PRICE—TWENTY-FIVE CENTS

FM AND TELEVISION

OCT. 1945

SELECTIVE CALLING FOR EMERGENCY COMMUNICATIONS

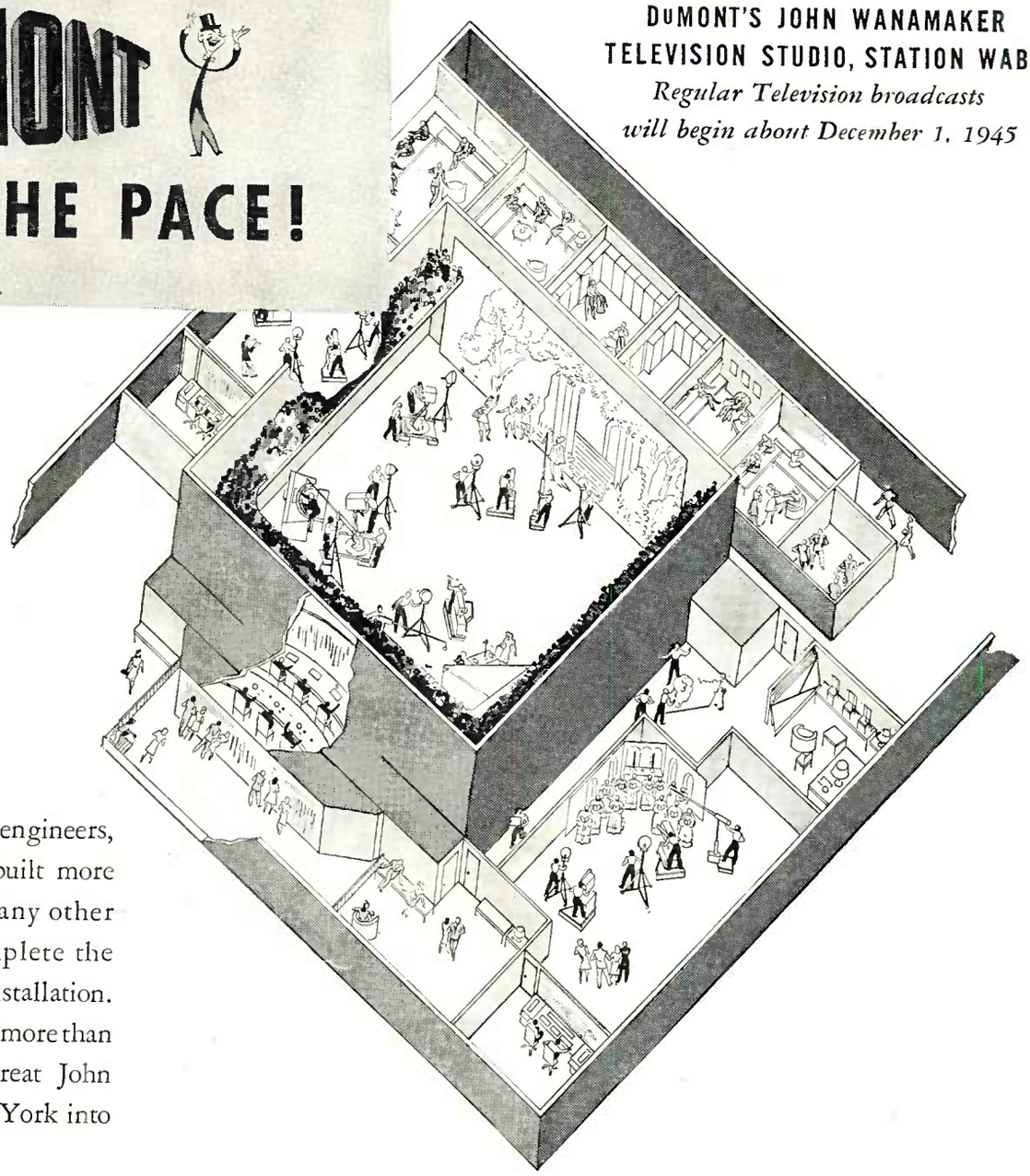
SEE PAGES [illegible] AND 41

Radio Trade Directory

★ ★ Edited by Milton B. Sleeper ★ ★

IN TELEVISION DuMONT SETS THE PACE!

DuMONT'S JOHN WANAMAKER TELEVISION STUDIO, STATION WABD
Regular Television broadcasts will begin about December 1, 1945



DuMONT TELEVISION engineers, who have designed and built more television stations than any other company, will soon complete the world's largest television installation. They are now transforming more than 500,000 cu. ft. of the great John Wanamaker store in New York into the first "Television City."

The largest studio (50′ x 60′ with a 50′ ceiling) boasts 4 cameras—the first studio to be so well equipped. A balcony accommodates 700 spectators and a rear glass wall of the control room permits sightseers to watch rehearsals and broadcasts. Two other "live talent" studios are equipped with 3 and 2 cameras each. Several cameras are mounted on a new type dolly providing extreme ranges of elevation and camera angle. A telecine studio has projectors for both 16 mm. and 35 mm. film.

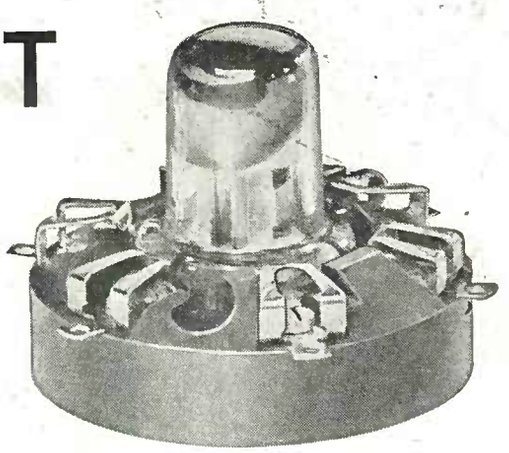
DuMont Television broadcasting equipment embodies all the flexibility and refinements accruing from more than 4 years of continuous and increasingly elaborate programming experimentation. Simplified precision control—the keynote of DuMont design—assures high efficiency and rugged dependability at low operating cost. DuMont leadership means adequate training of your technical personnel, and the finest craftsmanship for the least outlay.

DuMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

A NEW SOCKET

for very high frequencies

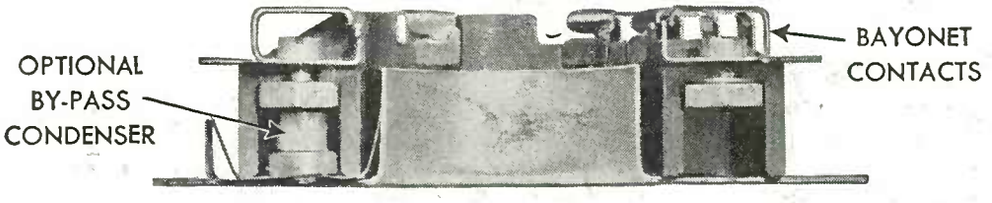


Type XLA

BORN of war-time necessity, this new socket, Type XLA, for the 6F4 and the 950 series acorn tubes, has been designed for working frequencies as high as 600 MC. The acorn tube is inserted in position, and rotated to engage the contacts. The tube terminals are held in a vise-like grip which insures permanently low contact resistance. Inductance is low and constant, and leads are short and direct. An internal shield, Type XLA-S, is available for tubes such as the 956. By-pass condensers may be conveniently mounted between the contact terminals and the chassis, but for minimum radiation a special ceramic condenser, Type XLA-C, may be mounted inside the socket in place of the contact screw. The socket is 1 17/32" diameter. Insulation is low loss R-39. Prompt delivery can be made without priority.

NATIONAL COMPANY, INC.

MALDEN, MASS.



J-T is ready!

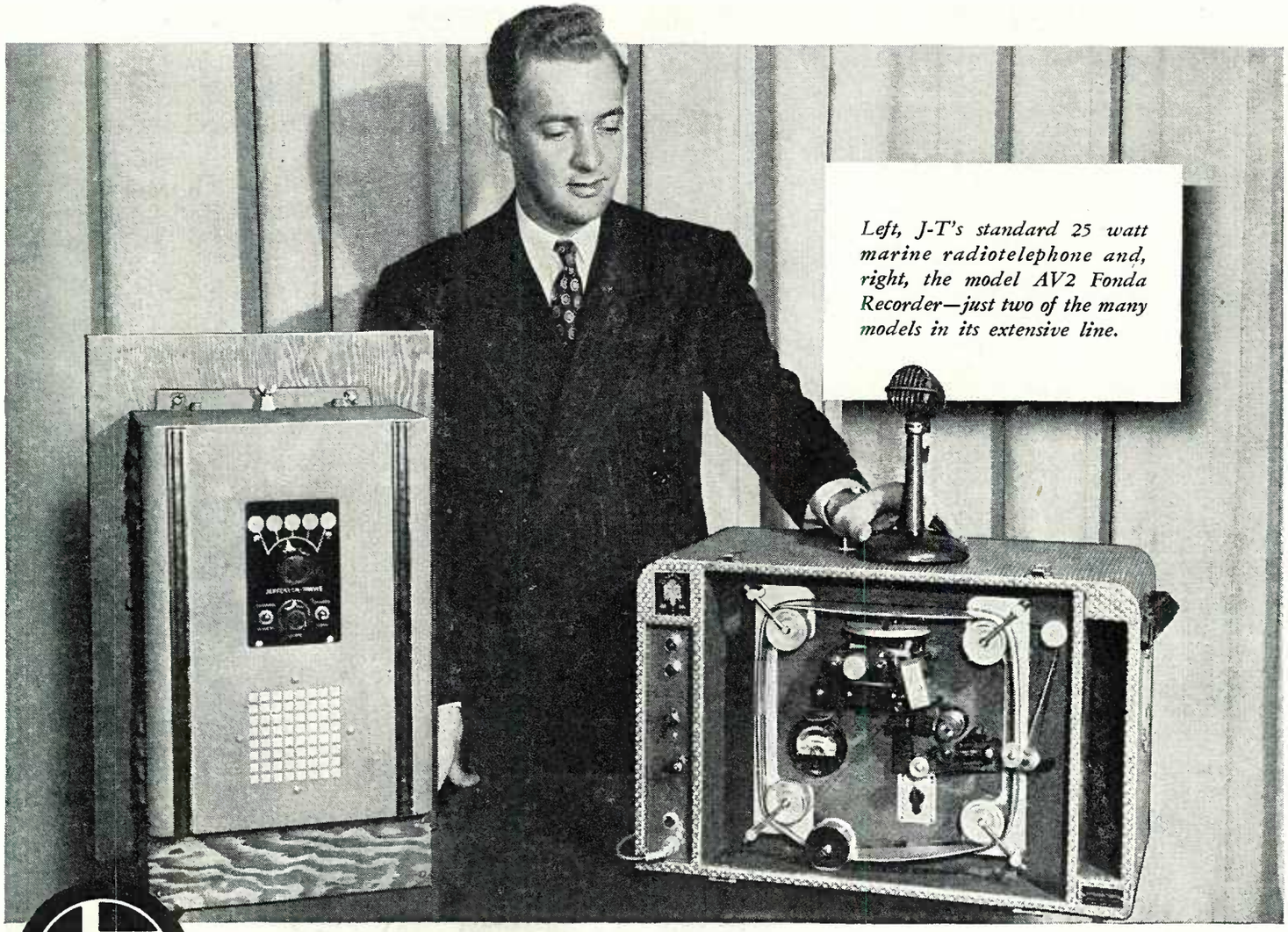
ON LAND, sea and in the air, hundreds of Jefferson-Travis radiotelephone units, installed before the war, are still in operation today after several years of constant use.

»These installations were built for long life, dependability, excellence of performance and designed to require a minimum of maintenance.

»Today, Jefferson-Travis is ready to reveal a number of new models embodying many refinements as a result of wartime research and engineering techniques. As specialists in the development of radiotelephone communications equipment for many purposes we are prepared to offer you the finest obtainable in this field.

»In addition, our Fonda Recorder Division has designed a new sound recording unit with outstanding advantages in economy, efficiency and fidelity. It records up to 8 hours on cellophane tape unattended. No skill is needed to operate it—any part of an 8-hour recording can be immediately located for playback.

»Simply write or phone any J-T branch office for a complete set of descriptive literature on our latest communications and recorder equipment.



Left, J-T's standard 25 watt marine radiotelephone and, right, the model AV2 Fonda Recorder—just two of the many models in its extensive line.

JEFFERSON-TRAVIS

Radio Communications Equipment

245 East 23rd Street, New York 10, N. Y.

NEW YORK · WASHINGTON · BOSTON

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 5 OCTOBER, 1945 NO. 10

CONTENTS

★ ★ ★ ★ ★ ★

MILTON B. SLEEPER, *Editor and Publisher*

WILLIAM T. MOHRMAN, *Advertising Manager*

ANDREW GLIER, *Circulation Manager*

STELLA DUGGAN, *Production Manager*

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THIS MONTH'S COVER

A VERY interesting development in emergency communications is represented by the equipment illustrated on this month's cover. It is the first production sample of a mobile transmitter and receiver designed for selective calling operation. That is, each mobile receiver is equipped with a vibrating-reed relay which, when an audio note of its particular frequency is received, turns on the output tube. No signals, unless preceded by the transmission of that audio note, can operate the loudspeaker. In this picture, left to right are E. N. Wendell, vice president of Federal Telephone & Radio Corporation, executive sales director Norman E. Wunderlich, and sales manager of mobile communications Gilbert G. Brown.

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.

WHAT'S NEW THIS MONTH

1. How Many Bands
2. Zenith FM Tests

1. There is a great deal more to the question of 1-band vs. 2-band FM receivers than the problems of receiver design. With the FCC now processing FM applications, and manufacturers putting on full steam to rush deliveries of FM transmitters, the major points emerging from current developments are:

1. FM receivers must have two bands because the band from 88 to 106 or 108 mc. cannot accommodate a sufficient number of stations to provide the competitive FM system envisioned by the FCC.

2. Moreover, the shift of FM broadcasting to the new band has greatly limited FM service to radio listeners. While it is true, according to Norton's theory, that the higher frequencies afford greater *line-of-sight* range than the lower band, it is also true and most unfortunate that a great number of listeners do not live within line-of-sight of stations to be located in population centers. Therefore, it will be necessary to supplement the limited-range stations on 88 to 108 mc. with long-range stations on the old frequencies. That calls for 2-band sets.

3. If the extra cost of a second FM band is a significant price factor, it may prove advisable to leave out AM tuning in some receiver models. It has been assumed, in the past, that all sets with FM circuits must have AM circuits, also. However, it is now apparent that virtually all AM stations will install FM transmitters. And since low-priced midgets are good enough for AM, listeners may be pleased to save a few dollars by purchasing straight FM models, or FM-phonograph combinations.

Meanwhile, set manufacturers are registering deep concern over the fact that the FCC's idealistic concept of "perfect, interference-free" FM reception will prove a boomerang by cutting off a great number of listeners from the slightly-less-than-perfect FM service that is still far better than anything they can get on AM!

2. The first complete account of the comparative merits of transmission on the old and new FM frequencies is contained in the following report from Zenith Radio Corporation, Chicago, to the Secretary of the FCC, under the date of Sep-

(CONTINUED ON PAGE 64)

SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

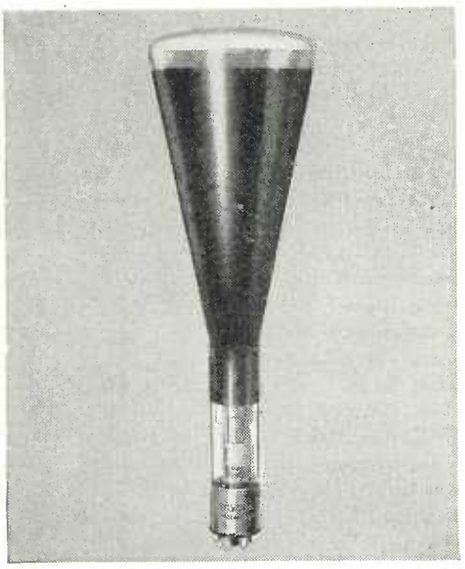
OCT. *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

SYLVANIA CATHODE RAY TUBES NOW AVAILABLE

Ready for New Television Sets To Be Produced

Sylvania Electric announces the welcome news that cathode ray tubes are once more available for the manufacturers of television sets.

Constant research in this field, combined with wide experience in large-scale production to meet war requirements, has placed Sylvania in a position to manufacture these tubes to a much higher standard than ever before.



Sylvania Electric precision built cathode ray tube now available to television set manufacturers.

This is an important factor to manufacturers of television receivers whose "plans" are rapidly becoming realities.

Check today with Sylvania Electric Products Inc., Emporium, Pa.

MANY MANUFACTURERS TO USE ELECTRICALLY SUPERIOR TUBE

Sylvania Lock-In Radio Tube Ideal For FM, Television, Radar

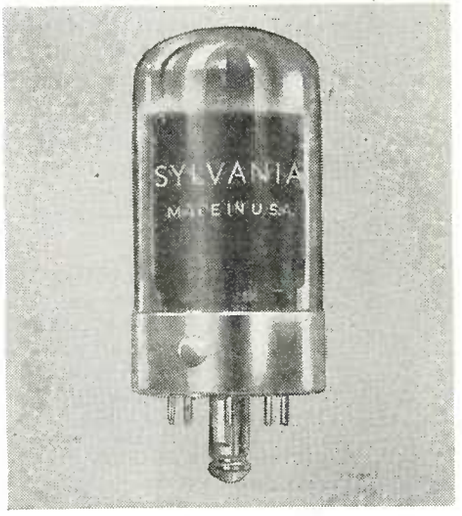
With the increasing trend toward higher frequencies—as shown by recent FCC decision assigning FM the band between 88 and 106 megacycles—set manufacturers will tend, more than ever, to use a tube ideally suited to the adoption of these very high frequencies.

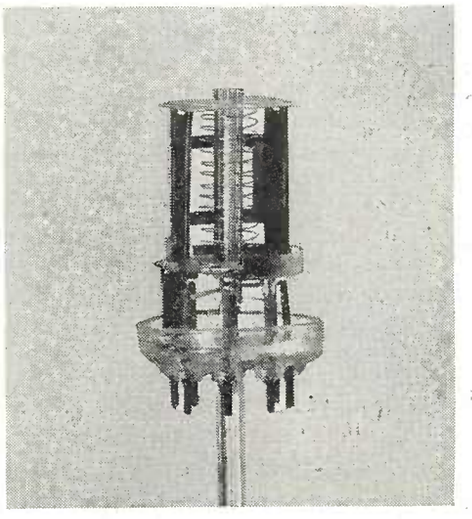
The Sylvania Lock-In is *known* to be electrically and mechanically superior to any tube made.

Electrically, it is more effieient because the element leads are brought directly down through the low-loss glass header to become sturdy socket pins—reducing lead inductance—and interelement capacity.

Mechanically, it is more rugged because support rods are stronger and thicker—there are fewer welded joints and no soldered joints—the lock-in lug is metal, not molded plastic—the elements are prevented from warping and weaving.

Today, set manufacturers considering the many developments in the field of communications, are looking to the Sylvania Lock-In Tube as a perfect electronic unit—the tube built to handle ultra-high frequencies.





The Sylvania Lock-In Tube showing construction—electrical and mechanical—that makes it superior to any tube made.

ADVERTISERS INDEX

To Our Friends and Customers

The Langevin Company Inc. believes its customers are entitled to a statement of the company's future plans. The entire life of the company has been spent in the audio frequency field. *It intends to remain in that field.*

Due to its war effort, its facilities, experience and personnel have been increased. It will continue to develop, design and manufacture—to better than FM standards — sound and broadcast speech input equipment.

Its products will continue to include quality transformers and quality amplifiers, ranging from the smallest unit to especially-engineered speech input systems for the large broadcast stations. Much of this equipment is now in production; some in development — some between development and production.

To our old customers, the above is sufficient. To those who may be interested in becoming customers — we are 23 years old, all our equipment carries the Union Label and is fully licensed under A.T.&T. patents.

Carl C. Langevin
PRESIDENT

The Langevin Company
INCORPORATED
SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St., 3

LOS ANGELES
1000 N. Seward St., 38

ENGINEERING SALES

Electronic Laboratories: Newly-appointed jobbers for E-L vibrators are: Radio Wire Television, Inc., Boston; Radio Products Sales, Denver; Radio Electric Products, Buffalo; Scott Radio Supply, Long Beach, Calif.; Hatry & Young, Hartford; Roehr Distributing Company, St. Louis; R & R Part and Supply Company, Lubbock, Texas; Central Missouri Dist. Company, Jefferson City.

New York: Walter Endel is back at Michaels' Brothers, 10 Congress Street, Brooklyn, as appliance division merchandising manager. During the past three and one-half years, he served as N. Y. chief of OPA Consumer Durable Goods Section, and later as assistant managing director of the Electronic Research Supply Agency.

Carter Motor: Has appointed Holliday-Hathaway Sales Company, 176 Federal Street, Boston 10, as representatives for the New England states.

Bentley-Harris: Has appointed Western Fiberglas Supply, Ltd., 739 Bryant Street, San Francisco 7, as their representative on the West Coast.

Lear: Factory representative for southern California, southern Nevada, Arizona, and Hawaii is Bert Caygill. His headquarters are at 409 E. 2nd Street, Los Angeles.

Galvin: Newly appointed acting director of field sales for the communications and electronics division is E. S. Goebel. He will be in charge of field salesmen on equipment for police, fire, buses and trucks, railroads, and public utilities.

Amperex: This column previously stated that Rogers Majestic Limited would distribute Amperex tubes in New Zealand. The territory is Newfoundland, not New Zealand.

