from an optical image causes photo-electrons to be emitted from these negative elements in proportion to its intensity. The maximum realizable sensitivity of Cs-O-Ag is of the order of 50 microamperes per lumen. In practice, this is seldom realized. 25 microamperes per lumen is more usual. In the bright parts of the image, more photo-electric current leaves the mosaic elements than in the dark parts, so that the elements charge positively from their −1.0 volt, negative-equilibrium level, at a rate proportional to their illumination. The photo-sensitive islands can never rise to a potential greater than +2.6 volts, even for saturated illumination in the ultra-violet part of the spectrum, or to greater than zero volts for saturated illumination in the infra-red. For illumination of average spectral distribution, the rise is limited to the neighborhood of a value of +0.1 volt.

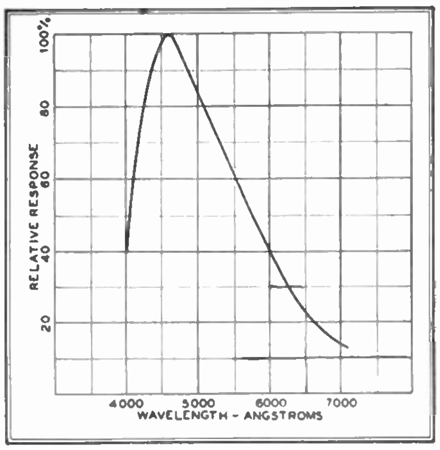


FIG. 45. SPECTRAL RESPONSE CURVE

Conclusion III: *The maximum excursion of potential of a mosaic element due to photo-electric emission, between absolute black and saturated light, is of the order of 1.1 volts, or roughly 1 volt.*

(1.24) *Dynamic Impedance:* The mosaic can be considered to be a voltage generator with a maximum output of approximately 1 volt at light saturation, and with a specific internal impedance. The internal impedance is resistive, and has been measured at 1 to 2 megohms. It exists because the potential between collector and mosaic has a finite ratio to the value of the collector current, as indicated in Fig. 46. This impedance is not to be confused with the impedance of the beam current, for it has been observed to *decrease* as the beam-current impedance *increases* — that is, as beam current *decreases*.[3]

The dynamic impedance is dependent

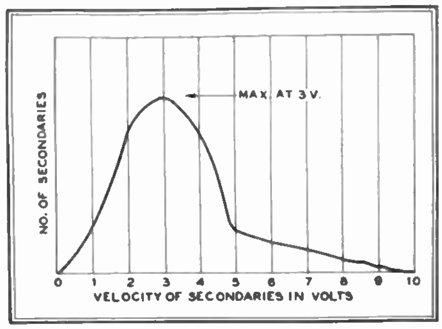


FIG. 44. VELOCITY OF SECONDARIES

on the redistribution function in an obscure manner. The maximum theoretical value of signal output is some fraction of 1 volt, this fraction being determined by the ratio of the load impedance to the internal impedance of the tube.

Since it is necessary that the load impedance be uniform over a band of frequencies (from zero to 4 mc. at least, under present standards) the load impedance is limited to 25,000 ohms at optimum design, because of the output capacitance of the tube. 100,000 ohms has been more usual in practice, and even 300,000 ohms, but in such case compensation for the loss in gain at high frequencies must be provided in the video amplifier. An average representative value of internal impedance is 1.5 megohms.

Conclusion IV: *The average, maximum obtainable signal between black and saturated white* can be calculated on a theoretical basis as approximately 1.0 volt × 25,000 × 1/1,500,000 = 16 millivolts. In spite of this fact, 2 millivolts of peak-to-peak video is usually the order of iconoscope output-signal encountered in practice.

(1.25) *Maximum Internal Generated Potential.* Consider a long-time view of current action in the tube. The beam current falling on the mosaic releases secondary currents. The illumination releases photo-currents. These currents flow to the second anode and redistribute themselves on the positively charged elements of the mosaic. The total current to the collector anode must balance the beam current, but the fraction of this current which is made up of photo-current is not known. If none of the photo-current flowed to the col-

[2] Local citation (actually between —0.5 volts and —1.5 volts).

[3] This was observed at Hazeltine Corporation Laboratories, indirectly, as an increase in video output with decreasing beam current, for advanced No. 2 grid potentials.

lector, i.e., if all of the photo-electrons redistributed themselves over the mosaic, it should make no difference to the sensitivity, because secondaries which would have been utilized in redistribution would then be deflected to the collector to complete the second-anode current-path, which is their normal function.

From the instantaneous standpoint, there is a different evaluation. All the elements of the mosaic are at various negative potentials with respect to their positive-equilibrium potential of 3 volts. The elements which have received the most illumination since the scanning beam last commutated them will be the least negative in potential. Those which have received no illumination whatever will be at the negative-equilibrium potential caused by redistribution. None of the elements, even those in the most brilliant parts of the image, will be electrified to much above zero potential, since +2.6 volts is the theoretical, maximum, positive photo-potential for an ultra-violet illumination, and there is little or no ultra-violet light transmitted from the image.

Conclusion V: *The maximum voltage output of the iconoscope is approximately equal to the negative equilibrium potential.* This is a reiteration of Conclusion III.

(1.26) *Saturation:* For a complete analysis of the theoretical limits to the sensitivity of the iconoscope, it becomes necessary to inquire minutely into the instantaneous physical processes which occur in the neighborhood of the mosaic. Any rigorous analysis of these processes leads to involved transcendental equations, the solution of which cannot be useful because of the obscurity of some of the physical constants. A large amount of research would be necessary to determine these constants.

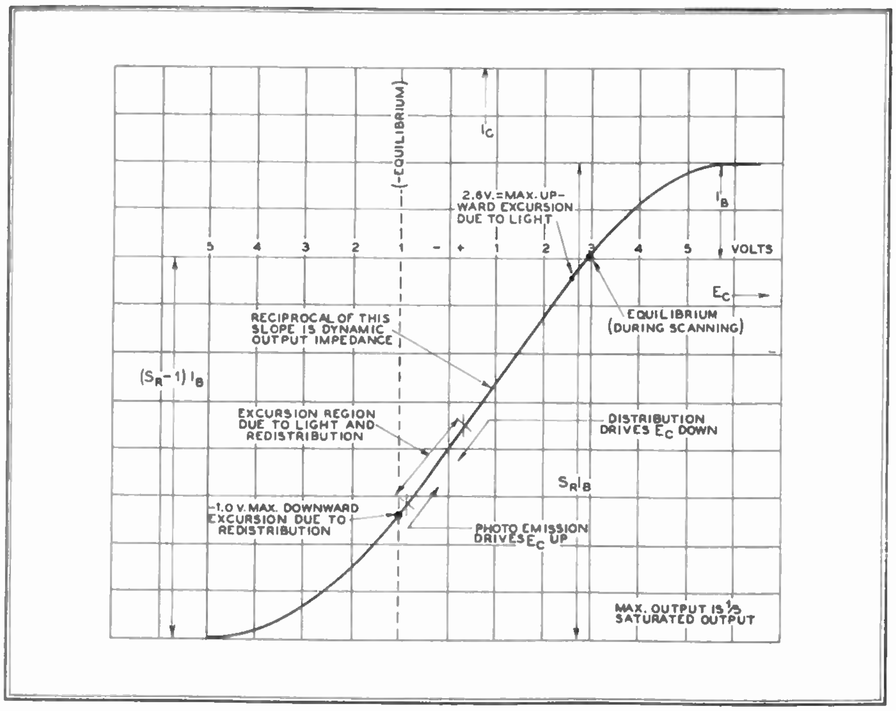


FIG. 46. DYNAMIC IMPEDANCE CHARACTERISTIC OF THE ICONOSCOPE CAMERA TUBE

There are, however, approximate methods by which the order of magnitude of iconoscope sensitivity can be calculated.