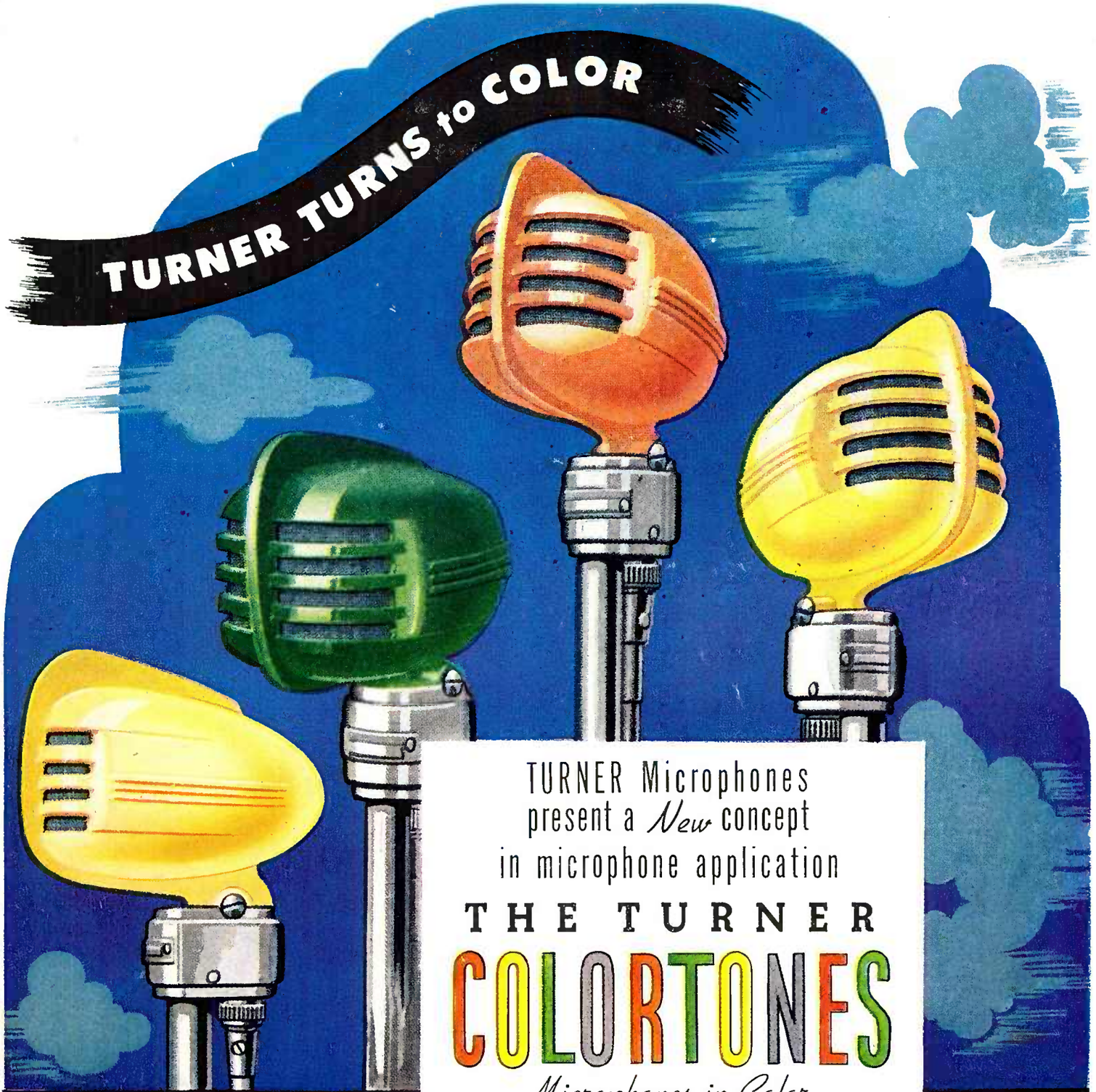
Bliley: Representative for California and Arizona is Herb Becker, formerly of San Francisco. He has opened new offices at 1406 South Grand Avenue, Los Angeles 15.

Stromberg-Carlson: Has appointed Adams-Erickson, Inc., 80 Boylston Street, Boston, as distributors for the greater Boston area. Carl G. Erickson was New England manager for Gross Distributors for the past 15 years.

Westinghouse: W. S. Lefebre, former western sales manager for Philco, is now assistant sales manager of the Westinghouse home radio division. He will make his headquarters at Sunbury, Pa.

(CONTINUED ON PAGE 80)

TURNER TURNS to COLOR



TURNER Microphones
present a *New* concept
in microphone application

THE TURNER COLORTONES

Microphones in Color

DESIGNED BY ARTHUR C. HAGGSTROM, INDUSTRIAL DESIGNER, ROCKFORD, ILLINOIS

BLAZING new trails in the field of practical microphone application, Turner introduces the Colortones. . . . New Crystal and Dynamic Microphones in a choice of rich color finishes. Conceived to meet the demands for functional color, their sparkling, streamlined beauty blends with modern electronic communications equipment. Executed in tough, rugged plastic, they incorporate all those sound engineering principles which have won Turner's world-wide reputation for faithful performance under difficult acoustic and climatic conditions. Now in the final stages of manufacture, Turner Colortones will be available soon. Write today for particulars and specifications.

THE TURNER COMPANY — Cedar Rapids, Iowa

PIONEERS IN THE COMMUNICATIONS FIELD

Licensed under U.S. Patents of the American Telephone and Telegraph Company and the Western Electric Company, Incorporated. Crystals licensed under Patents of the Brush Development Company

THE *Quiet* BALLENTINE
RECORD CHANGER MOTOR

Has these four characteristics achieved by advanced design, skilled engineering and precision manufacturing.

- Lowest Rumble
- Highest Efficiency
- Most Compact Design
- Longest Life

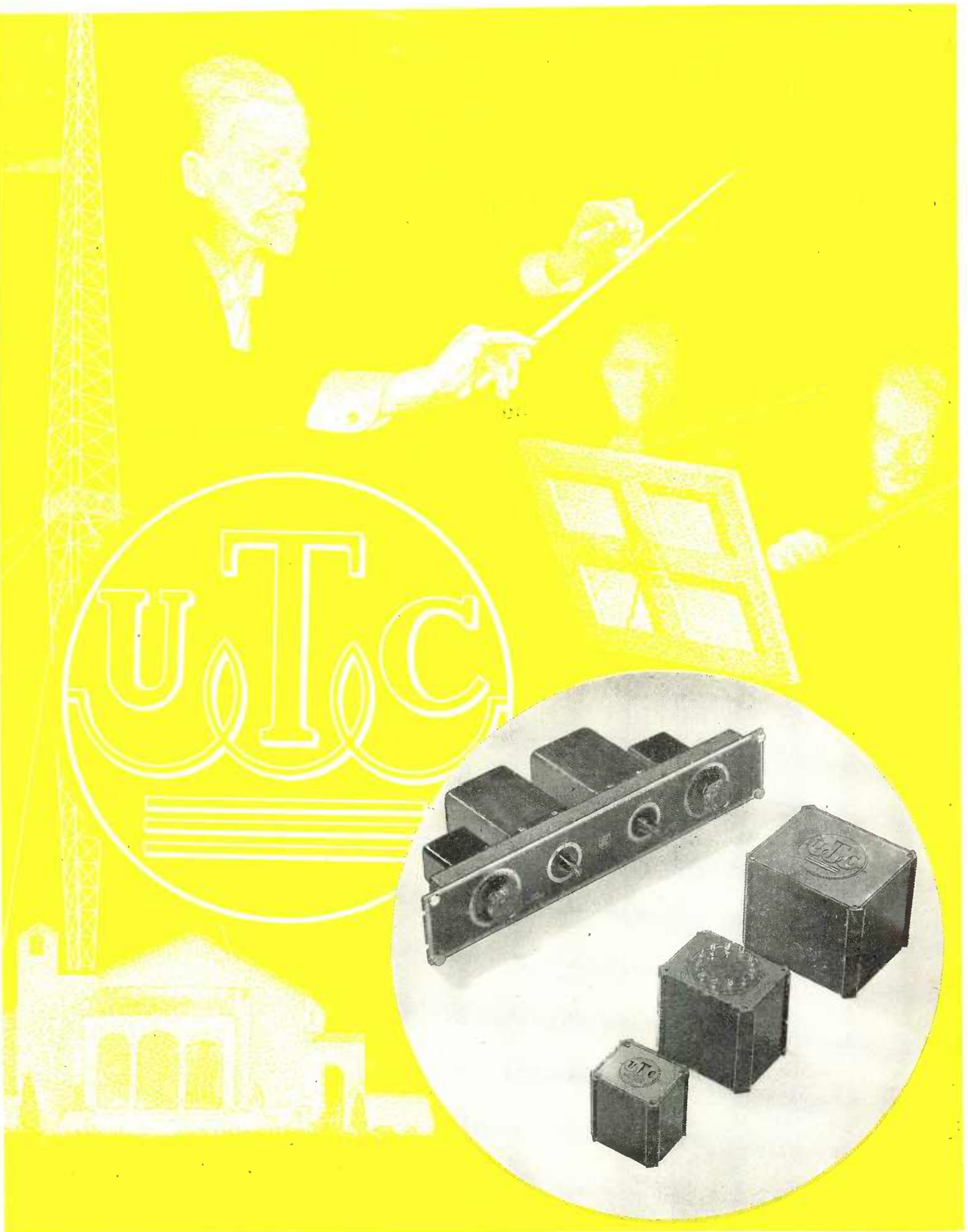
The *Quiet Ballentine* Changer Motor is recommended to record changer manufacturers seeking to provide the ultimate in performance.

RUSSELL ELECTRIC CO.

362 West Huron Street
Chicago 10, Illinois

Manufacturers of

BALLENTINE *RECORD CHANGER MOTOR*



BROADCAST STATION COMPONENTS

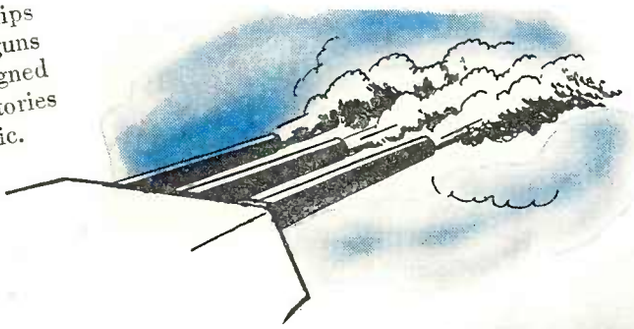
United Transformer Corp.

150 VARICK STREET • NEW YORK 13, N. Y.

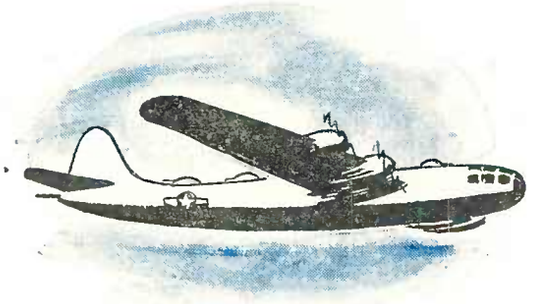
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

ARMY NAVY E AWARD — ALL PLANTS

All of the big guns on Navy ships and a majority of their smaller guns are directed by radars designed by Bell Telephone Laboratories and made by Western Electric.



What TEAMWORK



Bomb-directing radars used on B-29s were designed by the Laboratories and made by Western Electric.

Bell Telephone Laboratories and Western Electric were "naturals" for the leading part they played in the radar program. For years they've worked as a team in developing and producing complex electronic equipment.

Here are some unadorned facts about what their teamwork made possible.

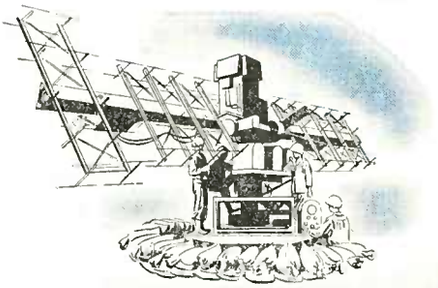
Up to the end of the war, Western Electric had furnished the Army, Navy and Air Forces with more than 56,000 radars of 64 different types, valued at almost $900,000,000.

In 1944 alone, Bell Laboratories worked on 81 different types of radar systems and Western Electric produced 22,000 radars of 44 different types — of which 20 were new in production that year.

Western Electric was the largest producer of the cavity magnetron and other essential vacuum tubes for radar. Number of tubes required for Western Electric radar systems varied from less than 100 to nearly 400 per system.

Complexity of radar manufacture is indicated by the fact that even a simple type may require 4,000 labor hours to manufacture and the larger types as much as 40,000 labor hours.

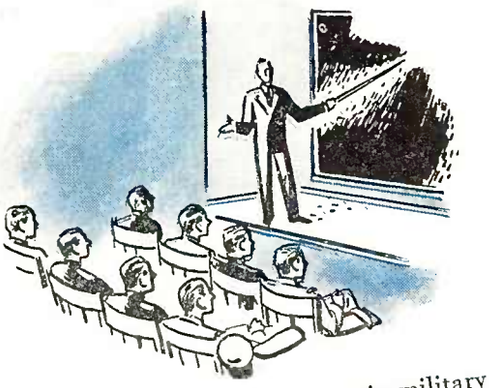
This team developed and produced low altitude radar bombsights widely used against the enemy's merchant shipping.



From the very beginning, ground radars made by Western Electric played an important role in all theatres of war.

did for RADAR

Bell Laboratories developed more than 100 different radar test sets. In 1944, Western produced over 40,000 test sets of 68 types.



A school to train military personnel to operate and maintain radar was established by the Laboratories. Over 100 courses were given to some 4,000 officers and men.

The same team is working for YOU!

The unique combination of brain power and manufacturing facilities that made Bell Laboratories and Western Electric the nation's largest source of radar, is now devoted to bringing you the best in communications equipment for a world at peace. In peacetime off-shoots of radar—and in FM, AM and television broadcasting—in radio telephone equipment for every type of mobile service—this team can be counted on to lead the way.

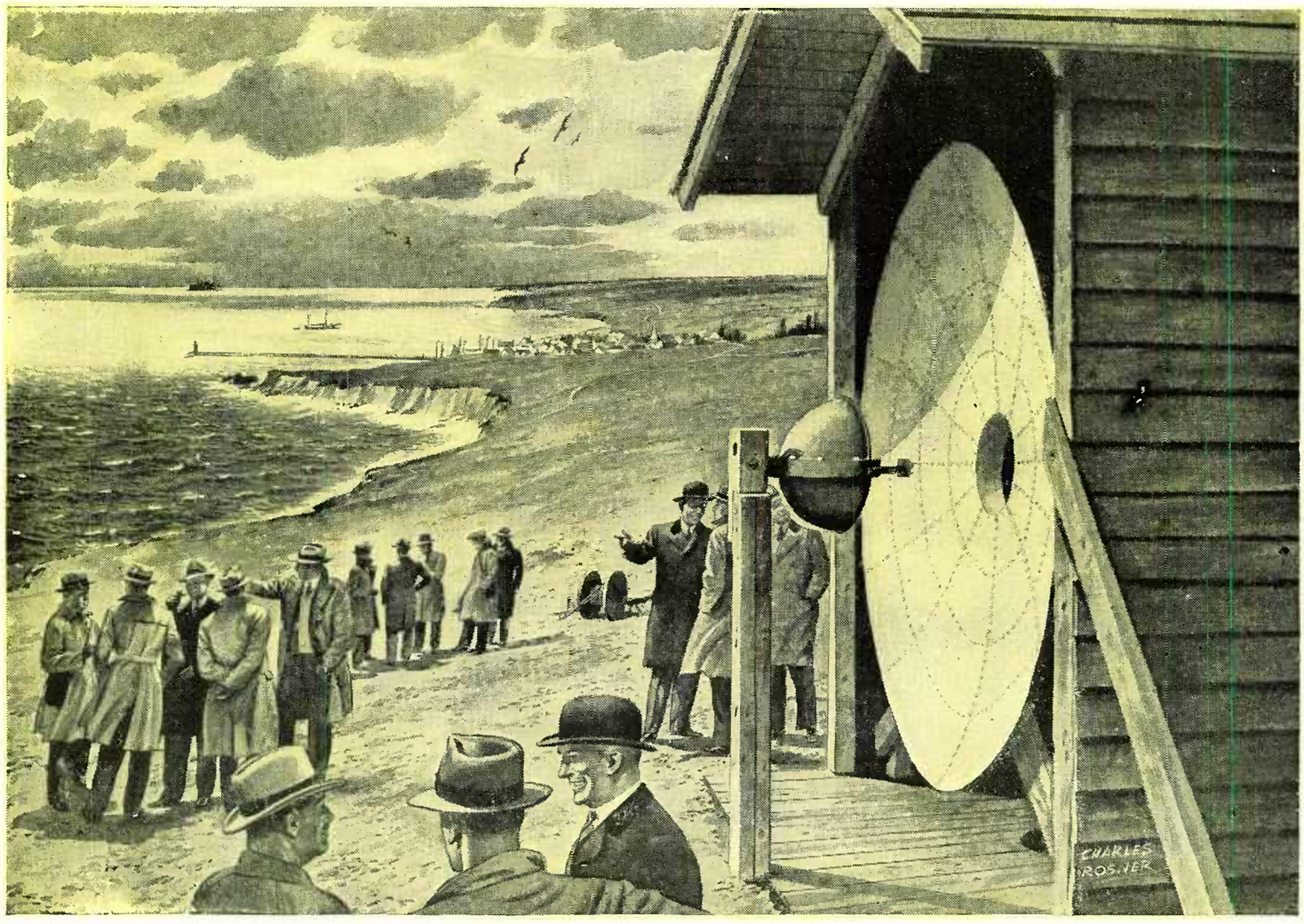
Western Electric built up a Field Engineering Force of more than 500 specialists. They served with all branches of the Armed Forces on all fighting fronts.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communication.

Western Electric

Manufacturing unit of the Bell System and nation's largest producer of communications and electronic equipment.



Federal's men know Microwave

On a gusty Mareh day in 1931 . . . when man's voice was beamed aeross the English Channel from an antenna less than an ineh long and powered by a mere half-watt . . . Mierowave was born.

This was the inauguration of a new teehnique in the art of eommunieation . . . blazing the trail for modern, high fidelity television, FM transmission, pulse time modulation, plurality of eurrents on a common carrier, and eertain other commereial applieations for this teehnique.

Many of the seientists now at work in Federal laboratories partieipated in that triumph and helped in its developement through the years. Now they are engaged in extending its application, opening vast and striking possibilities for the future of commnnieations.

Pioneer in the field of mierowave . . . a contributor to radio progress for more than 35 years . . . Federal stands for leadership in researeh, development and manufaeture of equipment and eomponents for every segment of the eommunieations industry.

FEDERAL TELEPHONE & RADIO — FTR

ARMY-NAVY E — M

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

"HOME IS THE SAILOR . . . HOME FROM THE SEA"

TO A HAVEN GRACED BY MUSIC AND CHARM

Home on leave! In this place that holds so much to be remembered, they again, for a little while, spend happy hours enriched all the more by cherished music. Some fine day, when he returns for good, they will fulfill their dreams for this talented daughter and this lovely home. One of those dreams includes the postwar Freed-Eisemann Radio-Phonograph.

. . .

With eyes on the future and hands long experienced, Freed-Eisemann engineers and craftsmen have planned for this family and you a *new* radio-phonograph—preeminent in performance and design. This instrument will bring you magnificent war-born advancements . . . in FM (Frequency Modulation) . . . in international shortwave . . . in standard radio reception . . . in reproduction of recorded music . . . living—ringing true!

The new Freed-Eisemann Radio-Phonograph will seem to annihilate distance and take you right to the scene of the broadcast! You'll hear the surge of orchestral crescendo—each tone clear and pure. You'll hear the lowest bass and highest treble. You'll recognize and enjoy all the subtle nuances that make great artists great.

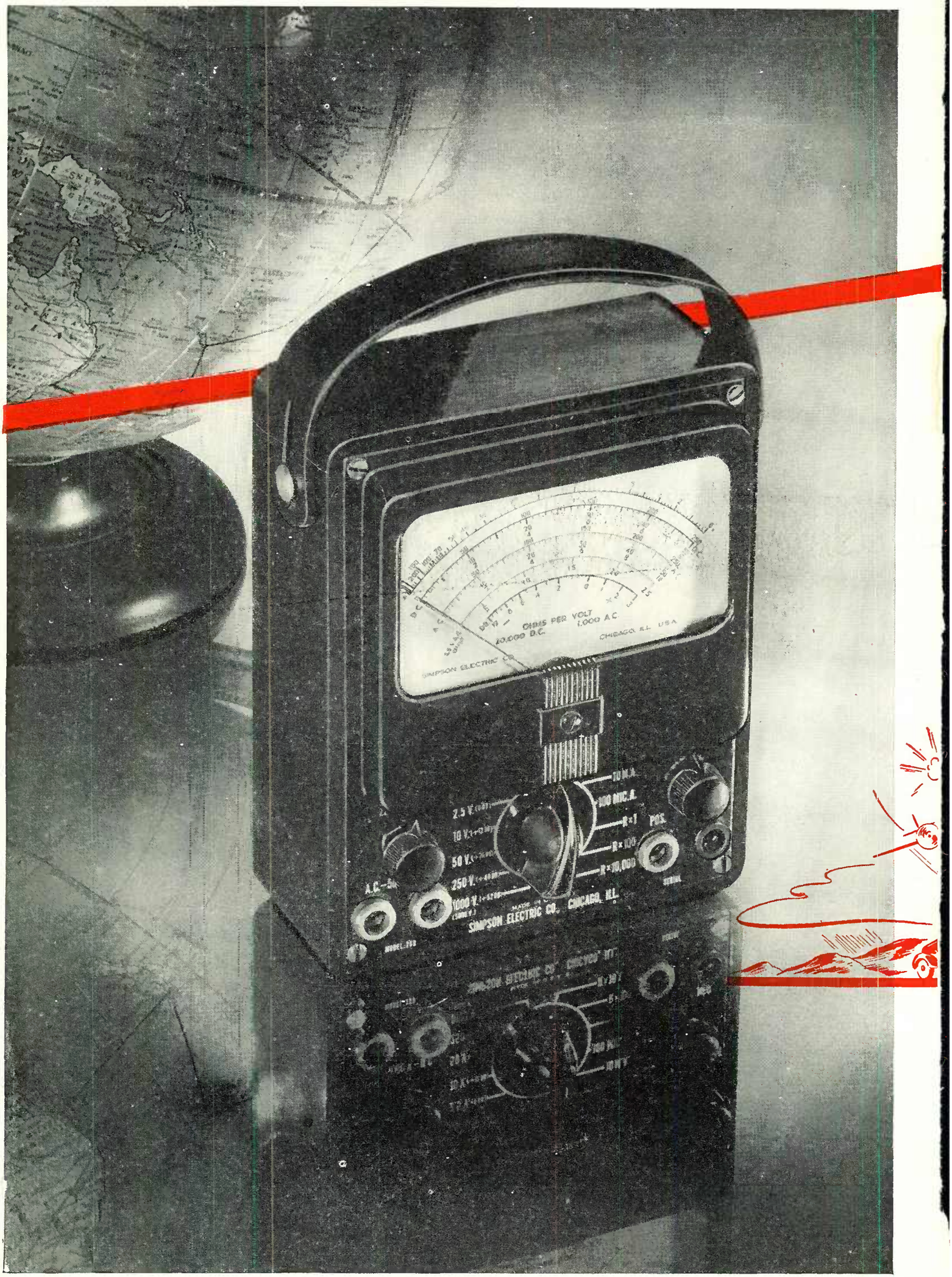
As distinguished in design as in musical reproduction, this thrilling new instrument will come to you in both period and contemporary cabinets—in models which will express the talents of leading decorators and furniture craftsmen. These cabinets will, inevitably, "belong" in homes of distinction and gracious charm.

As in the past, expect great things from Freed-Eisemann—a name which, since crystal-set days, has marked quality radio. And expect the postwar Freed-Eisemann Radio-Phonograph to be a musical instrument which will adorn your home and enhance your enjoyment of life. Freed Radio Corporation, New York 13, N. Y.

BUY VICTORY BONDS

Freed-Eisemann

ONE OF THE WORLD'S GREAT RADIO-PHONOGRAPHS



The most honored instrument of the war

This is not our own appraisal of the Simpson 260. We knew, before the war, that it was a fine instrument but, frankly, we didn't know *how* good it was until war wrote the record. Now the story of the 260 is written into the records of such wartime industrial developments as that of synthetic rubber, and into the vast and secret research and servicing of radar.

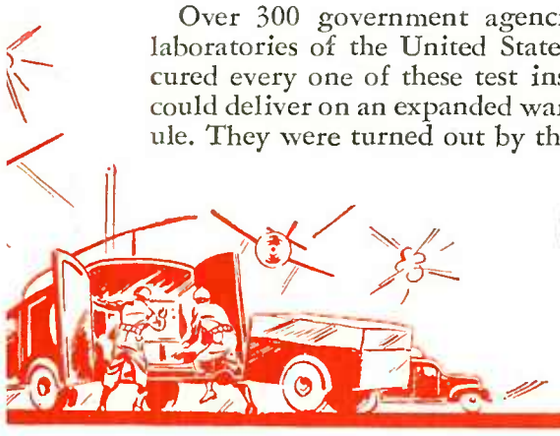
Originally designed as a radio serviceman's test unit, the Simpson 260, because of its sensitivity and wide range was found adaptable to general service duties in the entire electronics and electrical fields. Not a warborn instrument, the 260 was given thousands of essential war jobs in the production and servicing of communications equipment. It made a vital contribution to the success of tactical operations.

Over 300 government agencies and university laboratories of the United States and Canada procured every one of these test instruments Simpson could deliver on an expanded war production schedule. They were turned out by the thousands. Every branch of the armed services—Army, Navy, Marines, Coast Guard—carried them to the far ends of the earth. They were compelled to perform under conditions often so arduous that testimonials of amazement at their ability to function at all became commonplace as the record grew.

Chosen on its merits, the Simpson 260 became uniquely *the* test instrument of the war.

AVAILABLE NOW TO YOU

Now the Model 260, always the preferred instrument of radio servicemen, is available again to a widened field of peacetime services. We ask you to remember its record as an example of the quality and advanced engineering that goes into all Simpson instruments, as evidence that other new Simpson developments are well worth waiting for. They will be released as soon as Simpson standards for their manufacture are satisfied. They will continue the leadership that has given Simpson a world-wide reputation for "instruments that *stay* accurate" with ideas that *stay* ahead.



SIMPSON ELECTRIC COMPANY
5200-5218 W. KINZIE ST., CHICAGO 44, ILL.

Simpson

INSTRUMENTS THAT STAY ACCURATE

SIMPSON 260, HIGH SENSITIVITY SET TESTER FOR TELEVISION AND RADIO SERVICING
Ranges to 5000 Volts—Both A.C. and D. C. 20,000 Ohms per Volt D.C.—1000 Ohms per Volt A.C.

At 20,000 ohms per volt, this instrument is far more sensitive than any other instrument even approaching its price and quality. The practically negligible current consumption assures remarkably accurate full scale voltage readings. Current readings as low as 1 microampere, and up to 500 milliamperes are available.

Resistance readings are equally dependable. Tests up to 10 megohms and as low as ½ ohm can be made. With this super sensitive instrument you can measure automatic frequency control diode balancing circuits, grid currents of oscillator tubes and power tube, bias of power detectors, automatic volume control diode currents, rectified radio frequency current, high-mu triode plate voltage and a wide range of unusual conditions which cannot be checked by ordinary servicing instruments. Ranges of Model 260 are shown below.

Price, complete with test leads.....$33.25
Carrying case 4.25

ASK YOUR JOBBER

Volts D.C. (At 20,000 ohms per volt)	Volts A.C. (At 1,000 ohms per volt)	Output	Milliamperes D.C.	Microamperes	Ohms	
2.5	2.5	2.5 V.	10	100	0-1000	(12 ohms center)
10	10	10 V.	100		0-100,000	(1200 ohms center)
50	50	50 V.	500		0-10 Megohms	(120,000 ohms center)
250	250	250 V.				
1000	1000	1000 V.				
5000	5000	5000 V.				

(5 Decibel ranges: —10 to +52 DB)

WATCH FOR NEW SIMPSON DEVELOPMENTS. THEY WILL BE WORTH WAITING FOR!

It's Here!

The NEW TEMCO *Multi-Frequency* COMMUNICATION TRANSMITTER

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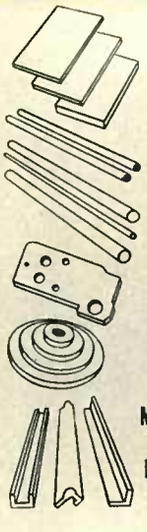

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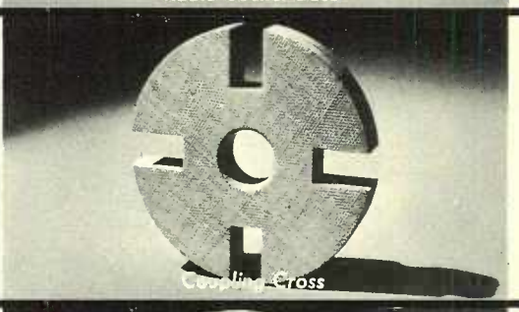

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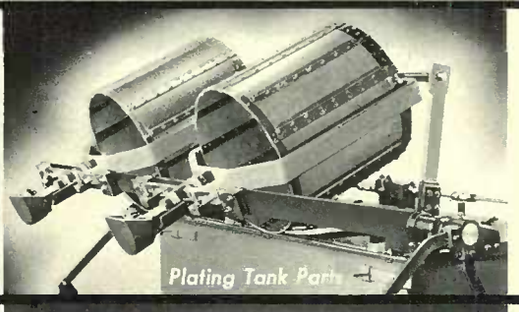

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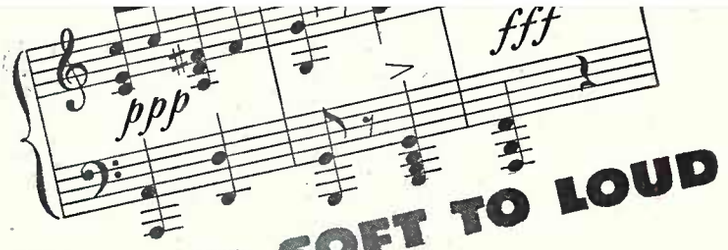

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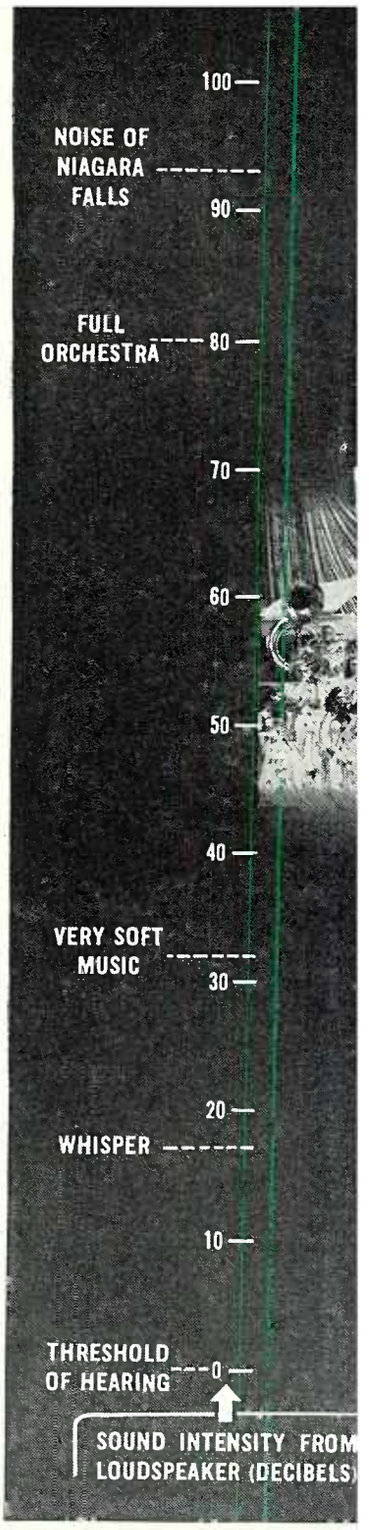

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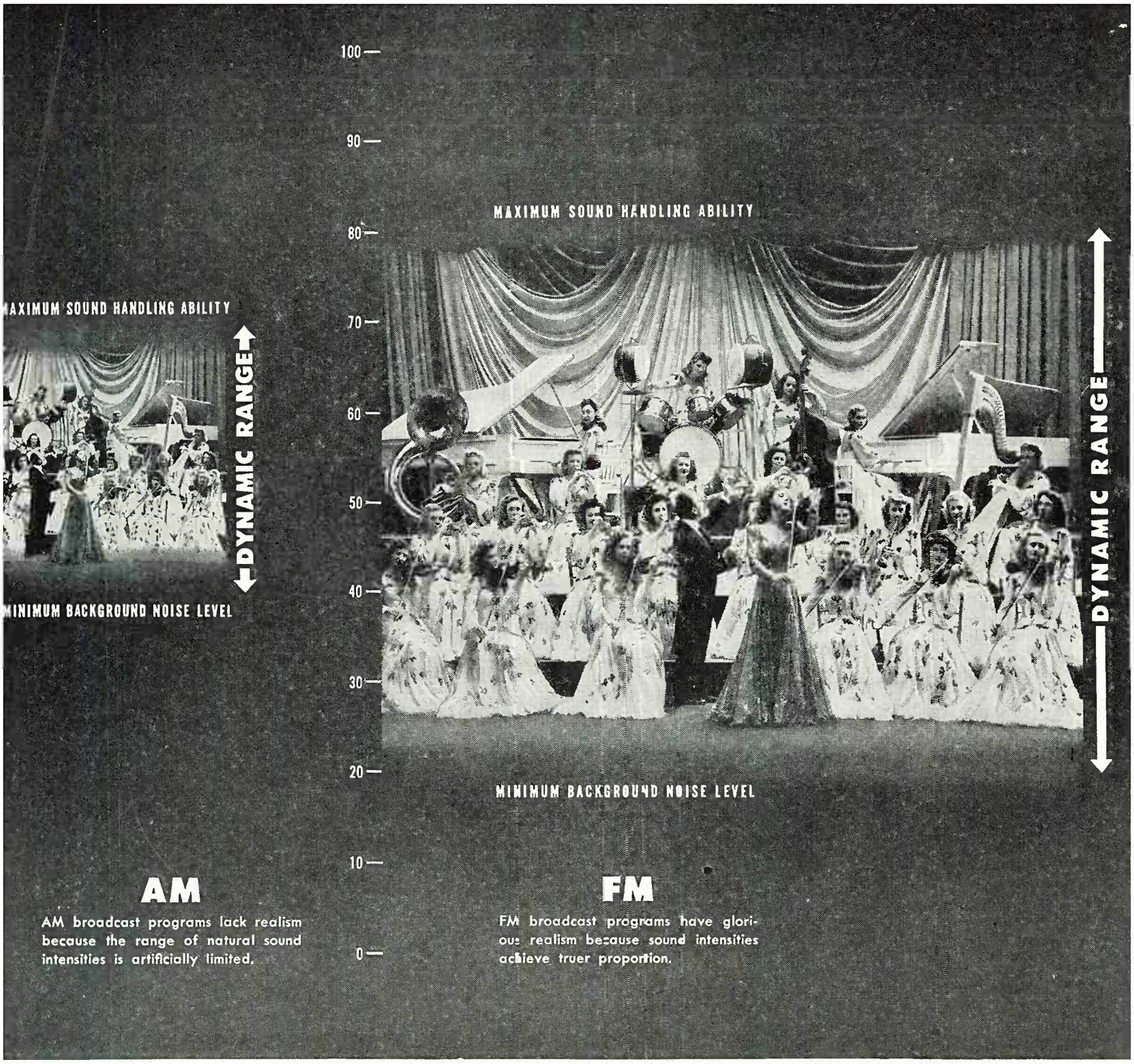

AM

AM broadcast programs lack realism because the range of natural sound intensities is artificially limited.

FM

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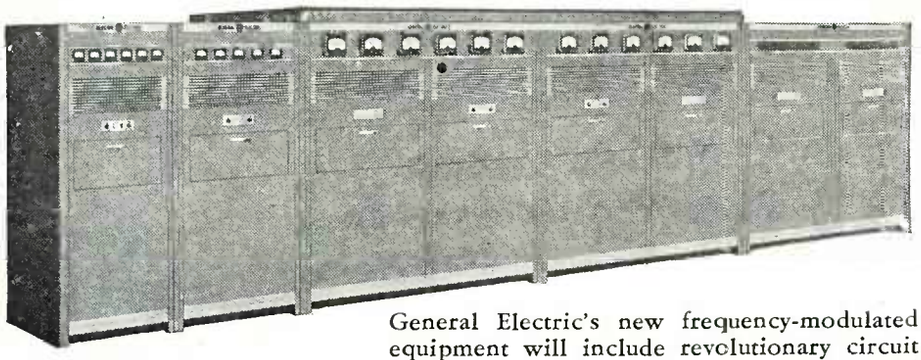

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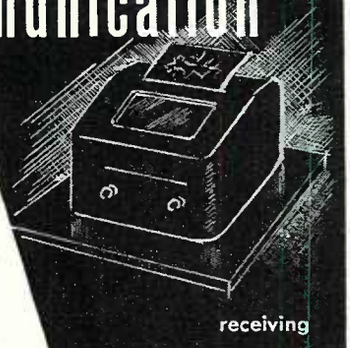
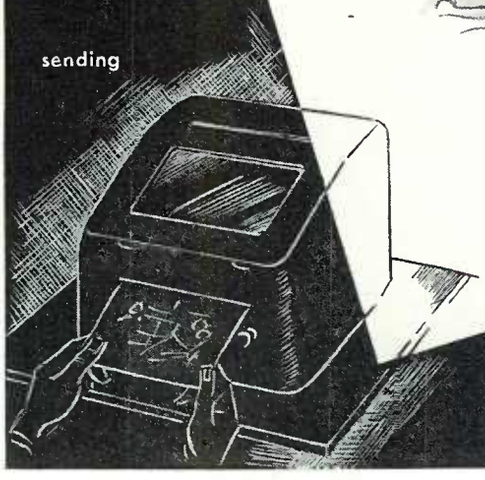


receiving

finch faxogram

This illustrates Finch broadcast communication receiving

sending



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DO FM LISTENERS WANT HIGH-FIDELITY?

A Discussion of the Tonal-Range Preferences of Broadcast Listeners

BY MILTON B. SLEEPER

ONE of the most thorough and accurately-controlled tests of listeners' acoustic preferences has been made by CBS engineers Howard A. Chinn and Philip Eisenberg, and reported in the *Proceedings* of the Institute of Radio Engineers.[1] The purpose of the tests was described in this way: "As contrasted to former studies that have been undertaken to determine the theoretical or ideal requirements for the transmission and reproduction of broadcast program material, this undertaking ascertained the tonal range and sound intensity that the average listener would select for use in his home when listening for enjoyment."

The account of the tests, the summary of listeners' preferences, and the conclusions drawn by the authors are extremely interesting and are worthy of careful study by those concerned with this highly important aspect of service to radio listeners.

Conduct of the Tests ★ For these tests, a high-fidelity speaker, operated through a suitable audio system, was set up in a room approximating home conditions. Except for one series of tests made with live talent, speech and music were reproduced from recorded "masters" cut on cellulose-nitrated coated discs. At full response, the reproducing system was essentially uniform from 40 to 10,000 cycles. Filters were used for reducing the extent of uniform response to approximately 70 to 7,000 cycles, and 120 to 4,000 cycles. These three conditions were described as:

Wide Range	40 to 10,000 cycles
Medium Range	70 to 7,000 cycles
Narrow Range	120 to 4,000 cycles

Also, during some tests, the volume was varied with and without changes in audio response, at the following levels:

High Volume:
70 db. sound intensity level
Moderate Volume:
60 db. sound intensity level
Low Volume:
50 db. sound intensity level

Each test called for registering a preference, or lack of preference, when two combinations of response and/or volume were offered alternately. It is obvious that the most coöperative listener would have a little difficulty in determining his true reactions to tests successively involving so many sets of conditions. In their diligence to examine all the aspects of listener preferences, Messrs. Chinn and Eisenberg further complicated their investigation by offering classical, popular, and piano music as well as male and female voices in all the combinations of audio response and volume.

Then, as if to make sure that no listener would have a chance to know his own mind, they limited each listening period to one minute, and presented the paired conditions alternately, each for 10 seconds!

A thoughtful consideration of these tests and the manner of presenting the conditions to be compared will probably lead to the conclusion that the preferences recorded by listeners, whatever they were, could not have represented their considered judgement, and that the only element found in ordinary home listening conditions was the size and furnishings of the room in which the speaker was installed!

Analysis of Preferences ★ The results were tabulated with the same thoroughness that the tests were conducted, and no doubt represent listener preferences as accurately as the manner of presenting the selections reproduced the manner in which listeners adjust their radios for tone and volume. Here, stated briefly, are the conclusions of the investigators.

As to tonal range: "In summarizing, the results of the above experiments indicate that listeners predominantly prefer a tonal range somewhere between a narrow and medium band. Although the preferences vary somewhat for different types of music and speech, the overwhelming majority *never* chose a wide band."

As to sound intensity: "In general, the sound intensity preference for speech seems to be somewhat louder than for music, particularly for narrow-band reproduction."

Further: "It may be argued, however, that this preference for restricted tonal range is the result of years of experience of listening to a narrow band on the radio and on recordings. The argument generally continues that, with experience, listeners will overcome this initial dislike and discover new enjoyment in wide range. It is important to understand that this argument is based on no published experimental evidence whatsoever. It is an hypothesis unfortunately very often stated as a fact. Actually, listeners have had extensive experience with wide range in speech, because that is what they hear all day long in ordinary conversation, yet in these tests, they did *not* prefer a wide band for speech. In addition, listeners have experienced in the sound produced in motion-picture theatres a relatively wide range."

Certainly, the results compiled from tests so thoughtfully planned cannot be lightly contradicted. However, careful consideration of the following observations may shed a modifying light on the conclusions quoted above:

How Listeners Listen ★ No one, in his home, adjusts his radio by switching back and forth, in 10-second intervals, between two settings of the volume and/or tone control. It would be difficult to sell sets that had to be adjusted that way!

Under typical listening conditions, some member of the family sets the volume to what seems to him an agreeable level, and there it stays, unless someone else asks to have it raised or lowered, until a change in the program, in the group activity, or the room-noise level requires readjustment.

As for the tone control, that is usually set for AM reception at a point where the background noise is reduced until it is not objectionable.

Relatively few listeners, of which this observer is one, are located where they are entirely dependent upon FM broadcasting and, therefore, have the opportunity of learning from day-to-day experience that, when there is no background noise, the use of any type of tone control only serves to debase the quality of reception, regardless of the audio range transmitted, or the type of program.

Reactions to Tone and Volume ★ The act of listening is not merely a matter of receiving intelligence. Sounds also produce a nervous reaction. This has been shown in tests of factory and office conditions where efficiency has been increased by eliminating noises to which, by habit, the workers had become oblivious. Another example

[1] Proc. I.R.E., Sept. 1945, "Tonal-Range and Sound Intensity Preferences of Broadcast Listeners" by Howard A. Chinn and Philip Eisenberg.

is the background noise of AM reception, which is increasingly objectionable as the audio response of the receiver is increased.

Sounds, music, and voices also produce nervous reactions by association. They may be reactions of fear, pleasure, exhilaration, annoyance, antagonism, or responsiveness. None of these reactions, which are all a part of listening to radio programs, could be experienced when conditions of reproduction were being changed every 10 seconds!

Adding further complications to the study of acoustic preferences is the fact that the response is conditioned by continued listening to sounds of the same general character. For example, a sudden change from narrow-range to wide-range reproduction makes the higher frequencies seem harsh. When the change is reversed, the loss of the high frequencies makes narrow-range reproduction seem dull and lifeless.

When the conditions are alternated in 10-second intervals, as in the case of the tests under discussion, it is impossible for any listener to appraise his own reactions. Therefore, the tests can only indicate listener preferences under that particular set of test conditions, but they do not indicate preferences which would be registered under normal listening circumstances.

Another factor which has an important effect on reactions to varying degrees of audio fidelity is the volume. This can be demonstrated in a striking manner with a good FM receiver tuned to high-fidelity transmission. First, adjust the tone control for narrow range reception, and set the volume at an agreeable level. After listening for a few minutes, turn up the tone control for wide range reception, but do not change the volume. When this is done, the volume will *seem* to have been increased greatly, and the result will give the impression of loud and harsh reception.

That sense of unpleasantness can be eliminated merely by turning down the volume. Then, after listening for five minutes with the volume at a comfortable level, turn the tone control back to the narrow-range setting. The volume level will *seem* to drop greatly, music will sound dull and flat, and voices will lack articulation.

The writer has performed this test several hundred times over a period of nearly six years in public demonstrations of FM reception, in dealers' stores, and at home. Under these different conditions, every listener has voiced a definite preference for wide-range FM reception. There was not a single exception to this preference among listeners of all types and ages.

Dynamic Range ★ Many students of electrical reproduction have observed that an important factor in the realism of high-fidelity reception of live talent programs originating at an FM station is the dynamic range which FM makes possible, in addition to the wide-range audio characteristic. This factor was lacking throughout the tests under discussion. Had the wide audio range samples afforded the realism of full dynamic range, the score of listener preferences might have been altered greatly.

Sound on Film ★ As for the reference by Messrs. Chinn and Eisenburg to listeners' experience with "relatively wider range" of sound produced in motion-picture theatres:

The true quality of sound on film was demonstrated in a very interesting way at the T.B.A. conference in New York last December. The program of television broadcasting included live talent and film transmission. Thus it was possible to hear both types of program material at their best. Under those conditions, the sound-on-film was a very poor second. Moreover, the opportunity of making a direct comparison between reproduction from live talent and film recordings emphasized the peculiar quality of film recordings. That special characteristic is the not inconsiderable degree by which "relatively wide range" can fall short of true reproduction. This is due partly to the lack of dynamic range in film recordings.