It must be emphasized that there are two agencies operating oppositely upon

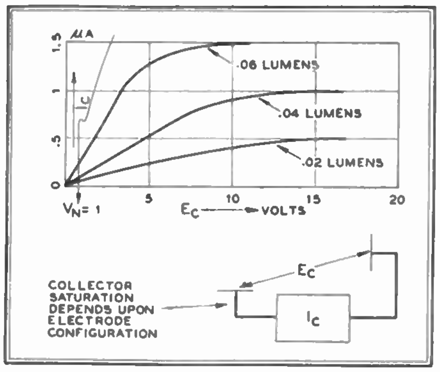


FIG. 47. PHOTO-CURRENT SATURATION

the potentials of the mosaic islands. The first of these agencies is the photo-emission current which operates continuously to charge the elements *positively*. The second is the redistribution current which operates continuously to charge the elements *negatively*. Two stipulations will be made: 1) the photo-current must be large enough to approximately counteract the negative equilibrium potential during the scanning period, and 2) the beam current must be sufficient to establish an equilibrium level during the commutation instant of contact during the scanning process. Zworykin has shown that the second of these requirements is fulfilled in the average iconoscope, as established by the fact of the occurrence of positive equilibrium at +3 volts. It is also fulfilled in other camera tubes where smaller beam-currents are used.

The conditions for fulfillment of the first stipulation depend upon the fact that there are two types of luminous saturation which can occur in the iconoscope: 1) photo-current saturation at a given illumination level due to insufficient potential gradient (see Fig. 47), and 2) photo-potential saturation at a given illumination level due to the low value of the stopping potential of photo-electrons (see Fig. 44).

Type 1 manifests itself as a *desaturation*[4] of the photo-current due to the −1-volt limitation of potential between mosaic elements and collector. Type 2 manifests itself as a limitation of the maximum voltage generated, due to photo-emission, at any element of the mosaic. Type 1 can be expressed mathematically by a *desaturation factor* defined by the ratio of the negative-equilibrium potential to the saturation potential indicated at the knee of the curve in Fig. 47. This ratio is approximately equal to 0.1. Type 2 is expressed as a limitation of output.

The first condition will be fulfilled if Charging Current = Capacitance × Time-rate-of-change-of-potential or: Photo-current/lumen × Lumens × Redistribution factor × Desaturation factor = Capacitance × Potential-change/unit-time. (6.1)

Let: s = saturation sensitivity of Cs-O-Ag in microamperes per lumen
L = intensity of light in lumens/cm²
f = redistribution factor = 0.25 [this factor enters the equation because (1-f) × (number of emitted electrons) fall back on the mosaic and cancel part of the potential rise due to photo-emission]
C = capacitance/cm² = 100 mmf
T = time of one scansion = 1/30 sec.
d = desaturation factor = 0.1

Substitution in the equation gives:

$$sLfd = C \cdot \frac{1}{T} \text{ or}$$

$$L = C/Tsfd \text{ (per volt rise).} \quad (6.2)$$

The illumination in the highlights for just-under-saturated operation (illumination to give the saturation voltage of approximately 1 volt at the mosaic) is then, after evaluation of the constants:

$$L = 2.4 \text{ millilumens/cm}^2.$$

This is for ideal caesiated-silver with a saturation sensitivity of 50 microamperes per lumen. Actually, the sensitivities commonly obtained in iconoscopes are about 10% of the theoretical optimum, partly

(CONTINUED ON PAGE 46)

[4] This concept was conveyed to the writer by Dr. R. C. Hergenrother during the course of a discussion.

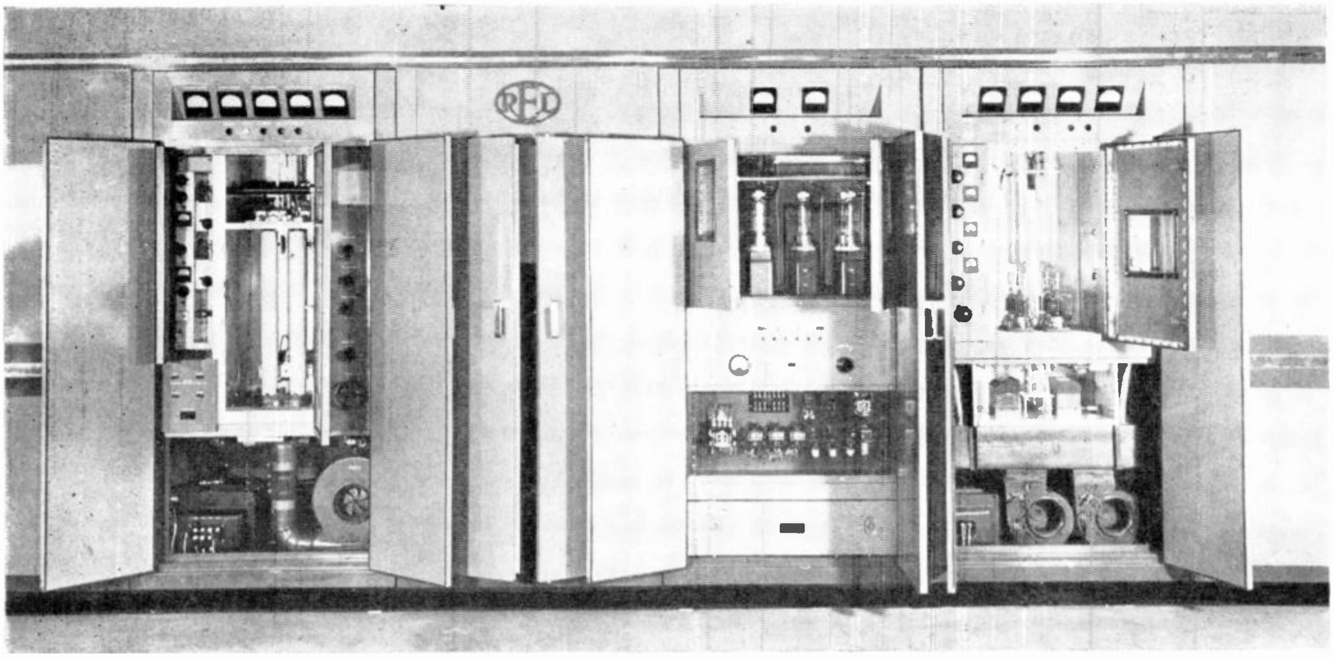


FIG. 1. LEFT TO RIGHT: 1-KW. MODULATOR AND DRIVER; ACCESS DOOR TO REAR; HIGH-VOLTAGE AND BIAS SUPPLIES, AND CONTROL CIRCUITS; 10-KW. FINAL AMPLIFIER WITH 4-TUBE QUADRILINE CIRCUIT

CHARACTERISTICS OF THE QUADRILINE AMPLIFIER

Details of the REL 10-Kw. Broadcast Amplifier, Employing 4 Tubes in a Push-Pull-Parallel Arrangement

BY J. R. DAY AND M. H. JENNINGS*

THE 10-kw. FM broadcast transmitter to be described is the culmination of fourteen months of intensive development work, during which time several different conventional power amplifier circuits were considered. The major design objectives were:

1. Low driving power
2. Stable, reliable operation of the power amplifier
3. High-power amplifier efficiency
4. A simple method of matching the power amplifier to its load
5. Ample power output reserve
6. Low tube cost
7. Simple mechanical design.

To meet the first and third requirements, tetrodes were the obvious tube type to use. To this end, several months were spent in an attempt to satisfy the design considerations by the use of two external anode tetrodes. However, this type of amplifier did not meet any of the design objectives in a manner which was believed consistent with the requirements of broadcast service, and was subsequently discarded.

Our final solution was the REL model 520 transmitter shown in Fig. 1. The left hand cabinet houses the standard REL 1-kw. transmitter, employing Eimac type 4-500A tetrodes, with the simplified Armstrong dual-channel phase shift modulator. The second frame from the right contains the high voltage supply, screen and bias supplies, and control circuits, while the right hand frame houses the final amplifier stage, which consists of 4 Eimac type 4-1000A tetrodes connected in the REL Quadriline circuit.

The 4-1000A, an internal anode tube of stabilized and long-tried design, was selected for several reasons:

1. It is capable of delivering the power required for thousands of hours.
2. Cooling requirements are relatively simple.
3. The internal anode design has proven itself through millions of service hours.
4. Plate circuit conductors become small, since an internal anode does not have to enter the end of the lines.
5. The socketing problem is simple, with only a plate cap to connect after the tube is in place.
6. Tube changing is rapid, requiring 5 to 10 seconds.
7. Tube elements are visible during operation.
8. The tube cost is very low.

The use of a 4-wire circuit is the outgrowth of experience gained with both coaxial and 2-wire open transmission lines as circuit elements. Coaxial line circuits are usually employed where it is necessary or desirable to use a single amplifier tube, the necessity for grounding at least one of the primary tube electrodes making this choice almost certain. Coaxial resonant circuits offer certain mechanical difficulties, particularly in connection with providing the necessary tuning adjustments. Properly designed and constructed they have, however, no external field, which is an important point that will be treated later.