Speech Reproduction ★ Finally, the conclusion was drawn from the series of tests that listeners "did *not* prefer a wide band for speech," although they are experienced with wide-range listening in ordinary conversation. It is true that many voices are high-pitched, harsh, and consequently unpleasant. Still, it is doubtful that anyone would prefer to converse under conditions which absorbed the higher frequencies. The higher frequencies provide both individuality and intelligibility to speech. As the high frequencies are progressively cut off, and the volume is increased to maintain the same effective level, first the identity of the voice and then the speech itself are lost. The same thing is true of orchestral music.

Conclusions ★ From this examination of the tests of tonal-range tests conducted by Messrs. Chinn and Eisenburg, it must appear to anyone of long experience with the preferences of listeners under conditions where each individual can control the tone and volume to suit himself, that the conclusions drawn from the tests only apply to alternate 10-second sampling of specific tone and volume conditions.

Furthermore, any effort to analyze listener preferences in terms of audio fidelity must 1) avoid changes of test conditions at a rate so high that listener response cannot become readjusted, 2) must permit each listener to control the tonal range and volume and sample the various conditions at his leisure, and 3) must afford full dynamic range of reproduction. Only then will his final choice indicate the same preference that he would register in his own home.

Fidelity Is a Cost Factor ★ This discussion has much more than academic interest to broadcasters and manufacturers. Tone quality is a determining factor in the design and cost of receiving sets, FM transmitting installations, and network facilities.

In a statement[2] submitted to the FCC on July 30, 1945, Paul W. Kesten, executive vice president of CBS, said "there are considerable data which indicate that the upper limits of public preference for high frequencies fell considerably short of the theoretical limits technically possible with FM." He was undoubtedly referring to the tests made by CBS engineers Chinn and Eisenberg.

If these tests are to be used as the basis for arguing against the fidelity requirements for FM stations which are set forth in "Standard of Good Engineering Practice for FM Broadcasting", it is of vital importance to determine whether or not results of the tests truly represent listeners' preferences.

That a fight is in the making on this point is indicated by the complete text of Mr. Kesten's remarks in his statement to the FCC. Contending that there is not justification "for forcing any AM licensee, who is willing to pioneer in FM, to compete with himself by a separate programming of his FM station," he listed as premise No. 1, "the purpose to exploit the higher fidelity characteristics of FM." He said:

"The first of these is, I think, the simplest to deal with — the idea of higher fidelity. This concept was derived, I believe, from the fact that overland telephone lines connecting network stations with each other usually carry only about 5,000 cycles of sound. Thus automatically it followed that a regular network program piped through an FM transmitter would not carry the higher frequencies, especially the overtones of fine music, and could not accordingly make use of the higher fidelity of which an FM transmitter is capable.

"This idea was made much of in 1935

(CONTINUED ON PAGE 77)

[2] "The Transition from AM to FM Broadcasting" containing statements relating principally to single-market FM coverage, by Paul W. Kesten and Frank Stanton, submitted to the FCC on July 30, 1945. Copies can be obtained from Columbia Broadcasting System, 485 Madison Avenue, New York 22, New York.

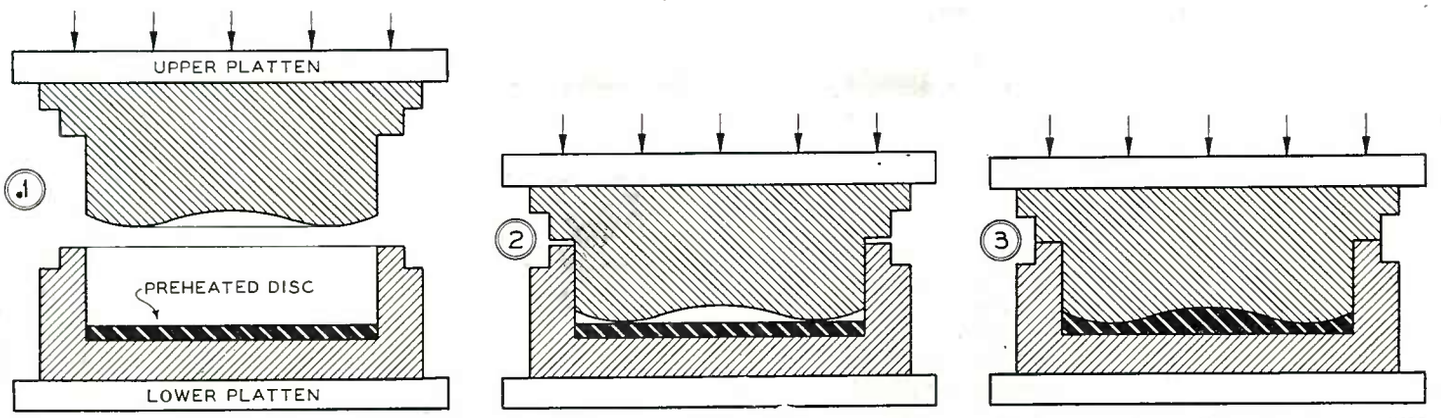


FIG. 1. THREE STAGES OF CLOSING THE DIES FOR MOLDING THE CORRECTION LENS USED IN TELEVISION OPTICAL SYSTEM

LENSES FOR PROJECTION TELEVISION

Low-Cost Method of Producing the Thermoplastic Lenses and Mirrors Used in Television Optical Systems

BY JOHN P. TAYLOR*

IN ORDER to produce the reflective optical system [1] developed by RCA in sufficient quantity for home television receivers, it was necessary to find a method of manufacture that would be relatively low in cost. There are two distinct parts to this problem.

First, there is the spherical mirror, mounted opposite the face of the cathode-ray tube. Then there is the aspherical correcting lens, through which the neck of the tube passes.

CORRECTING LENS ★ No machines are available to grind aspherical glass lenses in quantity production. Making them by laboratory methods would be far too expensive for use in home receivers. Thus, it was necessary to find a new method whereby the correcting lenses could be made at low cost, and in great numbers. Figs. 1 to 6 show how this problem was solved.

This was done by substituting methyl methacrylate, a clear, thermoplastic material, for glass. Thus the correcting lenses could be molded. (This material is known by the trade names *Lucite* and *Plexiglass*.)

Simply stated, the process consists of placing a flat disc of the thermoplastic material in a molding press, and applying heat and pressure to make the disc assume the shape desired. Then, while the disc is still under pressure, it is cooled by chilling the mold, so that it can be removed without altering its shape.

This seemingly easy solution, depicted in Fig. 1, was not reached without many a headache. In order that the lens would have just the right bending action on the light rays, it was necessary to have the contour of the dies exactly true. Moreover, the faces of the dies had to be free from any trace of scratches or blemishes. To achieve this, stainless steel plates were carefully ground by precision methods, hardened to resist abrasion, and polished to a mirror finish.

Preheating the methyl methacrylate discs before they are placed in the mold speeds the molding process. This is done, as indicated in Fig. 2, by the use of radio-frequency current. The disc is put between metal electrodes connected to an RF generator, and heat is generated throughout the disc by its resistance to the passage of the current.

This treatment is illustrated in Fig. 3. Here the operator is putting a disc, 8 ins. in diameter and ¼ in. thick, between the electrodes. Power of 1 kw., applied for 3½ minutes, raises the temperature of the disc to 150°. The oven, Fig. 3, is closed by screen doors which operate an interlock switch to cut off the current when the doors are opened.

The heated disc, usually referred to as a "preform," is soft and flexible after its RF treatment. The mold is heated by steam before insertion of the preform, and during the period when pressure is applied. When the molding cycle is completed, the steam is shut off and cold water is circulated to chill the mold.

Thermosetting materials, such as Bakelite, harden under the effects of heat and pressure. Lucite or Plexiglass, being thermoplastic, only soften under the influence of heat and, therefore, do not harden until they are cold.

After the mold has cooled to about room temperature, the press is opened and the lens removed, as shown in Figs. 5 and 6. The only additional operation required is that of boring the center hole to accommodate the neck of the cathode-ray tube. No polishing or finishing is required.

Lenses produced in this way have excellent optical properties. They show slightly better light transmission than glass and slightly less light-scattering effect. Both properties are, of course, advantageous. While they do not have the surface hardness or resistance to abrasion of glass, they have stood up well in tests during the past three years

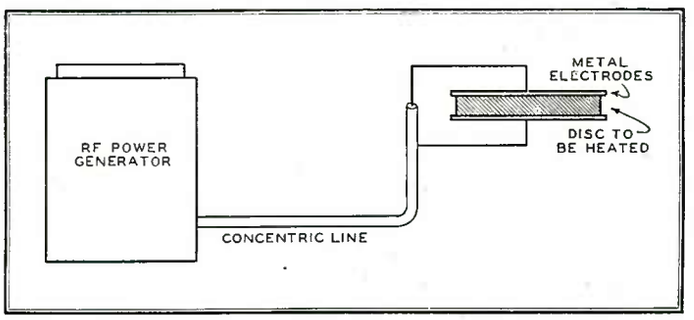
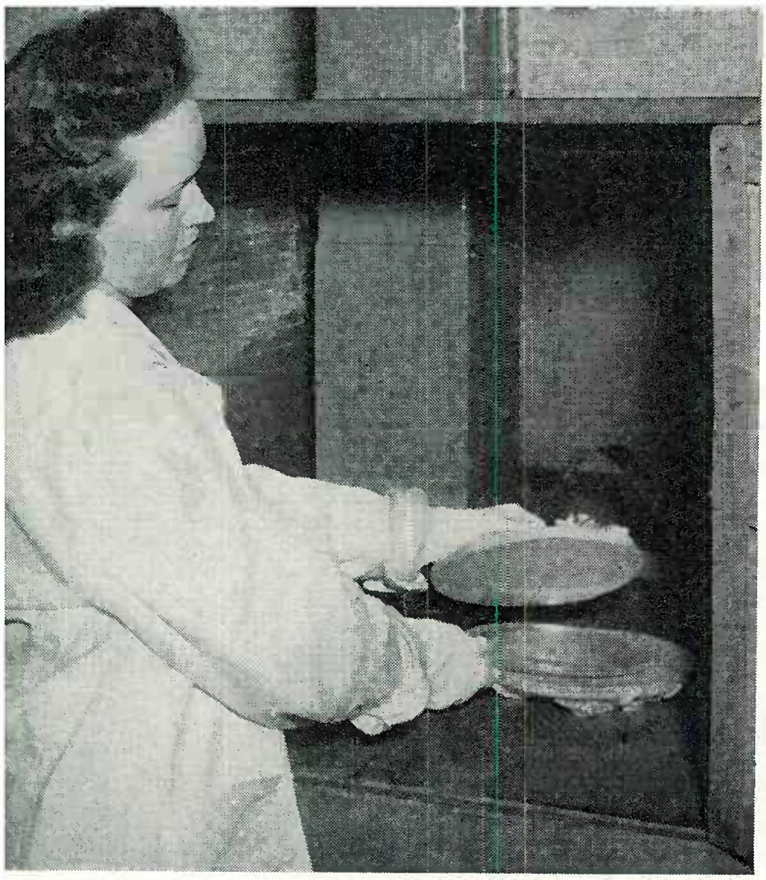


FIG. 2. PREFORM FOR LENS IS HEATED BY RF BEFORE IT IS INSERTED IN THE MOLDING PRESS

* Engineering Products, RCA Victor Division, Camden, N. J.

[1] "Lens System for Projection Television," by John P. Taylor, *FM* AND TELEVISION, June 1945.



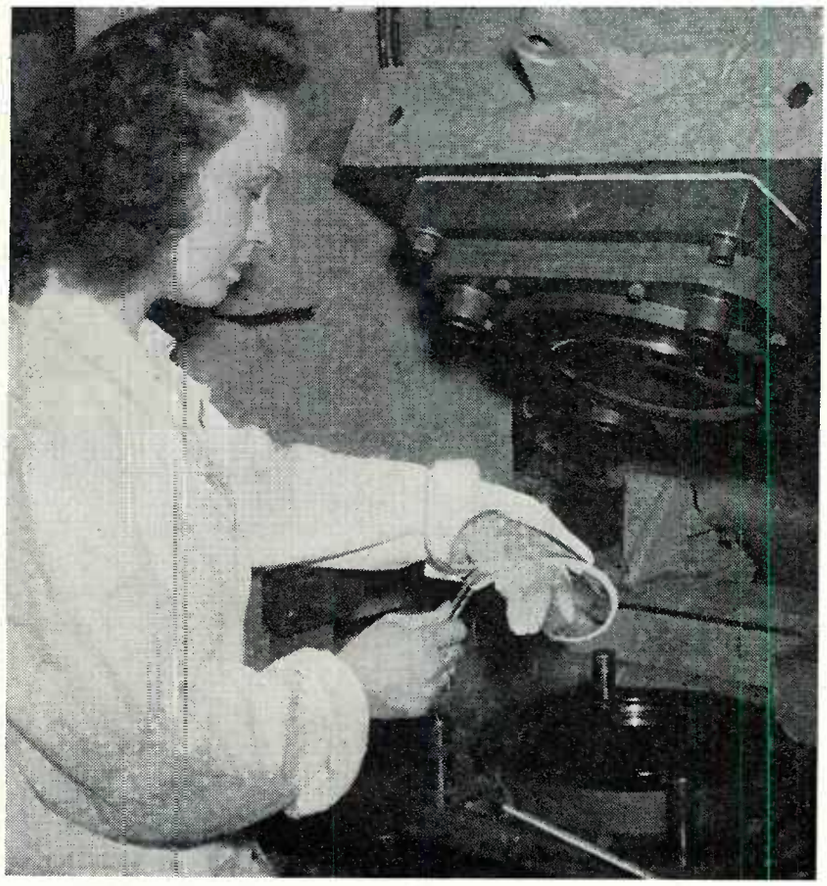


FIG. 3, LEFT. IN THIS OVEN THE PREFORM IS PLACED BETWEEN DISC ELECTRODES CONNECTED TO THE RF GENERATOR. THIS HEATS THE PREFORM EVENLY THROUGH. FIG. 4, RIGHT. THE HEATED PREFORM, NOW SOFT ENOUGH TO BE FLEXIBLE, IS INSERTED IN THE MOLDING PRESS, WHERE IT WILL BE FORMED, AS IN FIG. 1, INTO A PERFECT LENS

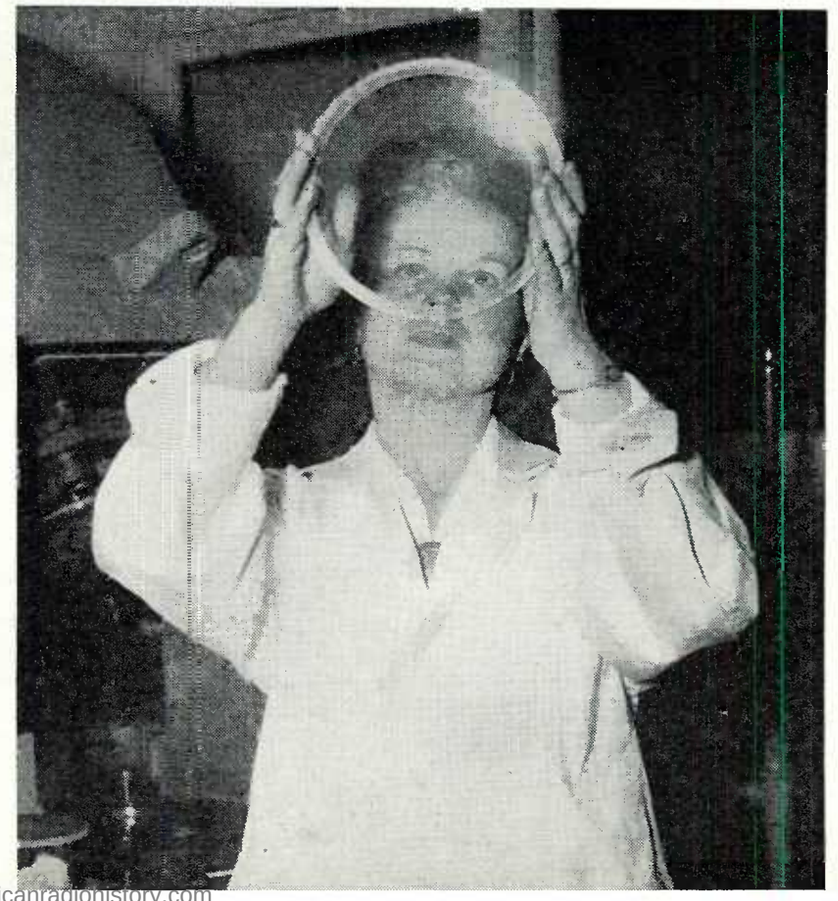
without any special care or protection.

SPHERICAL MIRROR ★ The ground and polished glass of the spherical mirror, which is the main lens in the reflective optical system, is shown in Fig. 7 before aluminizing. Shaped like a salad bowl, it is 14 ins. in diameter, with a 4-in. hole at the center. The inner surface is ground to a true spherical shape on a standard optical grinding machine.

The mirror surface is obtained by an alumnizing process which consists of placing the glass bowl, inner side down, on supporting rods in a bell jar, which is then evacuated. In the jar are two aluminum filaments from which aluminum is evaporated by heating them to incandescence. The aluminum vapor, thus driven off, condenses on the under side of the glass in a thin, uniform coating.

Fig. 9 shows the result after the aluminizing process is completed. The treated surface has a true mirror finish of highly

FIG. 5, LEFT. SINCE THIS IS THERMOPLASTIC MATERIAL, THE MOLDS MUST BE COOLED BY WATER CIRCULATION BEFORE THE LENS CAN BE REMOVED. FIG. 6, RIGHT. NO FINISHING PROCESS IS REQUIRED ON THE LENS SURFACE. THIS LENS WILL BE READY FOR OPTICAL CHECKING AS SOON AS A HOLE HAS BEEN CUT OUT AT THE CENTER



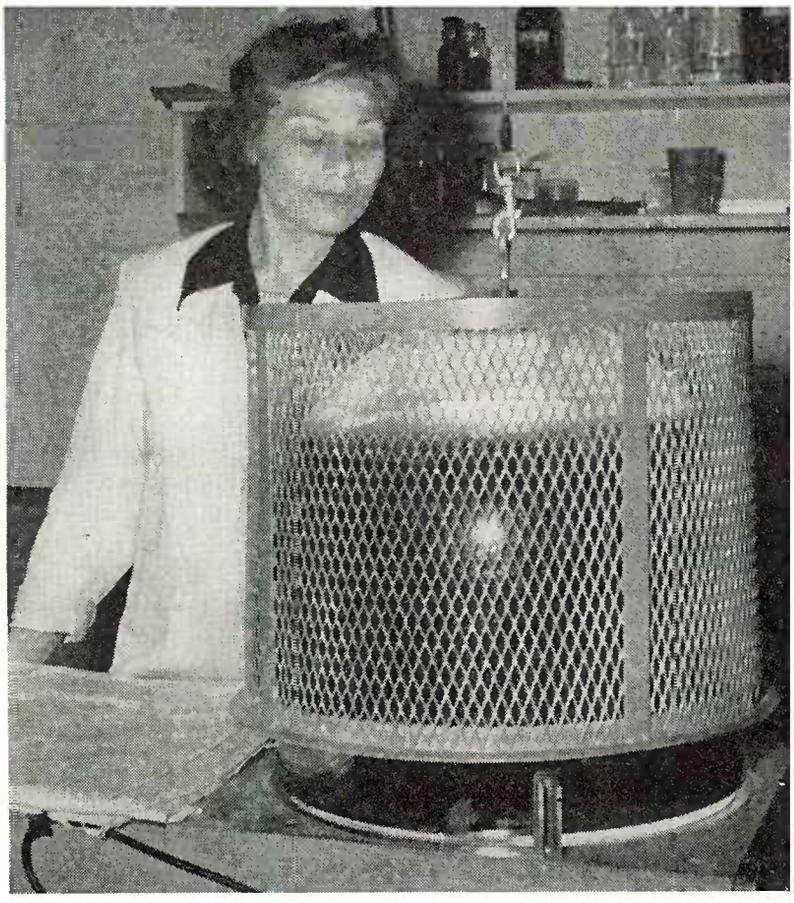


FIG. 7, LEFT. THE GLASS BLANK FOR THE MIRROR IS GROUND AND POLISHED ON STANDARD OPTICAL MACHINES, SINCE ITS SHAPE INVOLVES NO SPECIAL PROBLEMS. FIG. 8, RIGHT. THE BELL JAR AND PROTECTIVE SCREEN ARE LOWERED OVER THE GLASS BLANK, AND THE BELL JAR IS EVACUATED WHILE ALUMINUM IS DEPOSITED INSIDE THE BOWL

reflective properties, and as a lens it has very high light-gathering power.

The final step is to check the correcting lens in a test box. The box contains a standard spherical mirror and, at the focal point, an illuminated image simulating the face of the cathode-ray projection tube. Any defect in the shape of the correcting lens will be seen as distortion of the image when it is projected on a screen.

A pair of finished lenses, ready for mounting, is illustrated in Fig. 10. At the rear is the cabinet containing the RF generator used to preheat the plastic discs.

Details of the method of mounting the optical system, and its advantages over other lens systems were described in detail by the author in *FM* AND TELEVISION for June, 1945. That article also explained why, through the use of the reflector and correcting lens, greater optical efficiency is obtained than with other lens arrangements.

FIG. 9, LEFT. HERE IS THE BLANK SHOWN IN FIG. 7 AFTER THE ALUMINIZING PROCESS HAS BEEN COMPLETED. THE REFLECTIVE POWER IS MUCH HIGHER THAN THE RELATIVELY INEFFICENT SILVERING OF ORDINARY MIRRORS. FIG. 10, RIGHT. A FINISHED REFLECTOR AND CORRECTING LENS, READY TO BE CHECKED BEFORE MOUNTING IN A RECEIVER

FM STANDARDS OF GOOD ENGINEERING PRACTICE

As Released by the Federal Communications Commission on September 20, 1945

THERE are presented herein the Commission's engineering standards relating to the allocation and operation of FM broadcast stations. These standards also apply to non-commercial educational (FM) broadcast stations, except as noted herein. The Commission's Rules and Regulations contain references to these standards, which have been approved by the Commission and thus are considered as reflecting its opinion in all matters involved.

The standards set forth herein are those deemed necessary for the construction and operation of FM broadcast stations to meet the requirements of technical regulations and for operation in the public interest along technical lines not otherwise enunciated. These standards are based upon the best engineering data available, including evidence at hearings, conferences with radio engineers, and data supplied by manufacturers of radio equipment and by licensees of FM broadcast stations. These standards are complete in themselves and supersede previous engineering standards or policies of the Commission concerning FM broadcast stations. While these standards provide for flexibility and indicate the conditions under which they are applicable, it is not expected that material deviation from the fundamental principles will be recognized unless full information is submitted as to the need and reasons therefor.

These standards will necessarily be revised from time to time as progress is made in the art. The Commission will accumulate and analyze engineering data available as to the progress of the art so that these standards may be kept current with technical developments.

1. Definitions

A. FM BROADCAST STATION: The term *FM broadcast station* means a station employing Frequency Modulation in the FM broadcast band and licensed primarily for the transmission of radiotelephone emissions intended to be received by the general public.

B. FREQUENCY MODULATION: The term *frequency modulation* means a system of modulation where the instantaneous radio frequency varies in proportion to the instantaneous *amplitude* of the modulating signal (amplitude of modulating signal to be measured after pre-emphasis, if used) and the instantaneous radio frequency is independent of the *frequency* of the modulating signal.

C. FM BROADCAST BAND: The term *FM broadcast band* means the band of frequencies extending from 88 to 108 mc., which includes those assigned to noncommercial educational broadcasting.

D. CENTER FREQUENCY: The term *center frequency* means:

(1) The average frequency of the emitted wave when modulated by a sinusoidal signal:

(2) The frequency of the emitted wave without modulation.

E. FREQUENCY SWING: The term *frequency swing* means the instantaneous departure of the frequency of the emitted wave from the center frequency resulting from modulation.

F. FM BROADCAST CHANNEL: The term *FM broadcast channel* means a band of frequencies 200 kc. wide and is designated by its center frequency. Channels for FM broadcast stations begin at 88.1 mc. and continue in successive steps of 200 kc. to and including 107.9 mc.

G. ANTENNA FIELD GAIN: The term *antenna field gain* of an FM broadcast antenna means the ratio of the effective free space field intensity produced at one mile in the horizontal plane expressed in millivolts-per-meter for 1 kw. antenna input power to 137.6 mv/m.

H. FREE SPACE FIELD INTENSITY: The term *free space field intensity* means the field intensity that would exist at a point in the absence of waves reflected from the earth or other reflecting objects.

I. MULTIPLEX TRANSMISSION: The term *multiplex transmission* means the simultaneous transmission of two or more signals within a single channel. Multiplex transmission as applied to FM broadcast stations means the transmission of facsimile or other signals in addition to the regular broadcast signals.

J. PERCENTAGE MODULATION: The term *percentage modulation* as applied to frequency modulation means the ratio of the actual frequency swing to the frequency swing defined as 100% modulation, expressed in percentage. For FM broadcast stations, a frequency swing of ± 75 kc. is defined as 100% modulation.

K. EFFECTIVE RADIATED POWER: The term *effective radiated power* means the product of the antenna power (transmitter output power less transmission line loss) times (1) the antenna power gain, or (2) the antenna field gain squared.

L. SERVICE AREA: The term *service area* as applied to FM broadcasting means the service resulting from an assigned effective radiated power and antenna height above average terrain.

M. ANTENNA HEIGHT ABOVE AVERAGE TERRAIN: The term *antenna height above average terrain* means the average of the antenna height above the terrain from two to ten miles from the antenna. (In general a different antenna height will be determined by each direction from the antenna. The average of these various heights is considered as the antenna height above average terrain.)

2. Engineering Standards of Allocation

A. BASIS FOR FM ALLOCATIONS: Sections 3.202 to 3.205 inclusive of the Rules and Regulations describe the basis for allocation of FM Broadcast Stations, including the division of the United States into Areas I and II. Where reference is made in the Rules to antenna heights of Community Stations, Section 2 E (1) of these Standards should be consulted; for other classes of FM broadcast stations, Section 2 E (2) should be consulted.

As noted in Section 3.204 (b) of the Rules, the Commission will designate service areas for Metropolitan Stations in Area II. In addition to the showing required by this Rule a special showing must be included in the application concerning the area proposed to be served, in the event that (1) such area is smaller than the service area designated by the Commission, or (2) such area is smaller than that which would appear to be the appropriate service area, in cases where it has not been designated by the Commission. The proposed area to be served must be substantially greater than that which could be served by a Community station.

B. FIELD INTENSITY CONTOURS: In determining the predicted and measured field intensity contours of FM broadcast stations the following shall govern:

(1) Community stations will normally not be required to determine their contours.

(2) Metropolitan Stations shall determine the extent of their 1,000 μv/m and 50 μv/m contours.

(3) Rural stations shall determine their 1,000 μv/m, 50 μv/m and 20 μv/m contours.[1]

The above contours shall be determined in accordance with the methods prescribed in these standards.

C. FIELD INTENSITY REQUIREMENTS: Although some service is provided by tropospheric waves, the service area is considered to be only that served by the ground wave. The extent of the service is determined by the point at which the ground wave is no longer of sufficient in-

[1] The 20 μv/m contour is desired in this case for use by the Commission in determining the usability of a signal of such low intensity.

tensity to provide satisfactory broadcast service. The field intensity considered necessary for service is as follows:

TABLE I

Area	Median Field Intensity
City business or factory areas	1,000 μv/m
Rural areas	50 μv/m

A median field intensity of 3,000 to 5,000 μv/m should be placed over the principal city to be served, and a median field intensity of 1,000 μv/m should be placed over the business district of cities of 10,000 or greater within the metropolitan district served. The field intensity to be provided over the main studio is specified by Sections 3.203, 3.204, and 3.205 of the Rules.

These figures are based upon the usual noise levels encountered in the several areas and upon the absence of interference from other FM stations.

D. Satellites: A basis for allocation of satellite stations has not yet been determined. For the present, applications will be considered on their individual merits.

E. Service Area: The service area is predicted as follows:

(1) Community stations: A map, topographic where obtainable, shall be submitted for the area within 15 miles of the proposed antenna site. On this map shall be indicated the antenna location and a circle of 10 miles radius with the antenna location as center. Representative points shall be picked on this circle 15° apart and the elevation of these points determined. The average elevation of these points will be considered the average elevation of the circle. The difference between the elevation of the center of the radiating system and the average elevation of this circle shall be considered the height of the antenna over the terrain 10 miles from the transmitter. In cases where the applicant believes this method to be grossly in error due to peculiarities of the terrain, this method shall be used for determining the antenna height but a showing may be made, if desired, determining the height by other means and describing the method used. Calculations of the service contours of Community stations are not required.

(2) Metropolitan and Rural stations: Profile graphs must be drawn for at least eight radials from the proposed antenna site. These profiles should be prepared for each radial beginning at the antenna site and extending to ten miles therefrom. Normally the radials are drawn for each 45° of azimuth; however, where feasible the radials should be drawn for angles along which roads tend to follow. (The latter method may be helpful in obtaining topographical data where otherwise unavailable, and is particularly useful in connection with mobile field intensity measurements of the station and the correlation of such measurements with predicted field intensities.) In each case one or more radials must include the principal city or cities to be served, particularly in cases of rugged terrain, even though the city may be more than 10 miles from the antenna site. The profile graph for each radial should be plotted by contour intervals of from 40 to 100 ft. and, where the data permits, at least 50 points of elevation (generally uniformly spaced) should be used for each radial. In instances of very rugged terrain where the use of contour intervals of 100 ft. would result in several points in a short distance, 200- or 400-ft. contour intervals may be used for such distances. On the other hand, where the terrain is uniform or gently sloping the smallest contour interval indicated on the topographic map (see below) should be used, although only a relatively few points may be available. The profile graph should accurately indicate the topography for each radial, and the graphs should be plotted with the distance in miles as the abscissa and the elevation in feet above mean sea level as the ordinate. The profile graphs should indicate the source of the topographical data employed. The graph should also show the elevation of the center of the radiating system. The graph may be plotted either on rectangular coordinate paper or on special paper which shows the curvature of the earth. It is not necessary to take the curvature of the earth into consideration in this procedure, as this factor is taken care of in the chart showing signal intensities, Fig. 1.

The average elevation of the 8-mile distance between 2 and 10 miles from the antenna site should then be determined from the profile graph for each radial. This may be obtained by averaging a large number of equally spaced points, by using a planimeter, or by obtaining the median elevation (that exceeded for 50% of the distance) in sectors and averaging these values.

To determine the distance to a particular contour, Fig. 1, concerning the range of FM broadcast stations, should be used. This chart has been prepared for a frequency in the center of the band and is to be used for all FM broadcast channels, since little change results over this frequency range. The distance to a contour is determined by the effective radiated power and the antenna height. The height of the antenna used in connection with Fig. 1 should be the height of the center of the proposed antenna radiator above the average elevation obtained by the preceding method. The distances shown by Fig. 1 are based upon an effective radiated power of 1 kw.; to use the chart for other powers, the sliding scale associated with the chart should be trimmed and used as the ordinate scale. This sliding scale is placed on the chart with the appropriate gradation for power in line with the lower line of the top edge of the chart. The right edge of the scale is placed in line with the appropriate antenna height graduations and the chart then becomes direct reading for this power and antenna height. Where the antenna height is not one of those for which a scale is provided, the signal strength or distance is determined by interpolation between the curves connecting the equidistant points.

The foregoing process of determining the extent of the required contours shall be followed in determining the boundary of the proposed service area. The areas within the required contours must be determined and submitted with each application for these classes of FM broadcast stations. Each application shall include a map showing these contours, and for this purpose Sectional Aeronautical charts or other maps having a convenient scale may be used. The map shall show the radials along which the profile charts and expected field strengths have been determined. The area within each contour should then be measured (by planimeter or other approximate means) to determine the number of square miles therein. In computing the area within the contours, exclude (1) areas beyond the borders of the United States, and (2) large bodies of water, such as ocean areas, gulfs, sounds, bays, large lakes, etc., but not rivers.

In cases where the terrain in one or more directions from the antenna site departs widely from the average elevation of the 2- to 10-mile sector, the application of this prediction method may indicate contour distances that are different from those which may be expected in practice. In such cases the prediction method should be followed, but a showing may be made if desired concerning the distance to the contour as determined by other means. Such showing should include data concerning the procedure employed and sample calculations. For example, a mountain ridge may indicate the practical limit of service although the prediction method may indicate the contour elsewhere. In cases of such limitation, the map of predicted coverage should show both the regular predicted area and the area as limited or extended by terrain. Both areas should be measured, as previously described; the area obtained by the regular prediction method should be given in the application form, with a supplementary note giving the limited or extended area. In special cases the Commission may require additional information as to the terrain in the proposed service area.

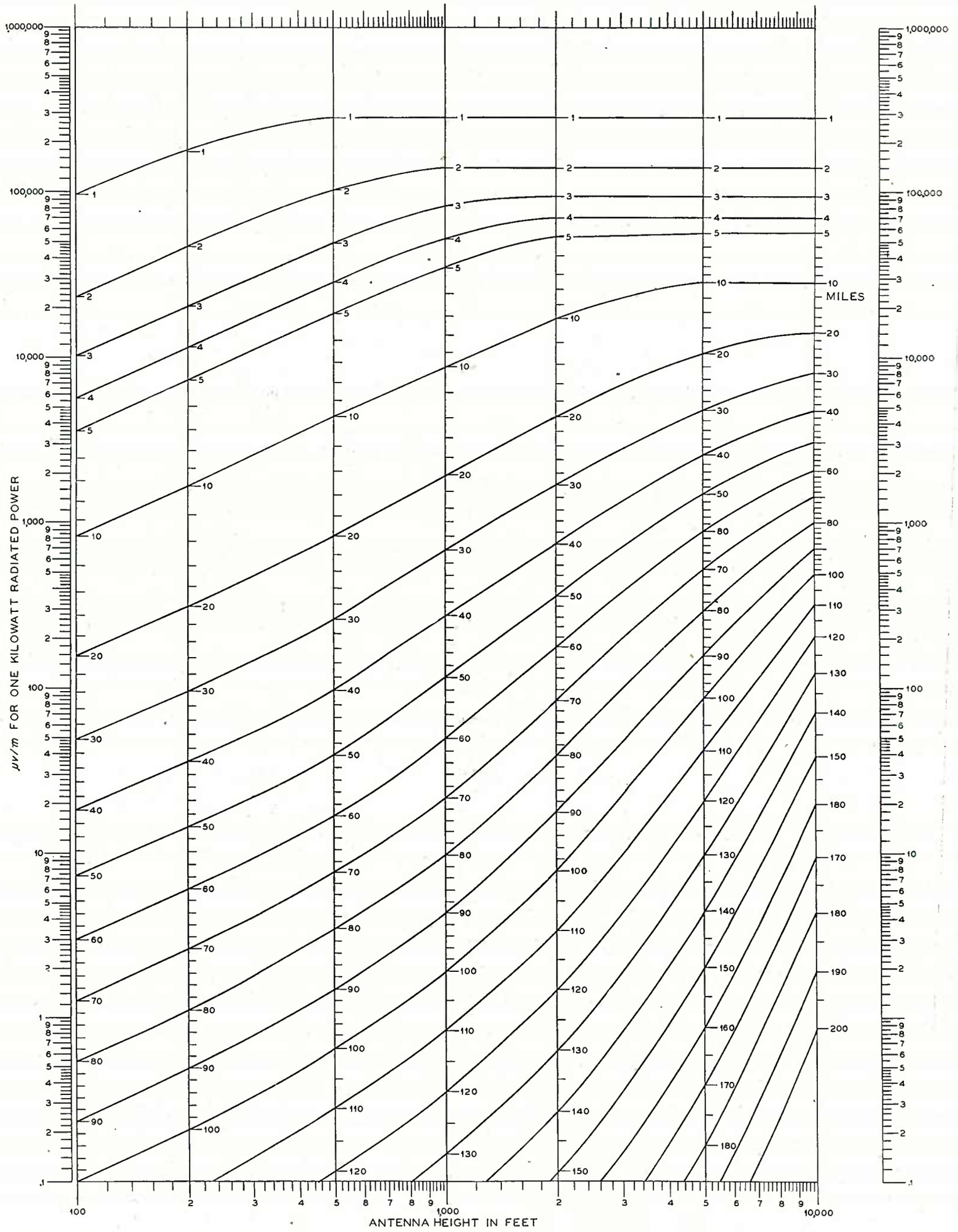


FIG. 1. GROUND WAVE SIGNAL RANGE FOR FM BROADCASTING: 98 mc, $\sigma = 5 \times 10^{-14}$ e.m.u., $\varepsilon = 15$, RECEIVING ANTENNA HEIGHT 30 FEET. FOR HORIZONTAL (AND APPROX. FOR VERTICAL) POLARIZATION

In determining the population served by FM broadcast stations, it is considered that the built-up city areas and business districts in cities having over 10,000 population and located beyond the 1,000 μv/m contour do not receive adequate service. Minor Civil Division maps (1940 Census) should be used in making population counts, excluding cities not receiving adequate service. Where a contour divides a minor division, uniform distribution of population within the division should be assumed in order to determine the population included within the contour, unless a more accurate count is available.

3. Topographical Data

In the preparation of the profile graphs previously described, the elevations or contour intervals shall be taken from the U. S. Geological Topographical Quadrangle Sheets for all areas for which such maps are available. If such maps are not published for the area in question, the next best topographic information should be used. Topographic data may sometimes be obtained from state and municipal agencies. The data from the Sectional Aeronautical Charts (including bench marks), or railroad depot elevations and highway elevations from road maps, may be used where no better information is available. In cases where limited topographic data can be obtained, use may be made of an altimeter in a car driven along roads extending generally radially from the transmitter site.

The Commission will not ordinarily require the submission of topographical maps for areas beyond 15 miles from the antenna site, but the maps must include the principal city or cities to be served. If it appears necessary, additional data may be requested.

The U. S. Geological Survey Topography Quadrangle Sheets may be obtained from the U. S. Geological Survey, Department of the Interior, Washington, D. C., for 10 cents each. The Sectional Aeronautical Charts are available from the U. S. Coast and Geodetic Survey, Department of Commerce, Washington, D. C., for twenty-five cents each. Other sources of topographic maps or data will be furnished at a later date.

4. Interference Standards

Field intensity measurements are preferable in predicting interference between FM broadcast stations and should be used, when available, in determining the extent of interference. (For methods and procedure, see Section 5.) In lieu of measurements, the interference should be predicted in accordance with the method described herein.

Objectionable interference is considered to exist when the interfering signal exceeds that given by the ratios of Table II. In Table II the desired signal is median field and the undesired signal is the tropospheric signal intensity exceeded for 1% of the time.

TABLE II

Channel Separation	Ratio of Desired to Undesired Signals
Same channel	10:1
Adjacent channel (200 kc. removed)	2:1

Objectionable interference is not considered to exist when the channel separation is 400 kc. or greater. Accordingly, FM broadcast stations in the same city or same area may be assigned channels 400 kc. apart. In the assignment of FM broadcast facilities the Commission will endeavor to provide the optimum use of the channels in the band, and accordingly may assign a channel different than that requested in an application.

In predicting the extent of interference with the ground wave service area of a station, the tropospheric signal intensity (from co-channel and adjacent channel stations) existing for 1% of the time shall be employed. The 1% values for one kc. of power and various antenna heights are given in Fig. 2,[2] and values for other powers may be obtained by use of the sliding scale as for Fig. 1. The values indicated by Fig. 2 are based upon available data, and are subject to change as additional information concerning tropospheric wave propagation is obtained.

In determining the points at which the interference ratio is equal to the values shown in Table II, the field intensities for the two interfering signals under consideration should be computed for a considerable number of points along the line between the two stations. Using this data, field intensity versus distance curves should be plotted (e.g., cross-curves on graph paper) in order to determine the points on this path where the interference ratios exist. The points established by this method, together with the points along the contours where the same ratios are determined, are considered to be generally sufficient to predict the area of interference. Additional points may be required in the case of irregular terrain or the use of directional antenna systems.

The area of interference, if any, shall be shown in connection with the map of predicted coverage required by the application form, together with the basic data employed in computing such interference. The map shall show the interference within the 50 μv/m contour.

5. Field Intensity Measurements in Allocation

When field intensity measurements are required by the Commissioner's rules or when employed in determining the extent of service or interference of existing stations, such measurements should be made in accordance with the procedure outlined herein.

Measurements made to determine the service and interference areas of FM broadcast stations should be made with mobile equipment along roads which are as close and similar as possible to the radials showing topography which were submitted with the application for construction permit. Suitable measuring equipment and a continuous recording device must be employed, the chart of which is either directly driven from the speedometer of the automobile in which the equipment is mounted or so arranged that distances and identifying landmarks may be readily noted. The measuring equipment must be calibrated against recognized standards of field intensity and so constructed that it will maintain an acceptable accuracy of measurement while in motion or when stationary. The equipment should be so operated that the recorder chart can be calibrated directly in field intensity in order to facilitate analysis of the chart. The receiving antenna must be non-directional and of the same polarization as the transmitting antenna.

Mobile measurements should be made with a minimum chart speed of 3 ins. per mile and preferably 5 or 6 ins. per mile. Locations shall be noted on the recorder chart as frequently as necessary to definitely fix the relation between the measured field intensity and the location. The time constant of the equipment should be such to permit adequate analysis of the charts, and the time constant employed shall be shown. Measurements should be made to a point on each radial well beyond the particular contour under investigation. The transmitter power shall be maintained as close as possible to the authorized power throughout the survey.

After the measurements are completed, the recorder chart shall be divided into not less than 15 sections on each equivalent radial from the station. The field intensity in each section of the chart shall be analyzed to determine the field intensity received 50% of the distance (median field) throughout the section, and this median field intensity associated with the corresponding sector of the radial. The field intensity figures must be corrected for a receiving antenna elevation of 30 ft. and for any directional effects of the automobile not otherwise compensated. This data should be plotted for each radial, using log-log coordinate paper with distance as the abscissa and field intensity as the ordinate. A smooth curve should be

[2] Fig. 2 is in preparation by the FCC, and should be available Nov. 1, 1945. This will be published in *FM* and Television as soon as it is made available.

drawn through these points (of median fields for all sectors), and this curve used to determine the distance to the desired contour. The distances obtained for each radial may then be plotted on the map of predicted coverage or on polar coordinate paper (excluding water areas, etc.) to determine the service and interference areas of a station.

In making measurements to establish the field intensity contours of a station, mobile recordings should be made along each of the radials drawn in Section 2 E above. Measurements should extend from the vicinity of the station out to the 1,000 μv/m measured contour and somewhat beyond (at the present time it is not considered practical to conduct mobile measurements far beyond this contour due to the fading ratio at weak fields, which complicates analysis of the charts). These measurements would be made for the purpose of determining the variation of the measured contours from those predicted, and it is expected that initially the correlation of the measured 1,000 μv/m with the predicted 1,000 μv/m contour will be used as a basis in determining adherence to authorized service areas within the 50 μv/m contour. Adjustment of power or antenna may be required to fit the actual contours to that predicted.

In addition to the 1,000 μv/m contour, the map of measured coverage shall show the 50 μv/m contour as determined by employing Fig. 1 and the distance to the 1,000 μv/m contour along each radial. The sliding scale shall be placed on the figure at the appropriate antenna height for the radial in question and then moved so the distance to the 1,000 μv/m contour (as measured) and the 1,000 μv/m mark are opposite. The distance to the 50 μv/m contour is then given opposite the 50 μv/m mark on the scale.

In predicting tropospheric interference on the basis of the above measurements, such measurements shall be carried out in the manner indicated above to determine the 1,000 μv/m contour. Using Fig. 1 and its associated sliding scale, the equivalent radiated power shall be determined by placing the sliding scale on the chart (using the appropriate antenna height) and moving the scale until the distance to the 1,000 μv/m contour (as determined above), and the 1,000 μv/m mark are opposite. The equivalent radiated power is then read from the sliding scale where it crosses the lower line of the top edge of the chart. Changing to Fig. 2[2] and using the equivalent radiated power just determined, the distance to the interfering contour under investigation is read in the usual manner.

In certain cases the Commission may desire more information or recordings and in these instances special instructions will be issued. This may include fixed location measurements to determine tropospheric propagation and fading ratios.

Complete data taken in conjunction with field intensity measurements shall be submitted to the Commission in affidavit form, including the following:

A. Maps: Map or maps showing the roads or points where measurements were made, the service and/or interference areas determined by the prediction method and by the measurements, and any unusual terrain characteristics existing in these areas. (This map may preferably be of a type showing topography in the area.)

B. Directional Radiation: If a directional transmitting antenna is employed, a diagram on polar coordinate paper showing the predicted free space field intensity in millivolts per meter at one mile in all directions. (See Section 7.)

C. Procedure: A full description of the procedures and methods employed including the type of equipment, the method of installation and operation, and calibration procedures.

D. Survey Data: Complete data obtained during the survey, including calibration.

E. Antenna and Power: Antenna system and power employed during the survey.

F. Personnel: Name, address, and qualifications of the engineer or engineers making the measurements.

All data shall be submitted to the Commission in triplicate, except that only the original or one photostatic copy need be submitted of the actual recording tapes.