Since the whole arrangement of a coaxial circuit amplifier is unsymmetrical, no advantage can be taken of the reduction in harmonic frequency power output that occurs with balanced or push-pull arrangements. Coaxial-type amplifiers can be paired to secure this advantage, but the mechanical elaborations necessary put them in an uneconomic class. Two-wire line circuit elements lend themselves admirably to the push-pull arrangement and are widely used in this fashion. A 2-wire line, or section of one used as a resonant element, has a very appreciable

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induction field, and since it is invariably necessary to enclose the whole amplifier both electrically and mechanically, great care must be exercised in the design of the enclosure so that, among other things, space coupling between input and output circuits does not occur, and that the enclosure does not give rise to dissipation of power or unbalance. An additional advantage of the push-pull connection using two tubes over the single-tube scheme is that, for a given power rating, the two smaller tubes employed are usually cheaper, simpler, and more reliable than the larger single tube. For good commercial reasons, all power tube types are generally operated very near their maximum capabilities.

Properly operated, a push-pull amplifier will generally continue to function in emergency if one tube fails. By arranging an even number of tubes greater than two in two symmetrical groups, they can be operated in push-pull-parallel fashion by the conventional connection to 2-wire line circuits. This process cannot generally be carried very far, usually not beyond 4 tubes, and sometimes not that far, because the accumulating shunt capacity of many tubes so shortens the external circuit that grave electrical and mechanical restrictions arise.

This particular amplifier retains the good points mentioned above and overcomes to a marked degree the disadvantages. It is basically a 4-tube push-pull-parallel arrangement, employing short sections of 4-wire balanced transmission line as input and output circuits. These circuits are open at one end and closed at the other by short circuits between adjacent line elements. The open end of the input circuit is connected directly to the grids of the 4 tubes, and the open end of the output circuit to the plates of the 4 tubes. The filaments of the 4 tubes are connected by short circuits between adjacent tubes.

Any or all sets of short circuits at the closed ends of the input and output circuits and at the filaments can be replaced by conducting sheets without affecting the principle of operation. It is more convenient to use the picture of the short circuits first given.

Referring to Fig. 2, the input circuit closed by the grid-cathode admittances is called the *input cage*, and the output circuit closed by the plate-cathode circuits is called the *output cage*. The excitation for the input cage, described in detail below, is such as to insure that variations in the flow of current in opposite grid lines are in the same direction, while simultaneously in opposite directions in adjacent lines. As a consequence, variations of plate current in opposite tubes occur in the same direction, and simultaneously in opposite directions in adjacent tubes. The cages are operated at resonance. That is, the distance from the short-circuited ends to the tube circuit terminations will be less than an odd number of quarter-wave lengths for the frequency of operation, the amount of shortening being dependent on the capacitance of the tube circuits. In most practical cases they are less than one quarter-wave long.

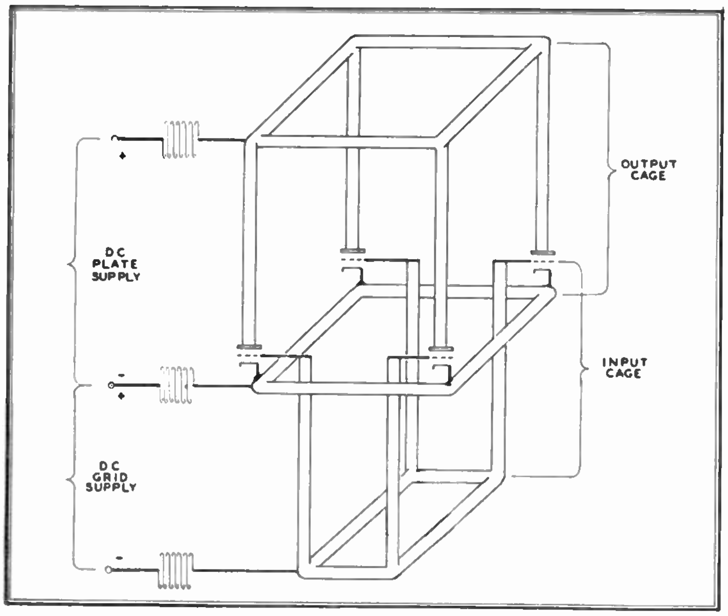
These conditions correspond exactly to those for the operation of tuned coaxial or 2-wire amplifiers. It will be seen that this is a push-pull-parallel connection, but differs from the usual version in that the entire amplifier is, by virtue of the 4-wire connection, arranged in a completely symmetrical fashion, thus securing the characteristically minimum external field of such lines.

This is of very great significance in practical amplifiers, since operation is substantially independent of the necessary enclosures and other nearby conducting and dielectric objects. Very much greater freedom in initial design is one direct result. Another is the reduction to entirely negligible proportions of the fraction of otherwise useful power lost by radiation and by dissipation external to the circuits.

When operating, the mid-points of all the short-circuit connections at the ends of the cages and at the cathode connection are so-called neutral points, insofar as the potential of all other points of the entire amplifier oscillate symmetrically with respect to them. Replacing the shorting bars by conducting sheets imparts to the sheets the same neutrality.

Coupling to the input circuit is accomplished as shown schematically in Fig. 3. This is one of many possible methods. A short 2-wire transmission line is connected to the coaxial line from the driver through series capacitors. The grid coupling loops produce a transformation from the 2-wire line into a 4-sided structure such that the inducing currents flow in phase in opposite legs, and out of phase in adjacent legs. To further insure that the main input cage, and hence the tube input electrodes, are correctly excited, diagonally opposite points of the cage near the tube electrodes are shorted together. This connection short-circuits the capacitively coupled out-of-phase components at opposite input electrodes, which might otherwise cause the latter to be unequally excited.

Fig. 4 indicates schematically, by the arrows, the relative directions of flow of the alternating component of current in the various parts of the whole input cage, including the grid-cathode admittances, at one instant of time. Since the long dimension of the cage is comparable to a quarter wavelength at the frequency of operation, there are the natural time delays in transmission, so that the arrows



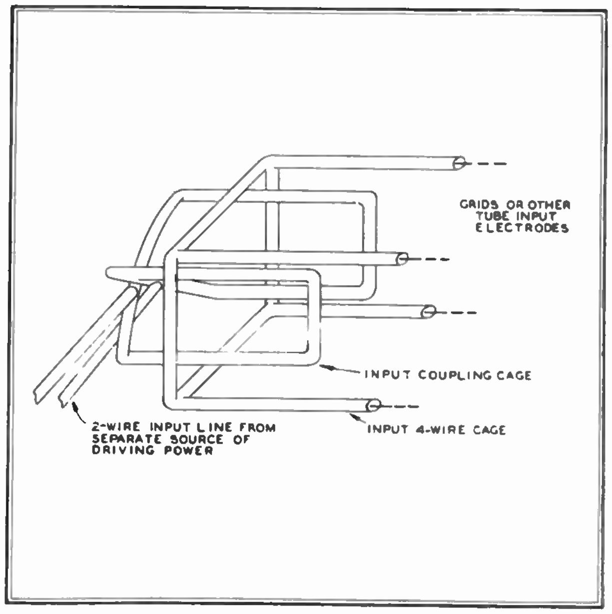
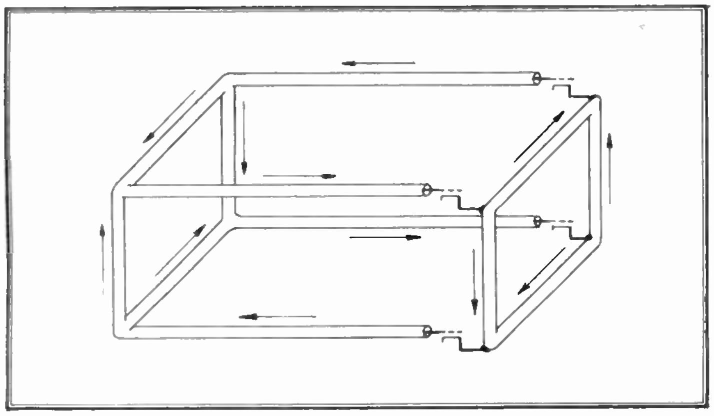


FIG. 2. GRID-CATHODE AND PLATE-CATHODE CAGES. FIG. 3. METHOD OF COUPLING TO THE INPUT CIRCUIT LINE

do not give a rigorous picture for one instant. They do, however, convey the sense of operation. It will be clear from this picture that radiation from the ends of the cage will be negligible, since there is no net flow in either direction around the square. These squares can be replaced, as noted earlier, by conducting sheets. Further, Fig. 4 makes clear that at distances greater than a side of the square ends, the net field due to the long dimension of the cage is small and is very rapidly decreased for increased distances. The radiation in this sense is also very small.



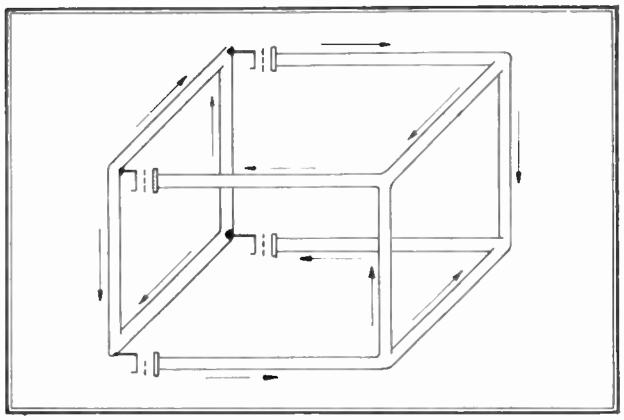


FIG. 4. RELATIVE DIRECTIONS OF AC FLOW IN THE INPUT CAGE. FIG. 5. CURRENT VARIATIONS IN THE OUTPUT CAGE

The voltage variations across the grid-cathode admittance give rise to current variations in the plate-cathode circuits which, since they are connected in a similar, resonant 4-wire cage, yield a situation as shown in Fig. 5, where the comments about external field and radiation loss apply equally. The cathode square is here the identical one shown in Fig. 4.

It should be noted that some of the driving energy of the input cage is directly available in the output cage, by the mechanism of the common cathode square. If a sheet is used here, the only common coupling left is that due to the residual length of the filament connection within the tube proper.

The resulting oscillating energy, in the output cage, can be abstracted for external use by an inductive coupling arrangement similar to that shown in Fig. 3.

Because of the increased mutual induction of the side elements of the cage, this amplifier functions much more satisfactorily, when one tube fails, than is the case for a similar failure in a 2-wire resonant circuit. The lump capacitance between tube electrodes and the inductance of the lead-in connections to them contribute shortening of the external part of the cage from the quarter wavelength value. The use of 4 tubes in the conventional push-pull-parallel arrangement with a 2-wire circuit results in a greater shortening than is the case for the 4-wire circuit.

This occurs because the characteristic impedance of any two adjacent sides of the 4-wire cage is lowered by the correctly-phased near presence of the other two sides; another manifestation of the increased mutual induction mentioned above. Because the characteristic impedance of a 2-wire circuit changes less rapidly than the ratio of axial conductor spacing to conductor diameter, and because of the proximity effects (non-uniform distribution of current over the surface of each conductor), the 2-wire circuit is always at a length disadvantage when used with 4 tubes compared to the 4-wire circuit under conditions of similar mechanical practicability.

The alignment of the 4-wire amplifier is extremely simple for an equipment of this power rating. Resonance of the input cage to the operating frequency is accomplished by means of the input series capacitors shown at the right of the grid lines in Fig. 6. When both the input cage and the grid-cathode cage have been resonated, balance of the individual screen currents can be achieved by a slight increase of one of the input series capacitors and a corresponding decrease of the other, an effect which occurs because of the necessity for correct phase relationship between the currents flowing in the input cage and those flowing in the grid-cathode cage.

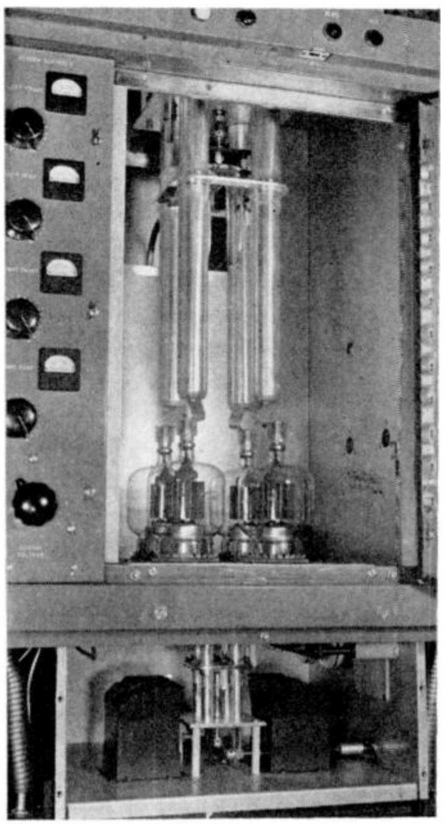


FIG. 7. OUTPUT CAGE AND PORTION OF THE HALF-WAVE MATCHING SECTION

Neutralizing is accomplished by resonating each screen lead to ground, however, since the circuit balance is so nearly perfect that it is possible to gang the front and rear capacitors of each pair of tubes, as shown in Fig. 6, thereby achieving a minimum number of controls. The neutralizing procedure consists merely of peaking the grid current with the neutralizing capacitors while the plate circuit is at resonance, and a final retouching with plate voltage applied to make the grid current and plate current track together.

Output power is taken from the plate circuit by an output cage, the position of which is variable with respect to the plate shorting-bar from the front panel. The midpoints of this cage are connected to a shielded half-wave open-wire matching section, which considerably simplifies the problem of matching the transmitter to either balanced or single coaxial line, or to an open-wire transmission line. Details of the output cage and a portion of the half wave matching section are shown in Fig. 7.

Final vernier adjustment of tube balance is accomplished by the use of the controls shown on the left panel in Fig. 7. A variable transformer is used to control the screen grid supply voltage, while series potentiometers provide control of individual screen currents, thus compensating for any remaining circuit or tube asymmetry.

The high voltage for the power amplifier is controlled by a motor-driven rotary tap switch which, under overload, reduces the voltage in discrete steps to 3,000 volts, at which point 4 overloads are allowed before the circuit shuts down

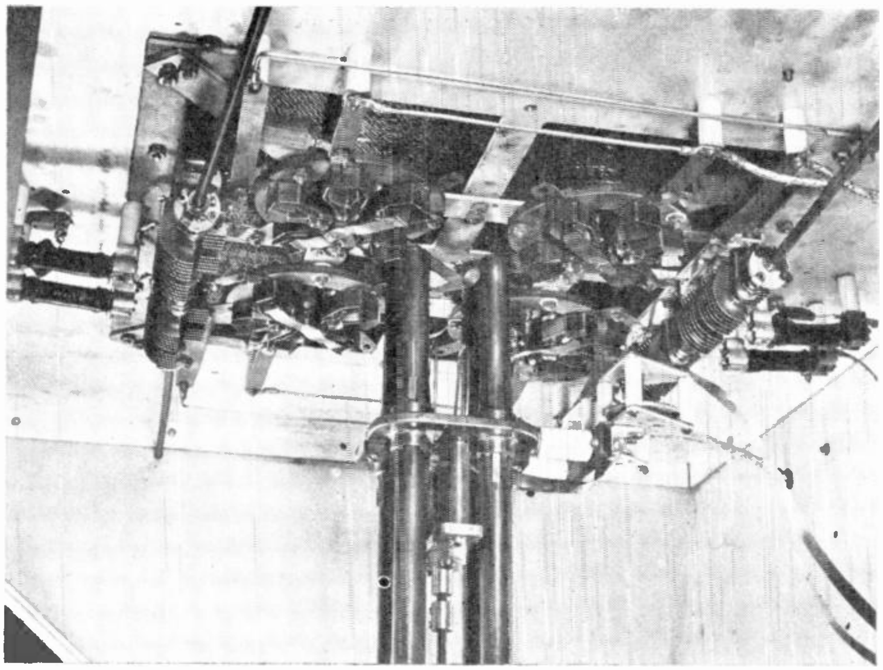


FIG. 6. CONSTRUCTION DETAILS OF THE INPUT AND THE NEUTRALIZING CONDENSERS

automatically. Connections for an alarm bell are provided at the last operating level. An automatic high-voltage shorting device is employed to short circuit the main filter capacitor when any door interlock circuit is opened.