6. Transmitter Location

A. Elevation: The transmitter location should be as near the center of the proposed service area as possible consistent with the applicant's ability to find a site with sufficient elevation to provide service throughout the area. Location of the antenna at a point of high elevation is necessary to reduce to a minimum the shadow effect on propagation due to hills and buildings which may reduce materially the intensity of the station's signals in a particular direction. The transmitting site should be selected consistent with the purpose of the station, i.e., whether it is intended to serve a small city, a metropolitan area or a large region. Inasmuch as service may be provided by signals of 1,000 μv/m or greater field intensities in metropolitan areas, and inasmuch as signals as low as 20 μv/m may provide service in rural areas, considerable latitude in the geographical location of the transmitter is permitted; however, the necessity for a high elevation for the antenna may render this problem difficult. In general, the transmitting antenna of a station should be located at the most central point at the highest elevation available. In providing the best degree of service to an area, it is usually preferable to use a high antenna rather than a lower antenna with increased transmitter power. The location should be so chosen that line-of-sight can be obtained from the antenna over the principal city or cities to be served; in no event should there be a major obstruction in this path.

B. Relation of Contour to Distribution of Population: The transmitting location should be selected so that the 1,000 μv/m contour encompasses the urban population within the area to be served and the 50 μv/m or the interference free contour coincides generally with the limits of the area to be served. It is recognized that topography, shape of the desired service area, and population distribution may make the choice of a transmitter location difficult. In such cases consideration may be given to the use of a directional antenna system, although it is generally preferable to choose a site where a non-directional antenna may be employed.

C. Site Tests: In cases of questionable antenna locations it is desirable to conduct propagation tests to indicate the field intensity expected in the principal city or cities to be served and in other areas, particularly where severe shadow problems may be expected. In considering applications proposing the use of such locations, the Commission may require site tests to be made. Such tests should be made in accordance with the measurement procedure previously described, and full data thereon must be supplied to the Commission. Test transmitters should employ an antenna having a height as close as possible to the proposed antenna height, using a balloon or other support if necessary and feasible. Information concerning the authorization of site tests may be obtained from the Commission upon request.

D. Blanket Areas: Present information is not sufficiently complete to establish *blanket areas* of FM broadcast stations, which are defined as those areas adjacent to the transmitters in which the reception of other stations is subject to interference due to the strong signal from the stations. Where it is found necessary to locate the transmitter in a residential area where blanketing problems may appear to be excessive, the application must include a showing concerning the availability of other sites. The authorization of station construction in areas where blanketing problems appear to be excessive will be on the basis that the applicant will assume full responsibility for the adjustment of reasonable complaints arising from exces-

sive strong signals of the applicant's station. As a means of minimizing interference problems, it is expected that stations adjacent in location will generally be assigned frequencies that are generally adjacent. Insofar as is feasible, frequency assignments for stations at separated locations will also be separated.

Cognizance must, of course, be taken regarding the possible hazard of the proposed antenna structure to aviation and the proximity of the proposed site to airports and airways. In passing on proposed construction, the Commission refers each case to the CAA for its recommendations. Antenna painting and/or lighting may be required at the time of construction or at a later date.

7. Antenna Systems

A. Polarization: It shall be standard to employ horizontal polarization. If the use of vertical polarization appears desirable in special circumstances, its use may be authorized upon a showing of need.

B. Surrounding Objects: The antenna must be constructed so that it is as clear as possible of surrounding buildings or objects that would cause shadow problems.

C. Directional Systems: Applications proposing the use of directional antenna systems must be accompanied by the following:

(1) Complete description of the proposed antenna system.

(2) Orientation of array with respect to true north; time phasing of fields from elements (degrees leading or lagging); space phasing of elements (in feet and in degrees); ratio of fields from elements.

(3) Calculated field intensity pattern (on letter-size polar coördinated paper) giving the free space field intensity in millivolts-per-meter at 1 mile in the horizontal plane, together with the formula used, constants employed, sample calculations and tabulation of calculation data.

(4) Name, address, and qualifications of the engineer making the calculations.

D. Adjacent Stations: Applications proposing the use of FM broadcast antennas in the immediate vicinity (i.e., 200 ft. or less) of (1) other FM broadcast antennas, or (2) television broadcast antennas for frequencies adjacent to the FM broadcast band, must include a showing as to the expected effect, if any, of such proximate operation.

In cases where it is proposed to use a tower of a standard broadcast station as a supporting structure for an FM broadcast antenna, an application for construction permit (or modification of construction permit) for such station must be filed for consideration with the FM application. Applications may be required for other classes of stations when their towers are to be used in connection with FM broadcast stations.

When an FM broadcast antenna is mounted on a non-directional standard broadcast antenna, new resistance measurements must be made of the standard broadcast antenna after installation and testing of the FM broadcast antenna. During the installation and until the new resistance determination is approved, the standard broadcast station licensee should apply for authority (informal application) to operate by the indirect method of power determination. The FM broadcast license application will not be considered until the application form concerning resistance measurements is filed for the standard broadcast station.

When an FM broadcast antenna is mounted on an element of a standard broadcast directional antenna, a full engineering study concerning the effect of the FM broadcast antenna on the directional pattern must be filed with the application concerning the standard broadcast station. Depending upon the individual case, the Commission may require readjustment and certain field intensity measurements of the standard broadcast station following the completion of the FM broadcast antenna system.

When the proposed FM broadcast antenna is to be mounted on a tower in the vicinity of a standard broadcast directional array and it appears that the operation of the directional antenna system may be affected, an engineering study must be filed with the FM broadcast application concerning the effect of the FM broadcast antenna on the directional pattern. Readjustment and field intensity measurements of the standard broadcast station may be required following construction of the FM broadcast antenna.

Information regarding data required in connection with standard broadcast directional antenna systems may be found in the Standards of Good Engineering Practice Concerning Standard Broadcast Stations.

In the event a common tower is used by two or more licensees for antenna and/or antenna supporting purposes, the licensee who is owner of the tower shall assume full responsibility for the installation and maintenance of any painting or lighting requirements. In the event of shared ownership, one licensee shall assume such responsibility and advise the Commission accordingly.

E. Auxiliary Antenna: It is recommended that an emergency FM broadcast antenna be installed, or, alternately, an auxiliary transmission line or lines if feasible in the particular circumstances. Data thereon should be supplied with the application for construction permit; if proposed after station construction, an informal application should be submitted to the Commission.

F. Protection of Air Navigation: When necessary for the protection of air navigation, the antenna and supporting structure shall be painted and illuminated in accordance with the specifications supplied by the Commission pursuant to section 303 (q) of the Communications Act of 1934, as amended.

These individual specifications are issued for and attached to each authorization for an installation. The details of the specifications depend on the degree of hazard presented by the particular installation. The tower paint shall be kept in good condition and repainted as often as necessary to maintain this condition.

General information regarding painting and lighting requirements is contained in the Obstruction Marking Manual available from the Civil Aeronautics Administration, Washington 25, D. C.

8. Transmitters and Associated Equipment

A. Electrical Performance Standards: The general design of the FM broadcast transmitting system (from input terminals of microphone pre-amplifier, through audio facilities at the studio, through lines or other circuits between studio and transmitter, through audio facilities at the transmitter, and through the transmitter, but excluding equalizers for the correction of deficiencies in microphone response) shall be in accordance with the following principles and specifications:

(1) Standard power ratings and operating power range of FM broadcast transmitters shall be in accordance with the following table:

Standard Power Rating	Operating Power Range
250 watts	250 watts or less
1 kw.	250 watts–1 kw.
3 kw.	1–3 kw.
10 kw.	3–10 kw.
25 kw.	10–25 kw.
50 kw.	10–50 kw.
100 kw.	50–100 kw.

Composite transmitters may be authorized with a power rating different from the above table, provided full data is supplied in the application concerning the basis employed in establishing the rating and the need therefor. The operating range of such transmitters shall be from one-third of the power rating to the power rating.

The transmitter shall operate satisfactorily in the operating power range with a frequency swing of ± 75 kilocycles, which is defined as 100% modulation.

(2) The transmitting system shall be capable of transmitting a band of frequencies from 50 to 15,000 cycles: Pre-

emphasis shall be employed in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 75 microseconds. (See Fig. 3.) The deviation of the system response from the standard pre-emphasis curve shall lie between two limits as shown in Fig. 3. The upper of these limits shall be uniform (no deviation) from 50 to 15,000 cycles. The lower limit shall be uniform from 100 to 7,500 cycles, and three db below the upper limit; from 100 to 50 cycles the lower limit shall fall from the three db limit at a uniform rate of one db per octave (four db at 50 cycles); from 7,500 to 15,000 cycles the lower limit shall fall from the three db limit at a uniform rate of two db per octave (five db at 15,000 cycles).

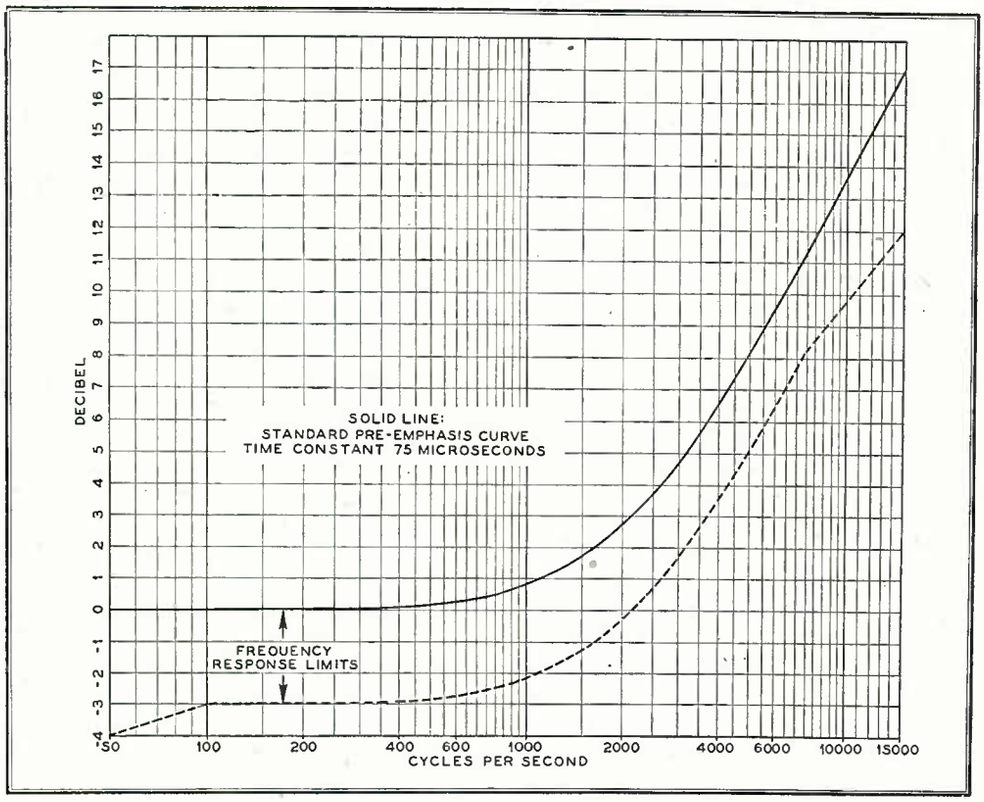


FIG. 3. STANDARD PRE-EMPHASIS CURVE. TIME CONSTANT 75 MICROSECONDS

(3) At any modulation frequency between 50 and 15,000 cycles and at modulation percentages of 25%, 50%, and 100%, the combined audio frequency harmonics measured in the output of the system shall not exceed the root-mean-square values given in the following table:

Modulation Frequency	Distortion
50 to 100 cycles	3.5%
100 to 7,500 cycles	2.5%
7,500 to 15,000 cycles	3.0%

Measurements shall be made employing 75 microsecond de-emphasis in the measuring equipment and 75 microsecond pre-emphasis in the transmitting equipment, and without compression if a compression amplifier is employed. Harmonics shall be included to 30 kc.[3]

It is recommended that none of the three main divisions of the system (transmitter, studio to transmitter circuit, and audio facilities) contribute over one half of these percentages since at some frequencies the total distortion may become the arithmetic sum of the distortions of the divisions.

(4) The transmitting system output noise level (frequency modulation) in the band of 50 to 15,000 cycles shall be at least 60 decibels below the audio frequency level representing a frequency swing of ± 75 kilocycles. The noise-measuring equipment shall be provided with standard 75-microsecond de-emphasis; the ballistic characteristics of the instrument shall be similar to those of the Standard VU meter.

(5) The transmitting system output noise level (amplitude modulation) in the band of 50 to 15,000 cycles shall be at least 50 decibels below the level representing 100% amplitude modulation. The noise-measuring equipment shall be provided with standard 75-microsecond de-emphasis; the ballistic characteristics of the instrument shall be similar to those of the Standard VU Meter.

(6) Automatic means shall be provided in the transmitter to maintain the assigned center frequency within the allowable tolerance (± 2,000 cycles).

(7) The transmitter shall be equipped with suitable indicating instruments for the determination of operating power and with other instruments as are necessary for proper adjustment, operation, and maintenance of the equipment (See Section 9).

(8) Adequate provision shall be made for varying the transmitter output power to compensate for excessive variations in line voltage or for other factors affecting the output power.

(9) Adequate provision shall be provided in all component parts to avoid overheating at the rated maximum output power.

(10) Means shall be provided for connection and continuous operation of approved frequency and modulation monitors.

(11) If a limiting or compression amplifier is employed, precaution should be maintained in its connection in the circuit due to the use of pre-emphasis in the transmitting system.

B. Construction: In general, the transmitter shall be constructed either on racks and panels or in totally enclosed frames protected as required by article 810 [4] of the National Electrical Code and set forth below:

(1) Means shall be provided for making all tuning adjustments, requiring voltages in excess of 350 volts to be applied to the circuit, from the front of the panels with all access doors closed.

(2) Proper bleeder resistors or other automatic means shall be installed across all capacitor banks to lower any voltage which may remain accessible with access door open to less than 350 volts within two seconds after the access door is opened.

(3) All plate supply and other high voltage equipment, including transformers, filters, rectifiers and motor generators, shall be protected so as to prevent injury to operating personnel.

(a) Commutator guards shall be provided on all high voltage rotating machinery. Coupling guards should be provided on motor generators.

(b) Power equipment and control panels of the transmitter shall meet the above requirements (exposed 220-volt AC switching equipment on the front of the power

[3] See Section 13 for measurement frequencies and other information.

[4] The pertinent sections of article 810 of the National Electrical Code reads as follows:
"8191. General. — Transmitters shall comply with the following:
"a. Enclosing. — The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.
"b. Grounding of controls. — All external metallic handles and controls accessible to the operating personnel shall be effectually grounded. No circuit in excess of 150 volts shall have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.
"c. Interlocks on doors. — All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened."

control panels is not recommended but is not prohibited).

(c) Power equipment located at a broadcast station but not directly associated with the transmitter (not purchased as part of same), such as power distribution panels, are not under the jurisdiction of the Commission; therefore Section 3.254 does not apply.

(4) Metering equipment:

(a) All instruments having more than 1,000 volts potential to ground on the movement shall be protected by a cage or cover in addition to the regular case. (Some instruments are designed by the manufacturer to operate safely with voltages in excess of 1,000 volts on the movement. If it can be shown by the manufacturer's rating that the instrument will operate safely at the applied potential, additional protection is not necessary.)

(b) In case the plate voltmeter is located on the low potential side of the multiplier resistor with the potential of the high potential terminal of the instrument at or less than 1,000 volts above ground, no protective case is required. However, it is good practice to protect voltmeters subject to more than 5,000 volts with suitable overvoltage protective devices across the instrument terminals in case the winding opens.

(c) Transmission line meters and any other radio frequency instrument which may be necessary for the operator to read shall be so installed as to be easily and accurately read without the operator having to risk contact with circuits carrying high potential radio frequency energy.

(5) It is recommended that component parts comply as much as possible with the component specifications designated by the Army-Navy Electronics Standards Agency.

C. Wiring and Shielding:

(1) The transmitter panels or units shall be wired in accordance with standard switchboard practice, either with insulated leads properly cabled and supported or with rigid bus bar properly insulated and protected.

(2) Wiring between units of the transmitter, with the exception of circuits carrying radio frequency energy, shall be installed in conduits or approved fiber or metal raceways for protection from mechanical injury.

(3) Circuits carrying radio frequency energy between units shall be coaxial, two wire balanced lines, or properly shielded.

(4) All stages or units shall be adequately shielded and filtered to prevent interaction and radiation.

(5) The frequency and modulation monitors and associated radio frequency lines to the transmitter shall be thoroughly shielded.

D. Installation:

(1) The installation shall be made in suitable quarters.

(2) Since an operator must be on duty during operation, suitable facilities for his welfare and comfort shall be provided.

E. Spare Tubes: A spare tube of every type employed in the transmitter and frequency and modulation monitors shall be kept on hand at the equipment location. When more than one tube of any type are employed, the following table determines the number of spares of that type required:

Number of Each Type Employed	Spares Required
1 or 2	1
3 to 5	2
6 to 8	3
9 or more	4

An accurate circuit diagram and list of required spare tubes, as furnished by the manufacturer of the equipment, shall be retained at the transmitter location.

F. Operations: In addition to specific requirements of the rules governing FM broadcast stations, the following operating requirements are specified:

(1) The maximum percentage of modulation shall be maintained in accordance with Section 3.268. However, precautions shall be taken so as not to substantially alter the dynamic characteristics of musical programs.

(2) Spurious emissions, including radio frequency harmonics, shall be maintained at as low a level as practicable at all times in accordance with good engineering practice.

(3) If a limiting or compression amplifier is employed, care should be maintained in its use due to pre-emphasis in the transmitting system.

G. Studio Equipment: Studio equipment shall be subject to all the above requirements where applicable except as follows:

(1) If properly covered by an underwriter's certificate, it will be considered as satisfying safety requirements.

(2) Section 8191 of Article 810 of the National Electrical Code shall apply for voltages only in excess of 500 volts.

No specific requirements are made with regards to the microphones to be employed. However, microphone performance (including compensating networks, if employed) shall be compatible with the required performance of the transmitting system.

No specific requirements are made relative to the design and acoustical treatment of studios. However, the design of studios, particularly the main studio, shall be compatible with the required performance characteristics of FM broadcast stations.

9. Indicating Instruments

An FM broadcast transmitter shall be equipped with suitable indicating instruments of acceptable accuracy to measure (1) the direct plate voltage and current of the last radio stage, and (2) the main transmission line radio frequency current or voltage.

The following requirements and specifications shall apply to indicating instruments used by FM broadcast stations:

A. Plate Current and Voltage: Instruments indicating the plate current or plate voltage of the last radio stage (linear scale instruments) shall meet the following specifications:

(1) Length of scale shall be not less than 2 3/10 inches.

(2) Accuracy shall be at least 2% of the full scale reading.

(3) Scale shall have at least 40 divisions.

(4) Full scale reading shall not be greater than five times the minimum normal indication.

B. Transmission Line Current and Voltage: Instruments indicating transmission line current or voltage shall meet the following specifications:

(1) Instruments having linear scales shall meet the requirements of A (1), (2), (3), and (4) above.

(2) Instruments having logarithmic or square law scales

(a) Shall meet requirements A (1) and (2) for linear scale instruments.

(b) Full scale reading shall not be greater than three times the minimum normal indication.

(c) No scale division above one-third full scale reading (in amperes) shall be greater than one-thirtieth of the full scale reading.

C. RF Instrument Scales: Radio frequency instruments having expanded scales.

(1) Shall meet requirements A (1), (2), and (4) for linear scale instruments.

(2) No scale division above one-fifth full scale reading (in amperes) shall be greater than one-fiftieth of the full scale reading.

(3) The meter face shall be marked with the words "Expanded Scale" of the abbreviation thereof (E. S.).

D. Instrument Replacements: No instruments indicating the plate current or plate voltage of the last radio stage or the transmission line current or voltage shall be changed or replaced without written authority of the Commission, except by instruments of the same maximum scale readings and accuracy. Requests for authority to use an instrument of different maximum scale reading and/or accuracy shall be made by letter or telegram giving the manufacturer's name, type number,

and full scale reading of the proposed instrument and the values of current or voltage the instrument will be employed to indicate. Requests for temporary authority to operate without an instrument may be made by letter or telegram stating the necessity therefor and the period involved.

E. ACCURACY: No required instrument, the accuracy of which is questionable, shall be employed. Repairs and recalibration of instruments shall be made by the manufacturer, or by an authorized instrument repair service of the manufacturer, or by some other properly qualified and equipped instrument repair service. In any event the repaired instrument must be supplied with a certificate of calibration.

F. RECORDING INSTRUMENTS: Recording instruments may be employed in addition to the indicating instruments to record the transmission line current or voltage and the direct plate current and/or direct plate voltage of the last radio stage, provided that they do not affect the operation of the circuits or accuracy of the indicating instruments. If the records are to be used in any proceeding before the Commission as representative of operation, the accuracy must be the equivalent of the indicating instruments and the calibration shall be checked at such intervals as to insure the retention of the accuracy.

G. IDENTIFICATION: The function of each instrument used in the equipment shall be clearly and permanently shown on the instrument itself or on the panel immediately adjacent thereto.

10. Auxiliary Transmitters

Auxiliary transmitters may not exceed the power rating or operating power range of the main transmitter, but need not conform to the performance characteristics specified by Section 8 A (2) to 8 A (5) inclusive. The subsequent portions of Section 8 apply to auxiliary transmitters.

11. Operating Power: Determination and Maintenance

A. DETERMINATION OF OPERATING POWER: The operating power of FM broadcast stations shall be determined by the indirect method. This is the product of the plate voltage (Ep) and the plate current (Ip) of the last radio stage, and an efficiency factor, F; that is:

$$\text{Operating power} = Ep \times Ip \times F$$

The efficiency factor, F, shall be established by the transmitter manufacturer for each type of transmitter for which he requests FCC approval, and shall be shown in the instruction books supplied to the customer with each transmitter. In the case of composite equipment the factor F shall be furnished to the Commission by the applicant along with a statement of the basis used in determining such factor.

B. MAINTENANCE OF OPERATING POWER: The operating power shall be maintained as near as practicable to the authorized operating power, and shall not exceed the limits of 5% above and 10% below the authorized power except in emergencies. In the event it becomes impossible to operate with the authorized power, the station may be operated with reduced power for a period of 10 days or less provided the Commission and the Inspector in Charge[5] of the district in which the station is located shall be notified in writing immediately thereafter and also upon the resumption of normal operating power.

12. Frequency and Modulation Monitors at Auxiliary Transmitters

Sections 3.252 and 3.253 require that each FM broadcast station have approved frequency and modulation monitors in operation at the transmitter. The following shall govern the installation of approved frequency and modulation monitors at auxiliary transmitters of FM broadcast stations in compliance with these rules:

In case the auxiliary transmitter location is at a site different from that of the main transmitter, an approved frequency monitor shall be installed at the auxiliary transmitter except when the frequency of the auxiliary transmitter can be monitored by means of the frequency monitor at the main transmitter. When the auxiliary transmitter is operated without a frequency monitor under this exemption, it shall be monitored by means of the frequency monitor at the main transmitter.