Additional features of the equipment are convenience outlets at the rear of each cabinet, interior cabinet lighting controlled by interlock switches, a standby high voltage rectifier tube, spare fuses mounted adjacent to those in use, and wrenches for adjustment of mechanical controls mounted within the cabinet.

When delivering rated power output, the final amplifier requires approximately 750 watts of driving power and operates at 5500 volts with a plate input of 12.2 kilowatts, giving a final amplifier efficiency of 82%, and an AC line-to-output transmission line efficiency of 53%. Although the equipment has a nominal power output rating of 10 kw., it is capable of delivering over 13 kw. At rated power output, failure of a single tube filament results only in an approximate 15% decrease in output, and a slight increase in the anode color of the remaining operative tubes.

Finally, low tube cost, a major design objective, has been thoroughly satisfied by the use of the 4 small, inexpensive, internal anode tubes.

It is believed that this equipment will completely fill the exacting requirements of the commercial FM broadcast service for a stable, efficient, easily-handled and readily-maintained transmitter.

TELEVISION HANDBOOK

(CONTINUED FROM PAGE 42)

because the surface is not continuous, but consists of isolated photo-sensitive islands, so that in practice an illumination of

$$L = 24 \text{ millilumens/cm}^2$$

is necessary in the brightest parts of the image for maximum unsaturated output.

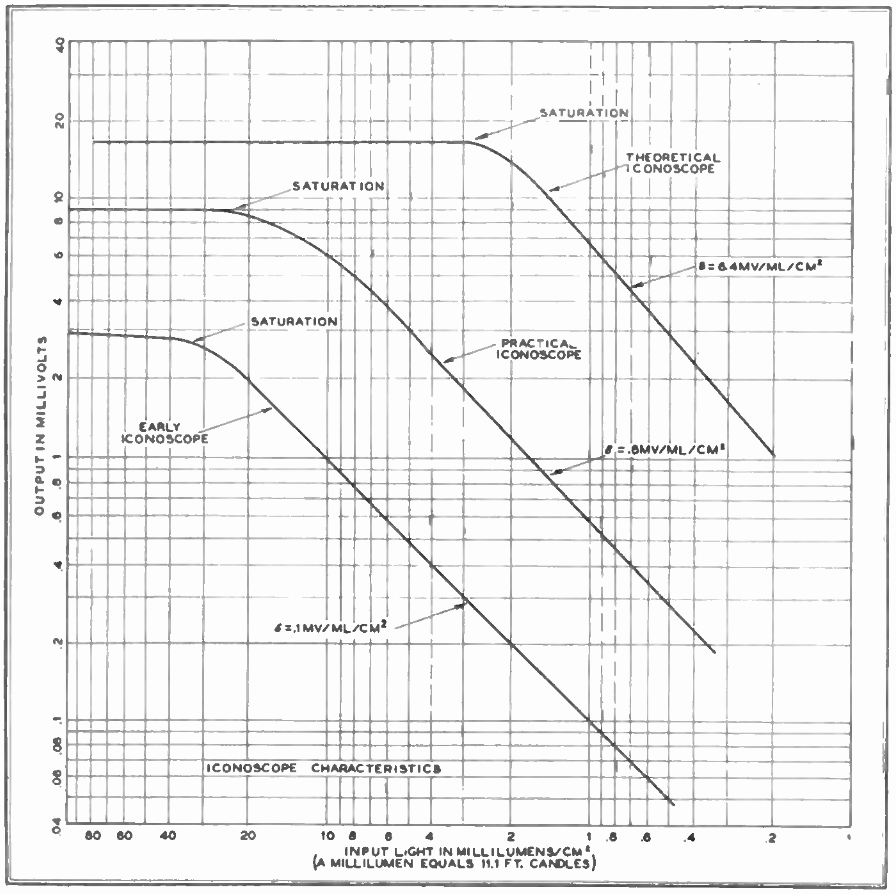


FIG. 48. ACTUAL AND THEORETICAL CHARACTERISTICS OF THE ICONOSCOPE

This is for caesiated silver having 5 microamperes per lumen sensitivity. (Zworykin gives a value of 7 as representative.)

The above analysis is based on the assumption that the mosaic is equivalent to a voltage generator with a (voltage-saturated) maximum, generated potential equal to the redistribution potential of approximately 1 volt.

This maximum exists because of the average difference of about 1 volt which exists between the stopping potential of photo-electrons and redistributed secondaries. This difference alone determines the order of magnitude of generated voltage in the output circuit. A photo-surface which has higher stopping potentials (higher velocities) of emitted secondaries, or lower threshold frequency of photo-emission, will improve the sensitivity of the iconoscope in direct ratio to the corresponding values for caesiated-silver.

Actually, it is doubtful if the full saturation potential is ever realized at the mosaic because of the involved nature of the redistribution process. The order of magnitude is correct, however, and 1 volt should be realized under some conditions.

With a 25,000-ohm load, the sensitivity S of the average iconoscope should be given by dividing the maximum output signal in volts (16 millivolts) by the illumination in millilumens necessary to give this signal (L = 24 millilumens/cm²):

$$S = 16 \times 10^{-3} / 24 \times 10^{-3} = 0.6 \text{ millivolts/millilumen/cm}^2. \quad (6.3)$$ [5]

(CONTINUED ON PAGE 53)

[5] Compare with 0.45 mv/ml/cm². Zworykin, Vol. II of "Television," p. 385, RCA Inst. Tech. Press, New York City.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

ample of this right in our home town of Great Barrington, not long ago.

The business manager of a nearby 250-watt AM station stopped in to call on us one afternoon because, he explained, he wanted us to bring him up to date on developments in FM and television. Particularly, he wanted to know if it was possible to get any FM or television reception in this area.

We explained to him that six FM stations can be heard here now, and that the number will be doubled by fall. However, no television signals come in here, and no stations are projected that will give us service.

What the man didn't tell us, as we learned later, was that he had just come from a Rotary Club luncheon where he delivered a talk on the progress of FM and television. He had assured his audience that they will have television reception in their homes "very soon," but, he confided, "FM has proved to be a flash in the pan, and is getting nowhere."

After talking to him, we really believe he was sincere. Certainly he was primed with the most amazing supply of misinformation we have ever heard.

A more recent example of the same sort of thing just came across the editorial desk in the form of a clipping from an unidentified New Jersey newspaper. It reported "an illuminating talk" by F. J. Schlink, president of Consumers Research, before the Kiwanis Club. According to the newspaper report: "FM broadcasting is petering out, Mr. Schlink declared before the Kiwanians, many of whom sell FM radio sets. This is due, in his opinion, to the Government's change in the wavelength. The new wavelength does not work satisfactorily, he said, and is making old sets obsolete."

Such complete lack of factual information might not be surprising from an AM station executive, but this man heads an organization which presumes to evaluate by scientific means the performance and

(CONCLUDED ON PAGE 56)

The trade mark, FAXIMILE has been applied for registration by Faximile, Inc., and the trade mark, FAXPAPER has been applied for registration by Radio Inventions, Inc.

These trade marks are to designate the products produced by Faximile, Inc., and Radio Inventions, Inc., and the products of licensees of the above companies.

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The trade mark,

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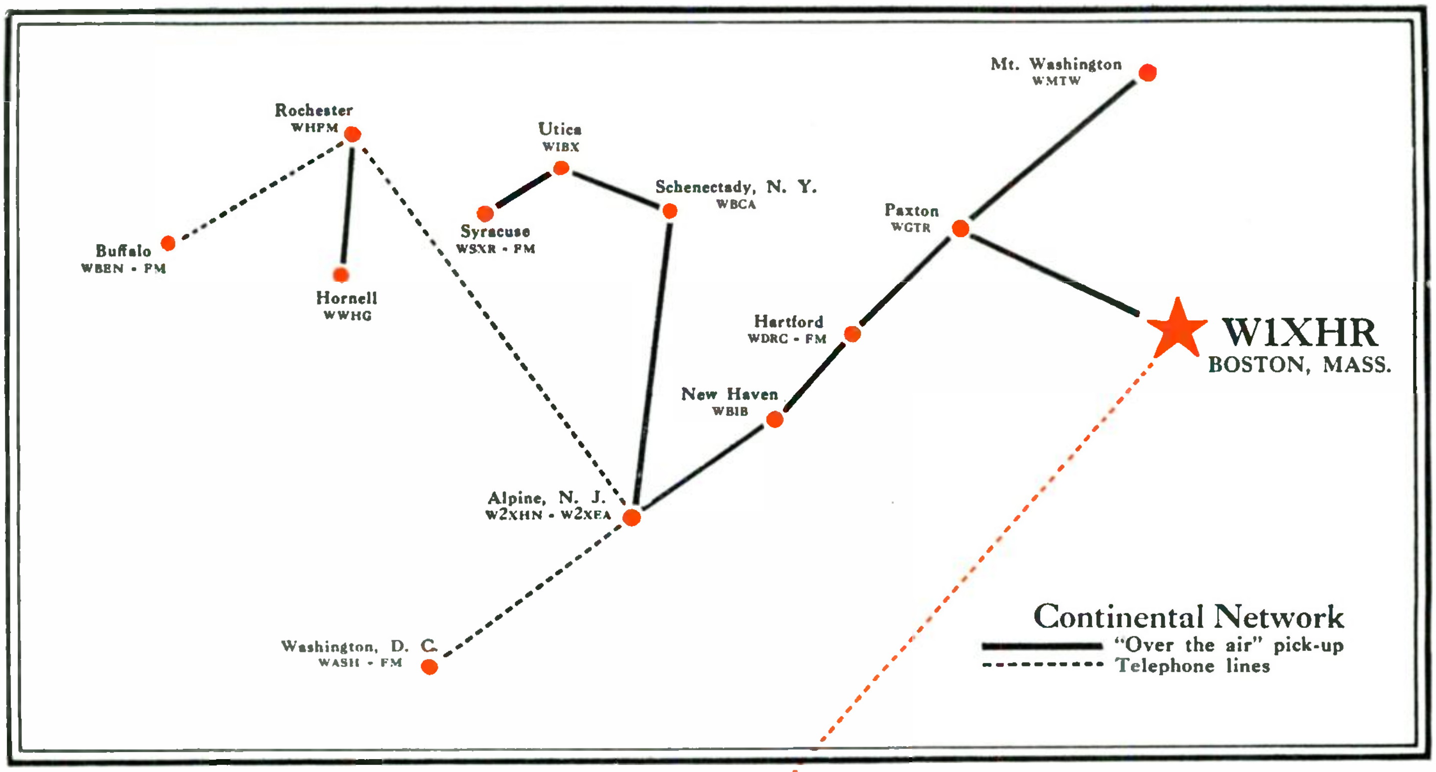
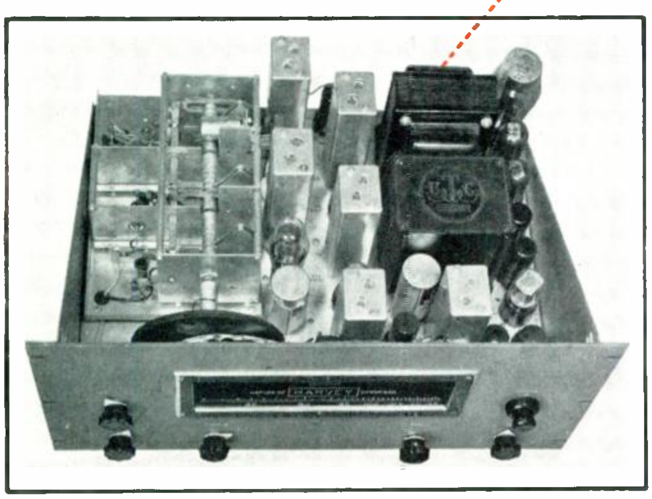
is now being used by Faximile, Inc., and registration will be applied for when term of use under the Trade Mark Laws has been completed.



The FM Receiver with Network Experience

In the recently formed Continental Network, W1XHR, Harvey's High Fidelity FM station, serves as the FM outlet for Eastern Massachusetts. Programs originating in Washington, D. C. are received from WGTR in Paxton, Mass. on 103.1 Mc. and rebroadcast on 92.1 Mc. Harvey's 193-R High Fidelity FM receiver is used as the Relay-Link receiver at W1XHR and furnishes quality audio signals to its transmitter for rebroadcast purposes.



The Model 193-R High Fidelity FM Receiver (top view) employs a double conversion superheterodyne circuit using two I.F. channels 10.7 Mc. and 4.6 Mc.

Price $490 f.o.b. Cambridge, Massachusetts

CHARACTERISTICS:

Frequency Range: 85 to 115 Mc.

Audio: an extremely high fidelity audio system is used, providing flat response from 10 to 40,000 cycles.

Sensitivity: RMS quieting signal of 1 microvolt.

Bandwidth: 250 Kc., adequate to pass the sidebands produced by 15 Kc. modulation, without appreciable band-edge attenuation.

Squelch Circuit: smooth, fast acting and adjustable from .1 microvolt to 1 microvolt.

Size: 21½" x 10½" x 15", available in an attractive gray wrinkle-finish cabinet.

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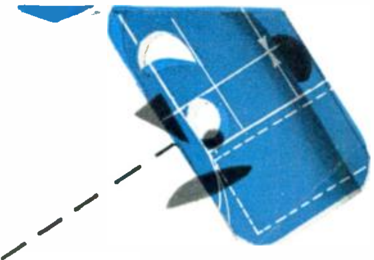

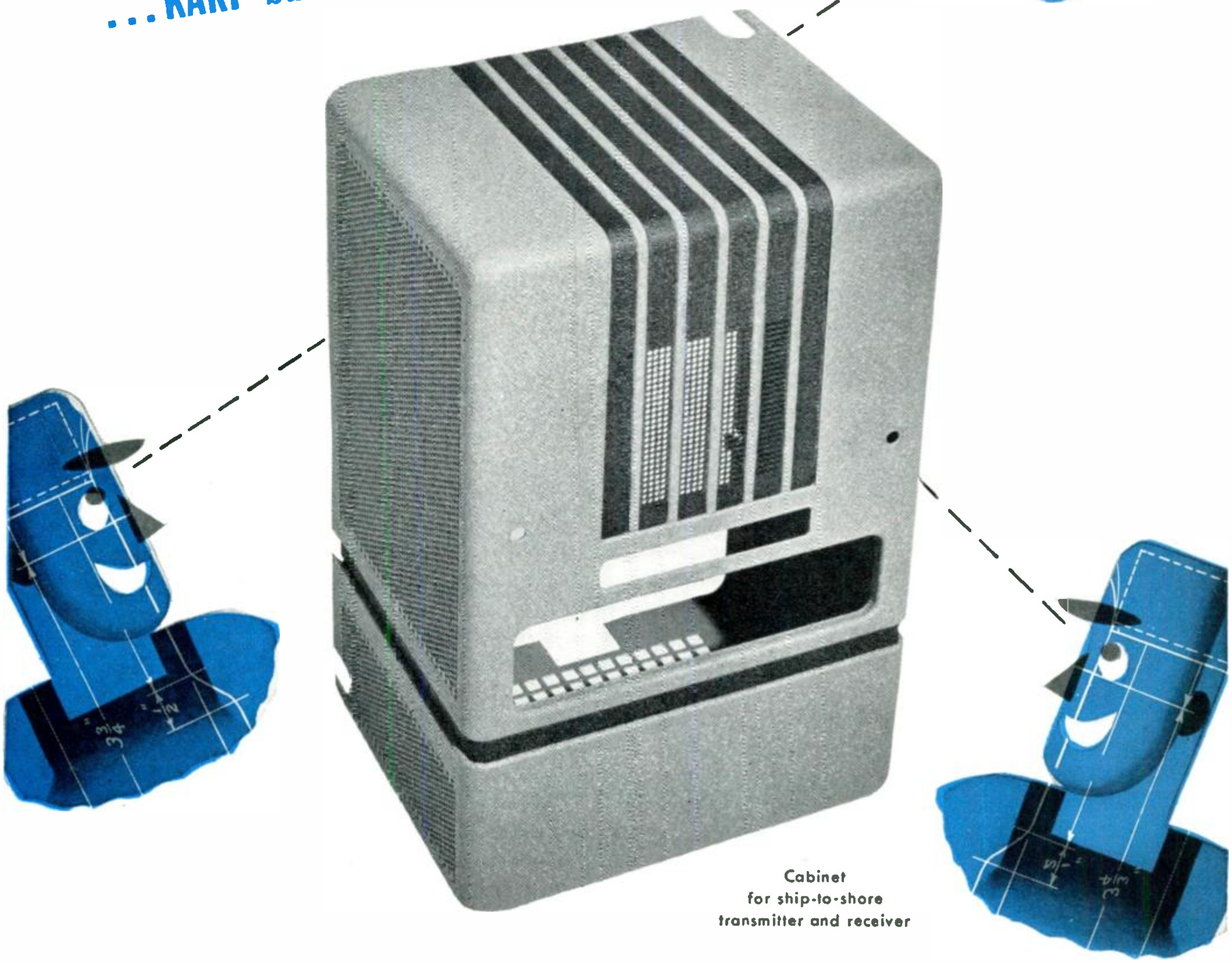

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for ship-to-shore
transmitter and receiver

No matter how you look at it, you'll find many reasons why Karp-built cabinets, housings and enclosures will add value to completed equipment assemblies.