The licensee will be held strictly responsible for any center frequency deviation of the auxiliary transmitter in excess of 2,000 cycles from the assigned frequency, even though exempted by the above from installing an approved frequency monitor.

Installation of an approved modulation monitor at the location of the auxiliary transmitter, when different from that of the main transmitter, is optional with the licensee. However, when it is necessary to operate the auxiliary transmitter beyond two calendar days, a modulation monitor shall be installed and operated at the auxiliary transmitter. The monitor (if taken from the main transmitter) shall be reinstalled at the main transmitter immediately upon resumption of operation of the main transmitter.

In all cases where the auxiliary transmitter and the main transmitter have the same location, the same frequency and modulation monitors may be used for monitoring both transmitters, provided they are so arranged as to be readily switched from one transmitter to the other.

[5] See Appendix 3 of Part I of the Rules and Regulations for addresses of Field Offices.

13. Requirements for Type Approval of Transmitters [6]

Section 3.254 of the Rules and Section 8 of these Standards concern the design, construction and technical operation of FM broadcasting station equipment. In order to facilitate the filing of and action on applications for construction permits specifying equipment of standard manufacture, the Commission will approve, as complying with the technical requirements, such equipment by type, subject to the following conditions and in accordance with the following procedure:

A. APPROVAL BY FCC: Approval of equipment by the Commission is only to the effect that insofar as can be determined from the data supplied, the equipment complies with the current requirements of good engineering practice and the current technical Rules and Regulations of the Commission. The approval may be withdrawn upon subsequent inspection or operation showing the equipment is not as represented or does not comply with the technical Rules and Regulations of the Commission and the requirements of good engineering practice.

B. PROGRESS OF THE ART: Such approval shall not be construed to mean that the equipment will be satisfactory as the state of the art progresses and/or as the Rules and Regulations of the Commission may be changed as deemed advisable.

C. APPROVED DESIGN: Applicants specifying equipment of approved manufacture need not submit detailed descriptions and diagrams where the correct type number is specified provided that the equipment proposed is identical with that approved.

D. PATENTS: In passing on equipment, no consideration is given by the Commission to patent rights.

E. APPLICATIONS FOR APPROVAL: For approval of FM broadcast transmitters, manufacturers shall submit FCC Form 319 completed with respect to all pertinent sections (two sworn copies). In addition or included therein shall be the data set forth below, all of which shall be verified before a notary public.[7]

(1) Photographs or drawings, or any other evidence that construction is in

[6] Tentative Standard.

[7] In connection with its type approval of FM equipment, the Commission may send a representative to observe tests made by such equipment by the manufacturer.

accordance with the requirements of good engineering practice.

(2) Data and curves showing overall audio frequency response from 50 to 15,000 cycles for approximately 25, 50 and 100% modulation. Measurements shall be made on at least the following modulation frequencies: 50, 100, 500, 5,000, 10,000 and 15,000 cycles. This shall be plotted below a standard 75 microsecond pre-emphasis curve (see Fig. 3).

(3) Data on audio frequency harmonics for 25, 50 and 100% modulation for the fundamental frequencies of 50, 100, 400, 1,000 and 5,000 cycles. Data on audio frequency harmonics for 100% modulation for fundamental frequencies of 10,000 and 15,000 cycles. Measurements shall include harmonics to 30,000 cycles. (Measurements at 10,000 and 15,000 cycles at 25 and 50% modulation are not practical at this time, due to the de-emphasis in the measuring equipment.)

(4) Carrier hum and extraneous noise (AM and FM) generated within the equipment and measured as the level below 100% modulation.

(5) Means of varying output power to compensate for power supply voltage variations.

(6) Data and curves on mean frequency stability for variations in ambient temperatures over the ranges encountered in practice.

(7) Data and curves on frequency stability for variations in power supply voltage from 85 to 115% normal.

(8) Net sale price.

F. Non-Listed Power Ratings: In case any manufacturer decides to produce a 100-kw. transmitter and submit data on it for approval, or any power rating not listed as standard, he shall give notice to the Commission which will release by public notice the manufacturer's name and the standard power rating of the transmitter to be produced at least 6 months prior to the delivery date or completion of such transmitter.

14. Requirements for Type Approval of Frequency Monitors [8]

Section 3.252 of the Rules requires each FM broadcast station to have in operation, at the transmitter, an approved frequency monitor independent of the frequency control of the transmitter. The frequency monitor shall be approved by the Commission and shall have a stability and accuracy of at least one-half (± 1,000 cycles) of the permitted frequency deviation of the FM broadcast station. Visual indication of the operating frequency shall be provided.

A. General Requirements: In general a frequency monitor for FM broadcast stations requires a stable source of radio frequency energy whose frequency is accurately known and a means of comparing the transmitter center frequency with this stable source. The visual indicator is calibrated to indicate the deviation of the transmitter center frequency from the frequency assigned.

Approval of a frequency monitor for FM broadcast stations will be considered on the basis of data submitted by the manufacturer. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details (two sworn copies).

In approving a frequency monitor based on these tests and specifications, the Commission merely recognizes that the type of monitor has the inherent capability of functioning in compliance with Section 3.252, if properly constructed, maintained and operated. The Commission accepts no responsibility beyond this and further realizes that monitors may have a limited range over which the visual indicator will determine deviations. Accordingly, it may be necessary that adjunct equipment be used to determine major deviations.

No change whatsoever will be permitted in the monitors sold under approval number issued by the Commission except when the licensee or the manufacturer is specifically authorized to make such changes. When it is desired to make any change, either mechanical or electrical, the details shall be submitted to the Commission for its consideration.

Approval is given subject to withdrawal if the unit proves defective in service and cannot be relied upon under usual conditions of maintenance and operation encountered in the average FM broadcast station. Withdrawal of approval means that no further units may be installed by FM broadcast stations for the purpose of complying with Section 3.252; however, this will not affect units already sold unless it is found that there has been an unauthorized change in design or construction or that the material or workmanship is defective.

B. General Specifications: The general specifications that frequency monitors shall meet before they will be approved by the Commission are as follows: [9]

(1) The unit shall have an accuracy of at least ± 1,000 cycles under ordinary conditions (temperature, humidity, power supply variations and other conditions which may affect its accuracy) encountered in FM broadcast stations throughout the United States, for any channel within the FM broadcast band.

(2) The range of the indicating device shall be at least from 2,000 cycles below to 2,000 cycles above the assigned center frequency.

(3) The scale of the indicating device shall be so calibrated as to be accurately read within at least 100 cycles.

(4) Means shall be provided for adjustment of the monitor indication to agree with an external standard.

(5) The monitor shall be capable of continuous operation and its circuit shall be such as to permit continuous monitoring of the transmitter center frequency.

(6) Operation of the monitor shall have no deleterious effect on the operation of the transmitter or the signal emitted therefrom.

C. Approval of Frequency Monitors: Tests to be made for approval of FM broadcast frequency monitors — The manufacturer of a monitor shall submit data on the following at the time of requesting approval:

(1) Constancy of oscillator frequency, as measured several times in one month.

(2) Constancy of oscillator frequency when subjected to vibration tests which would correspond to the treatment received in shipping, handling and installing the instrument.

(3) Accuracy of readings of the frequency deviation instrument.

(4) Functioning of frequency adjustment device.

(5) Effects on frequency and readings, of the changing of tubes, of voltage variations, and of variations of room temperature through a range not to exceed 10° to 40° C.

(6) Response of indicating instrument to small changes of frequency.

(7) General information on the effect of tilting or tipping or other tests to determine ability of equipment to withstand shipment.

Various other tests may be made or required, such as effects of variation of input from the transmitter depending upon the character of the apparatus.

Tests shall be conducted in such a manner as to approximate actual operating conditions as nearly as possible. The equipment under test shall be operated on any channel in the FM broadcast band.

15. Requirements for Type Approval of Modulation Monitors [10]

Section 3.253 requires each FM broadcast station to have an approved modulation monitor in operation at the transmitter. This monitor may or may not be a part of the FM broadcast frequency monitor. Approval of a modulation monitor for FM broadcast stations will be con-

(CONTINUED ON PAGE 82)

[8] Tentative Standard.

[9] In connection with its type approval of FM equipment, the Commission may send a representative to observe tests made of such equipment by the manufacturer.

[10] Tentative Standard.

SPOT NEWS NOTES

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

Clear Channel Hearing: Has been postponed by FCC from October 23rd to January 14th. If, as now expected, additional frequencies are granted for high-power FM stations, it may be found that there is no justification for special clear channel AM provisions.

Freeman A. Spindell: Appointed chief engineer of Browning Laboratories, Inc., Winchester, Mass. A graduate of Tufts College Engineering School '38, he spent three years as an instructor of electronics before joining Browning Laboratories as a designer of radar and radar test equipment.

I.R.E.: Rochester Fall Meeting will be held at Hotel Sheraton, November 12th and 13th. A most interesting schedule of papers has been announced.

The annual Winter Technical Meeting at Hotel Astor, New York City, January 23rd to 26th, will combine an ambitious program of papers with exibits by about 150 radio manufacturers.

Telegraph Business: Western Union has entered into a license agreement with Major E. H. Armstrong for the use of his FM patents in connection with projected radio relay systems to replace the use of wire lines. License grant runs to 1956.

Capt. Pierre H. Boucheron: Sales manager of Farnsworth Television & Radio before he was called into the Navy in 1941, is back at Farnsworth as director of public relations.

Chicago: Hallicrafters Company has started erection of a $600,000 one-story plant of 175,000 square feet at 5th and Kostner Avenues, Chicago.

William J. Larkin: Named engineering manager of National Company, Malden, Mass. After receiving his M.S. degree at M.I.T. in 1934, he joined the engineering department at National, and later was made chief mechanical engineer. He is largely responsible for the unusual design features of the new Navy receiver recently put into production at the National plant.

Boston: All conversations over the Fire Alarm Divisions radio system are now recorded on equipment manufactured by Sound Scriber Corporation, New Haven, Conn.

O.P.A.: Delay in settling price schedules on radio parts and sets is certainly deplorable, but it has kept cheap AM sets of only prewar performance from flooding the market while engineering of postwar FM-AM models is being finished.

Jansky & Bailey: FCC has approved the sale of their FM developmental station W3XO, Washington, D. C., to WINX, Inc., owned by *The Washington Post*. Price was $75,000.

WHAT IS R.M.A. POLICY?

ON August 28th, FM station WBCA ran a full-page advertisement in the "Schenectady Gazette," carrying the headline, "If you buy a new radio without FM you'll obviously have an obsolete radio!" Leonard Asch, president of Capitol Broadcasting Company, which owns WBCA, sent copies of that advertisement to a number of people. We received a copy at FM AND TELEVISION, and reproduced it last month on our News Picture page. R. C. Cosgrove, vice president of Crosley Corporation and president of the Radio Manufacturers Association, received a copy, too.

The advertisement quoted enthusiastic comments from G.E., Stromberg, Zenith, Philco, RCA, Freed, and Motorola. Yet here is what RMA president Cosgrove wrote Mr. Asch, on the stationery of the Radio Manufacturers Association, concerning the advertisement and the quotations it contained:

October 2, 1945

Mr. Leonard L. Asch, President
Capitol Broadcasting Co. Inc.
Schenectady 5, New York

Dear Mr. Asch:

Unfortunately, I have been away from the plant, almost constantly, since receiving your letter of August 28th, regarding your advertising campaign on FM sets, but I have had it with me and have talked to a number of people about it.

I wonder if you realize that the vast majority of radio sets will not have FM in them because the start of sets with Frequency Modulation will be about $60.00 retail, and more than half of the industry's volume is below this level?

Your statement to the effect that if you buy a new radio without FM you obviously will have an obsolete radio is misleading because this is not so.

Crosley, like all other manufacturers, will have Frequency Modulation in its radio models that are priced at a level to provide for this service.

I am wholeheartedly supporting the FM program, so don't get me wrong, but I think the kind of advertising you are doing is detrimental to the industry. What is the sense of confusing people and telling them that unless they get a certain type radio set they will have an obsolete model when over half the industry's production will not have FM in it?

Frankly, I think the advertising is ill-considered and damaging. I don't know whether the companies you have identified in your advertisement reported the program as you have outlined it, or whether you have just taken excerpts from statements without having a relationship to the purposes for which you are using them.

If you have this advertising money to spend, it seems too bad it can't be spent in a constructive way.

Yours very truly,
signed R. C. Cosgrove
President
Radio Manufacturer's Ass'n

Ray C. Ellis: Under whose direction the W.P.B. radio-radar division functioned so successfully, has been elected vice president of Raytheon Manufacturing Company, Newton, Mass.

Chicago: A new plant has been purchased by Communications Parts at 1101 North Paulina Street. Facilities will include machine shop, coil winding, assembly, and laboratory.

Subscription Radio: Plans for pig-squeal radio on rental basis have been abandoned. Project was headed by William Benton, recently appointed Assistant Secretary of State.

Boston: The *Boston Herald Traveler* has purchased AM station WHDH from Matheson Radio Company, subject to FCC approval, at a price of $850,000. It is understood that the newspaper will take over the Matheson FM application, now pending.

Maj. General William H. Harrison: Chief of the Signal Corps' procurement and distribution service since July 7, 1943, has retired and will return to A.T. & T. Where, before joining the Signal Corps, he was vice president in charge of operations and engineering.

Syracuse: Construction has started on G.E's. $10,000,000 radio and electronics plant. The buildings, to be laid out like a college campus on a 155-acre-park, will total over 1,000,000 square feet.

P.T.M.: First public demonstration of Federal Telephone & Radio Corporation's pulse time modulation was given on September 27th, when two groups of 24 persons talked simultaneously over a relay circuit from 67 Broad Street, New York to Telegraph Hill, near Hazlet, N. J., to Nutley, N. J., and back again to New York.

T.B.A.: Newest members are Westinghouse Electric Corporation, represented by C. J. Burnside; Syracuse University, represented by Kenneth Bartlett; and Western Reserve University, represented by Barclay S. Leathern.

Philadelphia: WFIL and WMIL-FM, affiliates of ABC, have been sold by Lit Brothers to the *Philadelphia Inquirer*. Roger W. Clipp will continue as general manager. There will be no changes in the station personnel.

D. E. Replogle: Has celebrated the 10th birthday of Electronic Mechanics, Inc., which he founded in 1935, to manufacture glass-bonded mica insulation under the trade name of Mykroy.

Chicago: Construction is nearly completed on a 3-story building which will house the

(CONCLUDED ON PAGE 80)

NEWS PICTURE

HERE, on the top floor, is the new publication office of *FM* AND TELEVISION Magazine. Occupying nearly 2,000 square feet, we have adequate space for editorial work, correspondence, drafting, circulation, addressing machinery, and mailing. Great Barrington, in the southwestern corner of Massachusetts, is the center of a section known for its fine estates and beautiful Colonial architecture. Equally distant from our New York office and Concord, N. H., where this publication is printed, these pleasant surroundings afford an ideal location for our headquarters.

CHANNEL CHART FOR FM BROADCASTING

This Chart Shows the Channel Numbers Assigned to FM Broadcast Frequencies by the FCC and the Type of Service to Be Performed on Each Channel

Ch. No.	Mc.	Svc.	Stations	Ch. No.	Mc.	Svc.	Stations
1	88.1	E		51	98.1	M	
2	88.3	E		52	98.3	M	
3	88.5	E		53	98.5	M	
4	88.7	E		54	98.7	M	
5	88.9	E		55	98.9	M	
6	89.1	E		56	99.1	M	
7	89.3	E		57	99.3	M	
8	89.5	E		58	99.5	M	
9	89.7	E		59	99.7	M	
10	89.9	E		60	99.9	M	
11	90.1	E		61	100.1	M	
12	90.3	E		62	100.3	M	
13	90.5	E		63	100.5	M	
14	90.7	E		64	100.7	M	
15	90.9	E		65	100.9	M	
16	91.1	E		66	101.1	M	
17	91.3	E		67	101.3	M	
18	91.5	E		68	101.5	M	
19	91.7	E		69	101.7	M	
20	91.9	E		70	101.9	M	
21	92.1	M		71	102.1	M	
22	92.3	M		72	102.3	M	
23	92.5	M		73	102.5	M	
24	92.7	M		74	102.7	M	
25	92.9	M		75	102.9	M	
26	93.1	M		76	103.1	M	
27	93.3	M		77	103.3	M	
28	93.5	M		78	103.5	M	
29	93.7	M		79	103.7	M	
30	93.9	M		80	103.9	M	
31	94.1	M		81	104.1	C	
32	94.3	M		82	104.3	C	
33	94.5	M		83	104.5	C	
34	94.7	M		84	104.7	C	
35	94.9	M		85	104.9	C	
36	95.1	M		86	105.1	C	
37	95.3	M		87	105.3	C	
38	95.5	M		88	105.5	C	
39	95.7	M		89	105.7	C	
40	95.9	M		90	105.9	C	
41	96.1	M		91	106.1	C1, F2	
42	96.3	M		92	106.3	C1, F2	
43	96.5	M		93	106.5	C1, F2	
44	96.7	M*		94	106.7	C1, F2	
45	96.9	M		95	106.9	C1, F2	
46	97.1	M*		96	107.1	C1, F2	
47	97.3	M		97	107.3	C1, F2	
48	97.5	M*		98	107.5	C1, F2	
49	97.7	M		99	107.7	C1, F2	
50	97.9	M*		100	107.9	C1, F2	

*Indicates channel available for assignment in the Mt. Washington area for a wide-coverage station
E indicates channel for Educational station
M indicates channel for Metropolitan station
C indicates channel for community station
C1, F2 indicates channel for community station in Area No. 1, or Facsimile station in Area 2

SELECTIVE CALLING FOR EMERGENCY COMMUNICATIONS

A Method of Overcoming Some of the Objectionable Features of Present Communications Systems

BY GILBERT G. BROWN*

WHEN the Federal Telephone and Radio Corporation, manufacturing associate of I. T. & T., entered the mobile communications field, it was in the fortunate position of having an engineering personnel capable of solving the most difficult communications problems, and ready, with an unprejudiced point of view, to tackle the job of producing equipment to meet requirements dictated by the experience of those who, during the war, have had to handle greatly increased traffic with prewar apparatus.

Going into the field to discuss present and future requirements with members of APCO, ESPRL, IMSA, NEAFC, ATA, and similar organizations, we asked them about conditions which have introduced new problems of operation, and improvements in apparatus design which are indicated by their experience.

What Operators Want ★ When the replies were tabulated, their similarity gave the impression that they had come from a mere handful of operators, rather than from many hundreds, in all sections of the Country.

Our analysis showed that the following points were mentioned most frequently:

1. Squelch circuits on receivers are opened by signals other than those from the associated headquarters transmitter.
2. Receivers have insufficient selectivity.
3. Two services, such as fire and police, cannot share the same channel without interference.
4. Substantial reduction of battery current drain is needed.
5. Higher intelligibility is desirable with wider frequency response and greater audio output from the receivers.
6. These improvements must not be attained by sacrificing any other factors of performance.

Each of these specifications is met entirely or in part by the Federal mobile and headquarters equipment shown in the accompanying illustrations. This has been done by the development of the "Selecto-Call" system, and by new refinements of electrical and mechanical design.

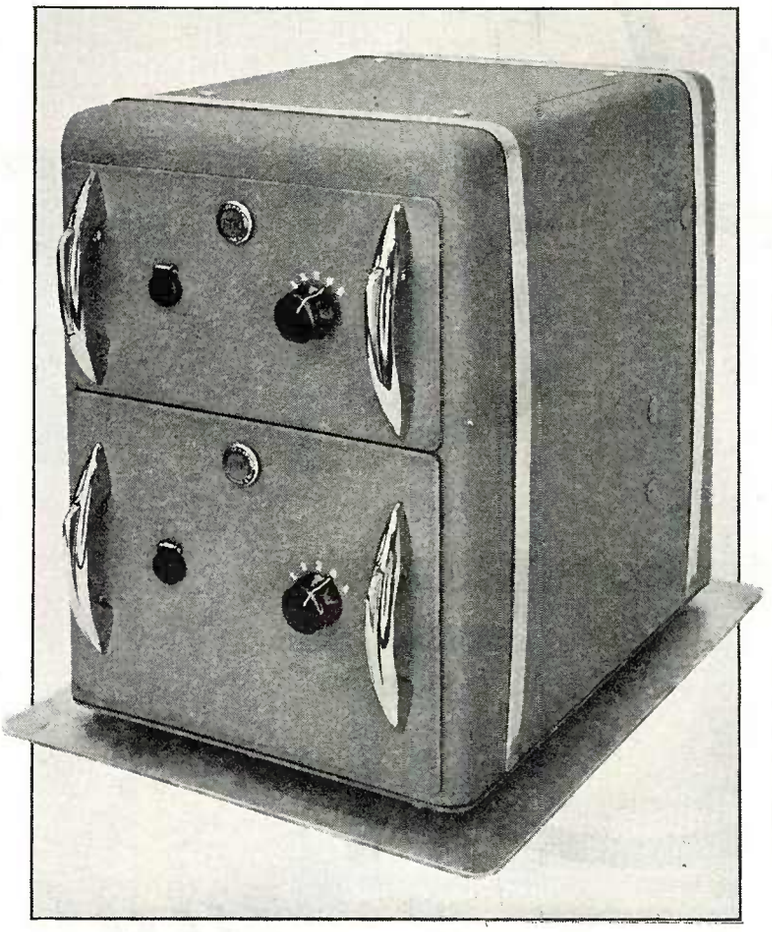


FIG. 1. THIS COMPLETE TRANSMITTER-RECEIVER IS ONLY 12 INS. HIGH. CONNECTIONS ARE MADE WHEN UNITS ARE INSERTED

The Need for Squelch Control ★ The Selecto-Call system, for which patents have been applied, involves the use of a squelch circuit which permits the output tube of the receiver to be off at all times until an audio-frequency tone of a specific frequency actuates a tuned-reed relay in the receiver. To make clear the special advantages of this new system, let us review the operation of receivers using the conventional type of squelch.

Every FM receiver used for police, fire, or other emergency services employs some kind of a squelch circuit to mute the output except during transmission on the frequency to which the receiver is tuned. One of the most annoying defects of receivers now in use, employing the conventional type of squelch circuit, has been the inability to distinguish between *wanted* and *unwanted* signals.