We will follow your designs with fidelity, or our design specialists can suggest design ideas which will enhance appearance, achieve ruggedness, save space or weight. Our work insures uniformity and accuracy—which mean production economy both in the fabrication and in your own assembling operations.

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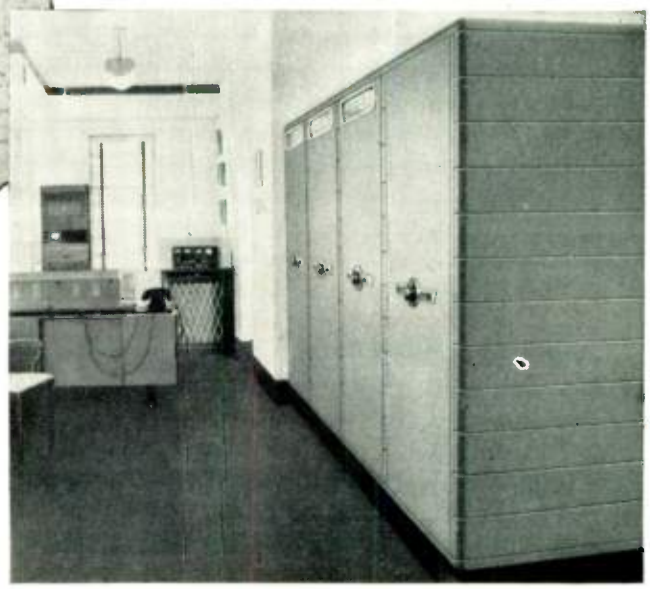
now operating in the new FM band at "WELD", Columbus, Ohio

Another Achievement for FM by Federal!



Here's the new transmitter room at Station WELD, showing Federal's 10-KW FM transmitter. Full-length hinged doors give unhampered access from both front and rear—with minimum overall space requirements.

THE 10-KW Federal transmitter, now on the air at Station WELD, marks a new high in FM transmitter capacity—the first new-band commercial transmitter of its power to be installed in this country!

Station WELD wanted the utmost in power — the finest in FM quality. That meant FM by Federal! For the Frequematic* modulator — an exclusive Federal feature — assures the last word in fidelity and mean carrier stability. Simple all-electronic circuits with standard receiver tubes assure unsurpassed dependability and economy.

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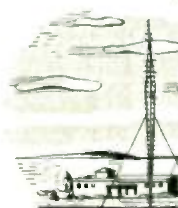

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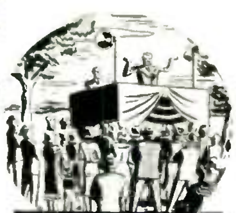

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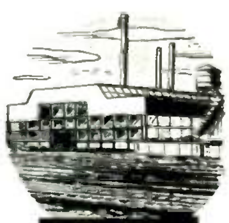

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TELEVISION HANDBOOK

(CONTINUED FROM PAGE 46)

These figures represent the practical limits of sensitivity of the iconoscope. Noise has been purposely omitted in the foregoing discussion inasmuch as it does not affect the sensitivity, but affects only the minimum illumination at which the tube works for a given signal-noise ratio.

It will be noted that the theoretical sensitivity as given is explicitly but not implicitly independent of the negative-equilibrium potential. If it were possible to establish a negative-equilibrium potential of greater value, the redistribution factor might actually be increased or decreased, depending upon the method used to establish this potential. It should be remarked that the establishment of a greater negative-equilibrium potential would tend to saturate the photo-current and unsaturate the photo-potential, thus increasing both the voltage output and the saturation level of illumination. This can be seen in Figs. 45 and 46. Also, it would be necessary to increase the beam current and decrease C, in order that the saturation stipulations, Section 1.26, be fulfilled. Thus the sensitivity might increase if the desaturation factor increased more rapidly than the decrease in redistribution factor.

(1.27) *Characteristics.* The characteristic of the iconoscope can be plotted from the data given in the preceding sections. This has been plotted for three types of iconoscopes in Fig. 48. There are shown the probable, maximum theoretical characteristic of the optimum iconoscope, the characteristic for a practically realizable iconoscope, and for an early iconoscope of about 1936.

It will be noticed that the tendency is for saturation to occur at quite low levels of light in very sensitive iconoscopes. The illumination saturation occurs when the photo-current counteracts the negative-equilibrium potential.

Sensitivity is the ratio of output voltage to illumination. This ratio is constant up to saturation, except in the immediate region where saturation occurs. Actually, the characteristic is not quite as linear as shown in the idealized curves of Fig. 48, but has a slight exponentiality which increases as saturation is approached.

It can be concluded that sensitivity and illumination-saturation are to the first approximation inversely proportional in the iconoscope.

(1.3) *Applications.* The iconoscope is so designed that it can be used with a lens having a focal length of approximately 7 ins. F-numbers f/3.5 to f/4.5 are usually satisfactory unless the lighting conditions are quite poor. The angle of view which can be obtained is approximately 22°.

Care must be taken to shield the iconoscope from external magnetic and electric fields. Shielding should be provided also against microphonic disturb-

(CONCLUDED ON PAGE 54)

TELEVISION HANDBOOK

(CONTINUED FROM PAGE 53)

ances, since the gain of the preamplifier and of the mixing amplifier together must be in the order of 100,000. Unless the camera is properly shielded against external radio or television fields, it is possible to pick up a television picture being broadcast from another station on the mosaic of the iconoscope, as it can act as an antenna. In such a case, rectification occurs in the preamplifier and both the desired picture and the undesired pictures will appear on the monitor.

Several stages of preamplification are usually included in the iconoscope camera in order to raise the level of video output from millivolts to volts. This signal is supplied via a coaxial cable to the mixing amplifier where blanking signals, and sometimes synchronizing signals, are injected. Shading signals are sometimes injected in the preamplifier and sometimes in the mixing amplifier.

Shading is a function of redistribution, and for this reason depends upon the pattern of illumination on the iconoscope mosaic. It will be recalled that under the subject of redistribution the fact was discussed that there is a continual rain of space-charge electrons falling back on the portions of the mosaic which are most brightly illuminated. This phenomenon tends to reduce the overall contrast-ratio in the iconoscope. In some cases where there is sharp contrast in minute areas of the picture, a phenomenon known as *local shading* occurs. This is due to the high value of sensitivity along the scanning line where an abrupt change occurs in the potential of mosaic elements which have just been scanned and those which are about to be scanned. The scanned elements are at positive equilibrium and the unscanned elements are somewhere between negative equilibrium and positive equilibrium. The sharp changes in potential between these two groups of elements can cause a directed rain of redistributed electrons which may produce streaking in the picture, apparent as an overshoot where sharp changes in contrast occur.

In addition to loss of contrast, the undesirable shading patterns cause a change in black level from one portion of the picture to another. This can be compensated in the overall picture by the use of a piece of apparatus called a shading generator.

A shading generator is used to generate a variety of waveforms both at horizontal and vertical deflection frequencies. Usually, sawtooth waveforms, parabolic waveforms, and exponential waveforms in both polarities and at both deflection frequencies are provided in this generator. Sometimes a reversed exponential waveform is added. These are the waveforms due to redistribution, or shading, which usually occur within an iconoscope picture.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 48)

intrinsic value of radio sets, among other things. Moreover, Consumers Research charges the public for publishing its findings.

Our personal opinion has always been that Consumers Research, as far as radio set ratings are concerned, is neither a responsible nor a reliable source of guidance. If Mr. Schlink's statements were reported correctly, they certainly confirm our opinion. We think he should schlink around where FM receivers are in operation before he makes any more public statements, and do a little first-hand researching. Since he is a New Yorker, it might be well for him to tune in on Alpine for the Continental Network programs on Wednesday nights at 8:00 to 8:30, or on Thursday nights at 9:00 to 10:00, E.D.T.

NEWS PICTURES

(CONTINUED FROM PAGE 29)

General Electric equipment is employed in this installation.

3 Fred Ebel sent us this photograph of Motorola FM equipment in action. It shows a meter-and-well attendant, acting under radio instructions, as he set the valves of the famous gas well known as Morgan Unit No. 1. Located 4 miles east of Carthage, this well, one of 125 used by United Gas, is 5,800 ft. deep. The Company operates 77 mobile units in its FM system to handle instructions to repair crews, demands of the compressor stations, and reports from meter-and-well attendants.

4 At the separate Camden plant where RCA transmitters are built, a 50-kw. FM broadcast transmitter is operating under test into a 4-bay Pylon antenna. The preproduction high-power amplifier design shown here is most like a cooling system in the form of RF tanks. Actually the power tubes are operated in metal-enclosed concentric tank assemblies, which are grounded and form an integral part of the transmitter. Since this housing is at zero potential, it acts as an effective shield and eliminates the need for special guard cages or enclosures, ordinarily required for the protection of personnel from dangerously high voltages.

The high-frequency power tube, RCA type 5592, developed especially for the new transmitter, is an air-cooled triode designed for grounded grid operation. The same type of tube is used in the driver and final amplifier stages.

According to Dana Pratt, manager of the transmitter section, "the use of grounded grid circuits in the FM frequencies provides greater stability, high efficiency, simpler overall circuits and, most important of all, eliminates the need for neutralization."

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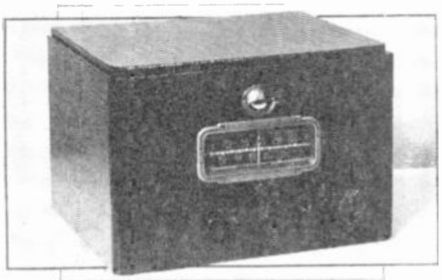
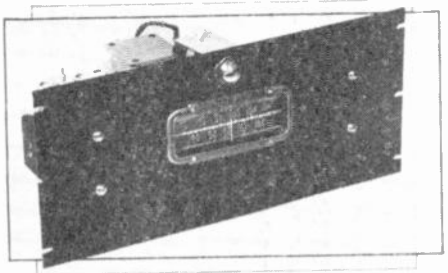


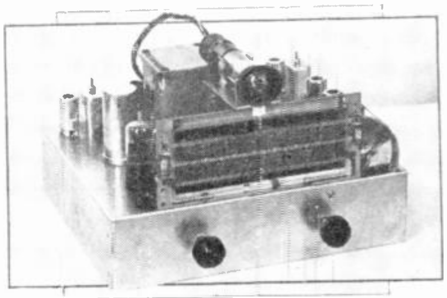
FOR THE LIVING ROOM or DEN

This cabinet model is available in a wide variety of leatherette finishes, as well as mahogany and walnut.



FOR THE RECORDING STUDIO or BROADCAST STATION

Rack panel measures 8¾ ins. high by 19 ins. wide, suitable for standard relay rack mounting.



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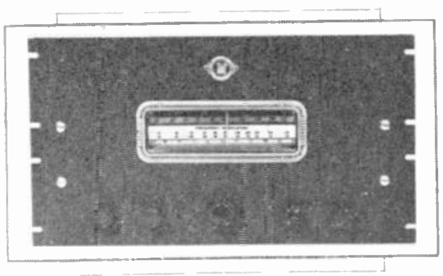
The Collins FM chassis can be easily adapted to ready-made consoles and book cases, or installed in wall mountings.

11 tubes are used in a genuine Armstrong circuit • 3 IF stages • 2 cascade limiters • Miniature tubes throughout • New FM band, 88 to 108 mc. • Stable oscillator circuit uses precision parts to eliminate drift.



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The Collins FM/AM tuner is the finest instrument of its kind on the market today. 17 tubes are used in its radically new circuits, employing the very latest in design. Many extra features are available on special order, to make this tuner fit your most exacting requirements.

THE COLLINS 10-B AMPLIFIER IS A 10-WATT, HIGH-FIDELITY UNIT DESIGNED SPECIFICALLY FOR USE WITH THE TUNERS DESCRIBED ABOVE

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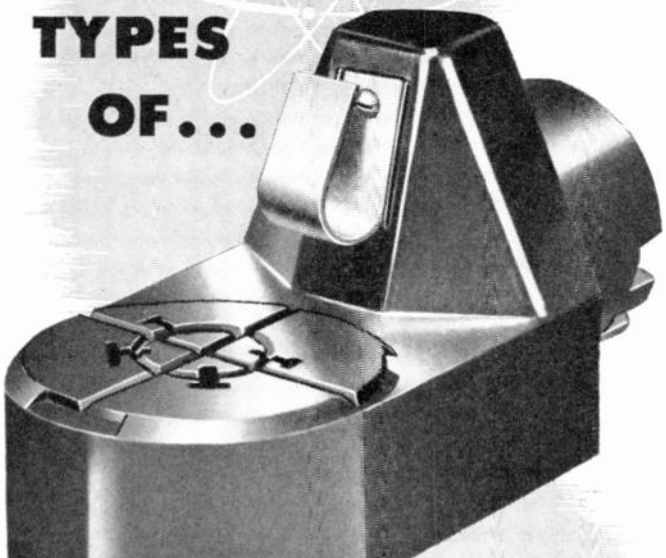

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To insure top performance and long uninterrupted tube life, leading manufacturers of electron tubes cooperated with Amphenol engineers in designing these new Industrial Sockets. With 36 types currently available, and more to come, Amphenol Sockets today are available for practically all electron tubes now in use.

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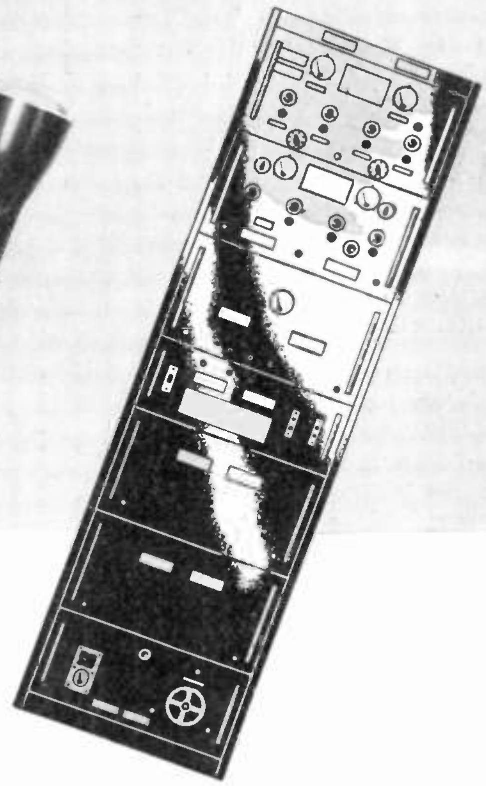

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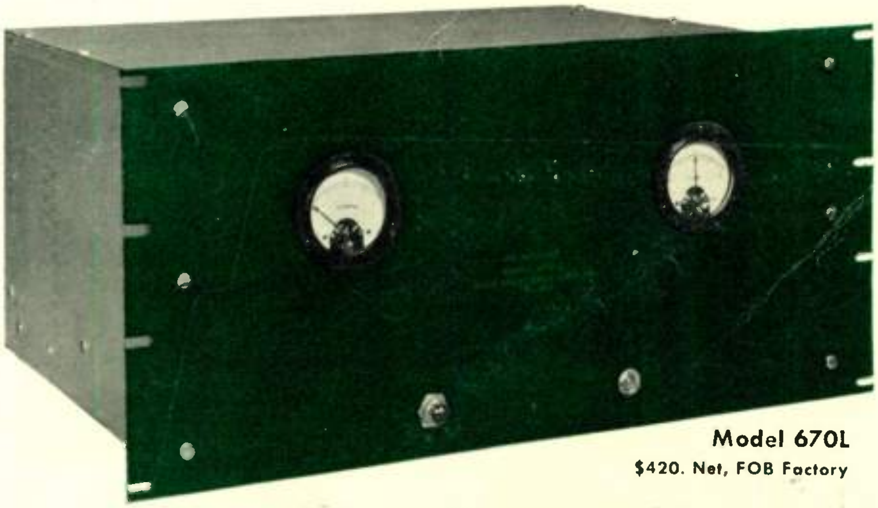

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