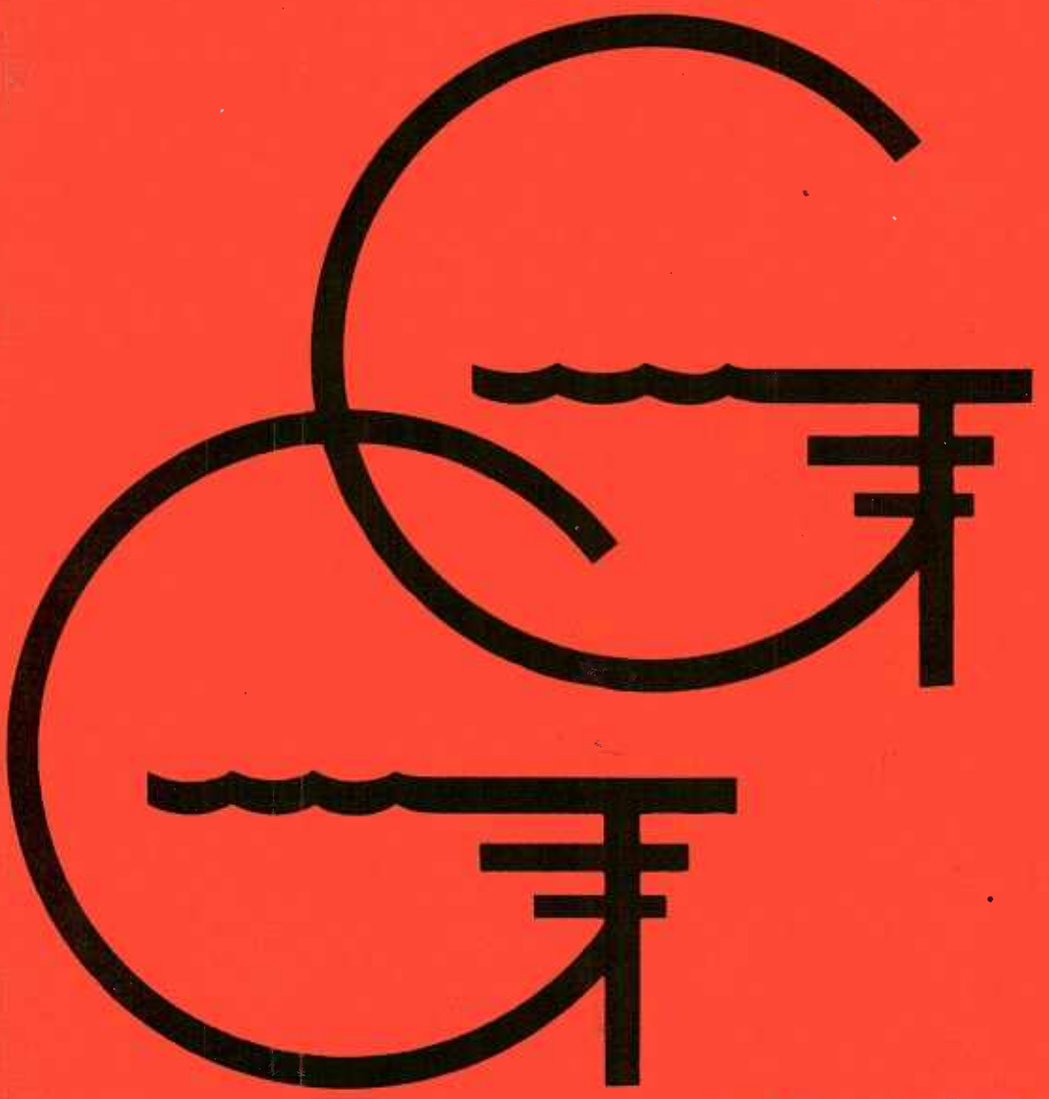
Many cases are known in emergency communication circles where FM transmitters are over-modulated, and the wide deviation resulting has spread into adjacent channels, opening up the squelch circuits of receivers, but not delivering a signal of sufficient strength to produce quieting. The result is a terrific blast of noise from the loud speaker which has a most aggravating and annoying effect upon those listening to the instrument.

This noise would be present when the squelch is opened by transmission from the car's headquarters station except for the fact that the strong carrier produces a DC voltage across the plate of a diode, and this voltage, which is the AVC voltage, is used as a negative bias on one or more variable-mu tubes in the RF part of the circuit.

In police radio communications, the receiver in the patrol car is usually on twenty-four hours a day. However, the transmitter at the headquarters station may be in operation only a few times a day and then only for a few seconds at a time. The sensitivity of a good receiver is such that a signal input of one-half microvolt is sufficient to open the squelch circuit. Therefore, with this tremendous sensitivity and no quieting signal coming from the fixed station transmitter, it is

*Sales Manager, Mobile Communications Section, Federal Telephone & Radio Corporation, 200 Mt. Pleasant Street, Newark, N. J.

What does



mean?

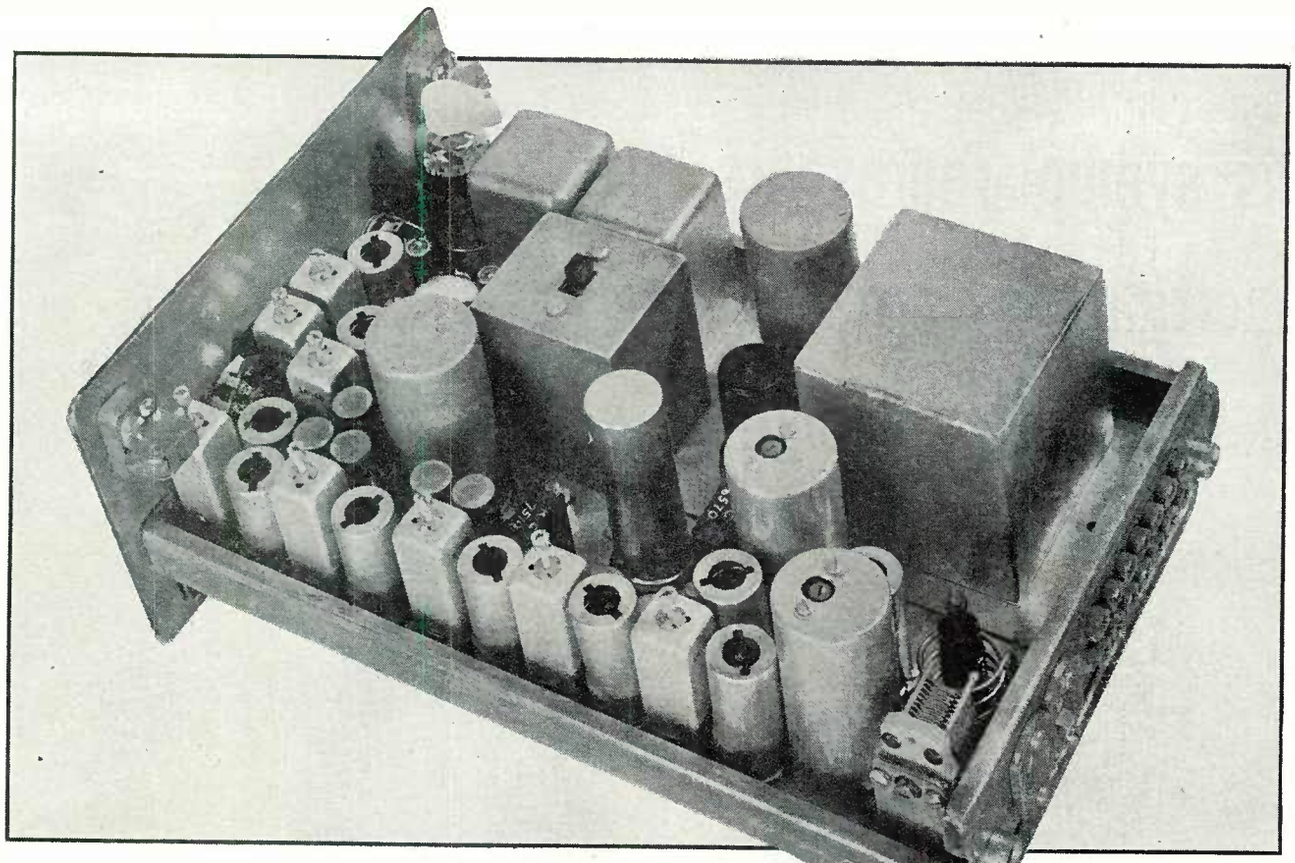


FIG. 2, ABOVE. HERE IS THE RECEIVER CHASSIS. THE SELECTO-CALL RELAY AND SWITCH ARE MOUNTED IN THE SQUARE CAN, WITH THE VIBRATING REED RELAY IN THE ADJACENT ROUND CAN

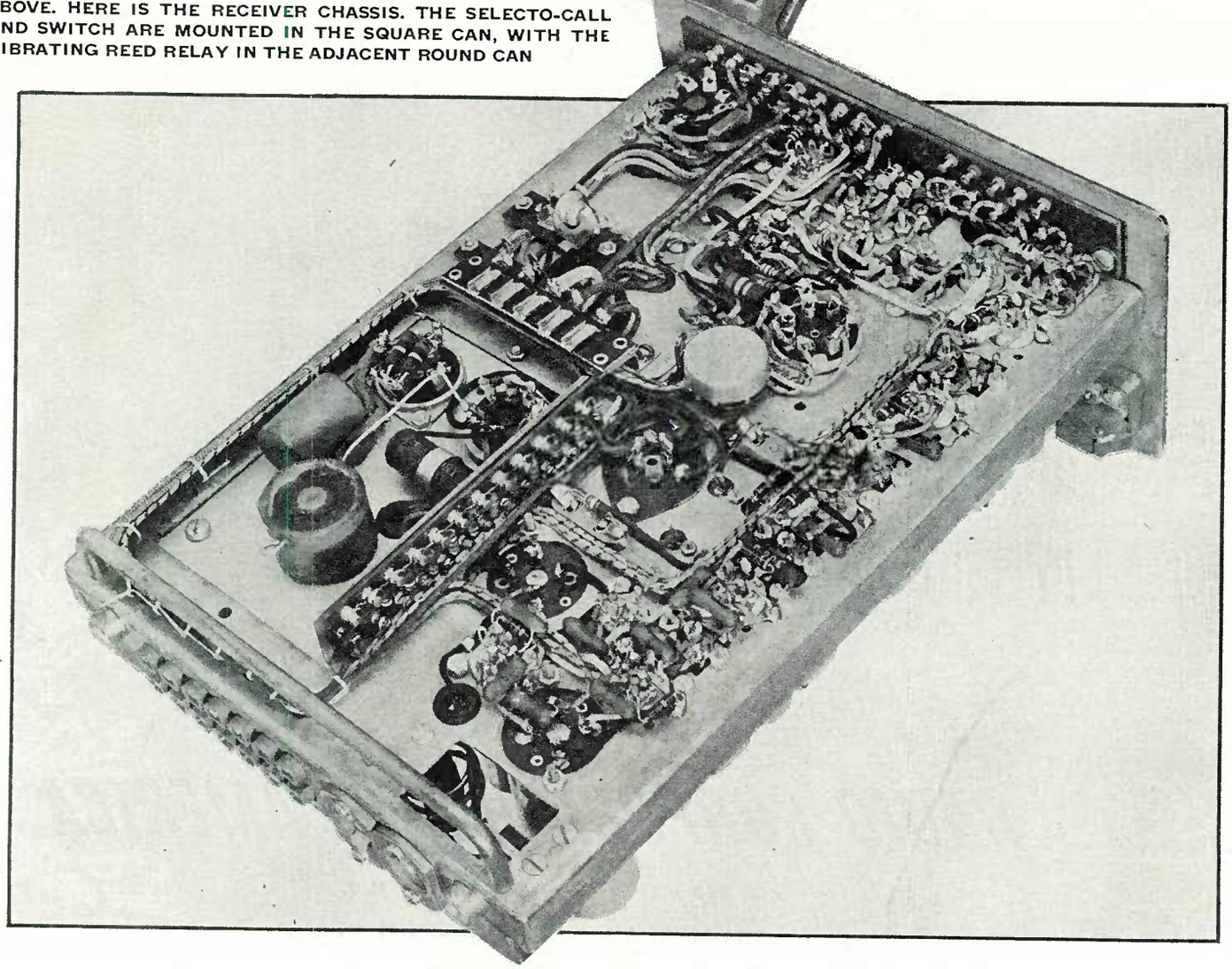


FIG. 3. VIEW OF THE BOTTOM OF THE RECEIVER CHASSIS. NOTE THE ACCESSIBILITY OF THE COMPONENTS, AS A RESULT OF TURNING THE SIDES OF THE CHASSIS UPWARD. A GUARD RAIL AT THE REAR SUPPORTS THE CHASSIS WHEN IT IS ON THE BENCH

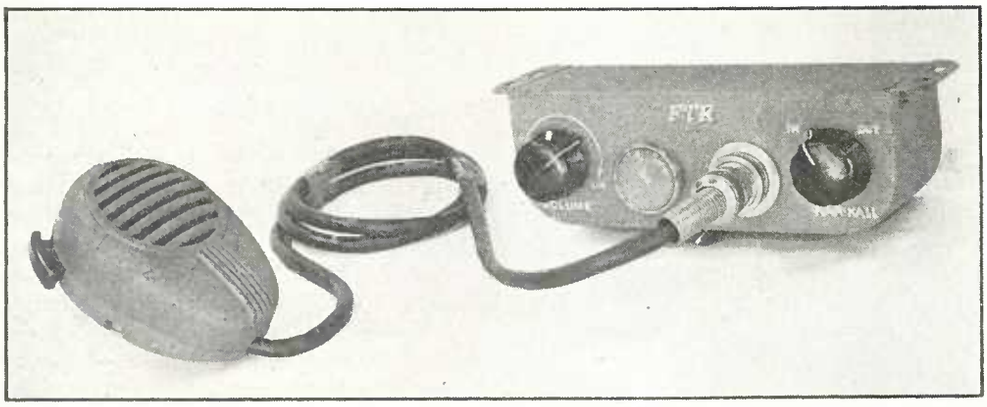


FIG. 5. HAND MICROPHONE AND DASHBOARD CONTROL WITH SELECTO-CALL SWITCH

necessary to mute the receiver in some manner. This is done by amplifying the noise picked up on the receiver, rectifying it and using this DC voltage to bias one of the audio tubes to cut off. When a carrier is applied to the mute circuit of the receiver, it produces a quiet signal which removes the voltage from the audio tube and permits the audio circuit to become operative. There are several ways of obtaining this so-called squelch action, but the results are the same.

These conventional squelch circuits have certain very pronounced defects. The most serious of these is that an adjacent channel or an alternate channel signal which deviates from its true frequency may produce sufficient carrier signal to kick open the squelch circuit, but not sufficient signal to produce a quieting action. In the report on Proposed Systems Standards prepared by Frank Bramley, Chief Radio Engineer of Connecticut State Police, for the Eastern States Police Radio League, it is noted that present day FM transmitters, operating on frequencies as much as ten channels removed from the receiver frequency, sometimes open the squelch on receivers for many miles around. The writer has ridden in police cars where the squelch circuit has been kicked open a dozen times in an hour. Since the greater portion of this interference is caused by signals on other channels and skip-distance effects, it is obvious that the solution lies in designing a squelch which cannot be opened by any carrier, regardless of its frequency, unless it originates at one specific transmitter.

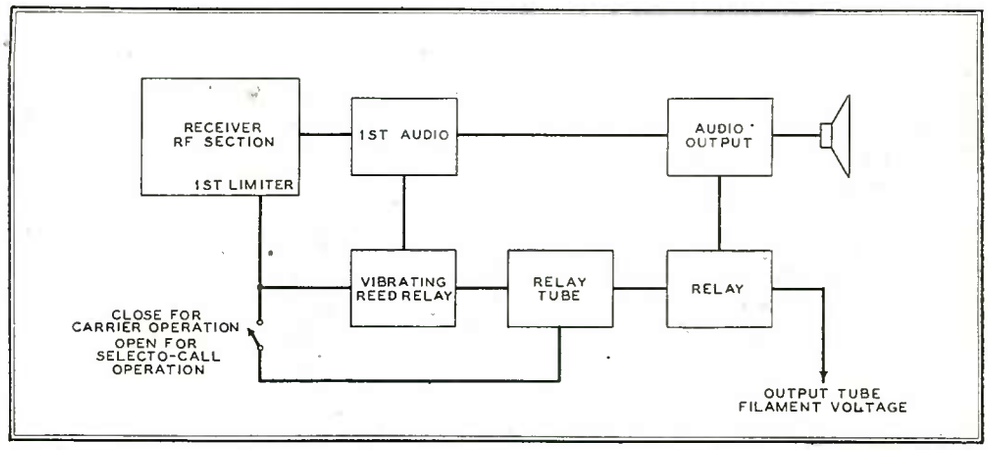
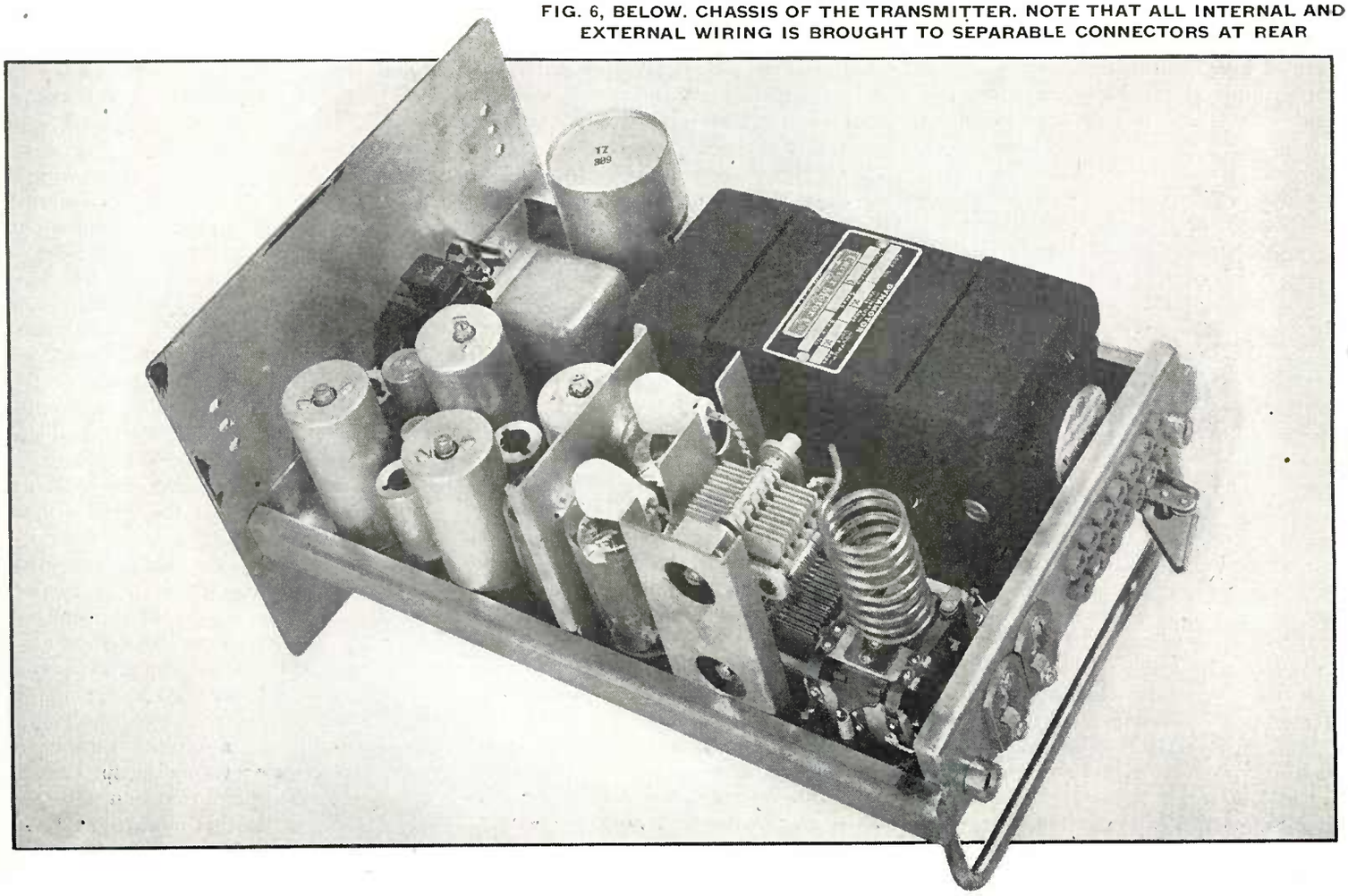


FIG. 4, ABOVE. BLOCK DIAGRAM SHOWING HOW THE VIBRATING RELAY OPERATES THE OUTPUT TUBE RELAY WHICH IS HELD CLOSED DURING CARRIER RECEPTION

FIG. 6, BELOW. CHASSIS OF THE TRANSMITTER. NOTE THAT ALL INTERNAL AND EXTERNAL WIRING IS BROUGHT TO SEPARABLE CONNECTORS AT REAR



Selecto-Call System ★ The Selecto-Call system is so designed that the squelch circuit permits the output tube of the receiver to be off at all times except when a signal is being transmitted from its associated headquarters transmitter.

During experimentation with various circuits, a receiver was designed in which the carrier turned on the output tube. This proved more desirable than the conventional squelch, but had one serious drawback. Carriers of unwanted stations which were on the frequency for which this receiver was tuned would also operate the output tube.

A step forward was made when an audio note, transmitted from the headquarters station, operated a tuned reed in the receiver to close a circuit and hold up a relay as long as the audio note was being received. This was satisfactory except that the filters required to remove this tone from the audio output were both bulky and expensive.

Further effort resulted in the development of the Selecto-Call system, by which important improvements were achieved. In this system the coil of the vibrating reed is placed in the audio driver tube circuit. When an audio note is transmitted by the headquarters station, it energizes the vibrating reed system in the receiver. If the note is of the frequency to which the reed is tuned, the reed vibrates at its natural frequency, and closes a contact which operates a relay. This relay closes the filament circuit of an instant-heating output tube. The moment the relay has been closed, a voltage derived from the carrier is used to hold it in the closed position. Therefore, continued transmission of the audio note is not necessary, thus eliminating the need for filters. Since these operations take place incredibly fast, the audio signal need be transmitted for only one second or less. The receiver then remains in an operating condition until the carrier from the fixed station has been turned off.

Operation of the Selecto-Call ★ The Selecto-Call can be set up for either carrier-controlled operation or for selective-calling operation. In the carrier-controlled operation, it resembles somewhat the so-called "codan" receiver in use a number of years ago. When operated as a selective-calling device, the system permits positive selection of specific receivers or groups of receivers to the exclusion of others.

In the block diagram, Fig. 4, the RF section of a typical FM receiver is shown together with a relay tube, a relay, and a tuned reed interconnected to the first audio amplifier and the output tube in such a manner as to produce the results outlined above.

The operation of the system on carrier-control does not require the use of the tuned reed. Essentially, its performance is as follows: When a carrier is received, the grid voltage of the first limiter tube increases. A DC amplifier tube and a relay tube are affected by this voltage increase in such a manner that a relay in the plate circuit of the relay tube is operated. This relay closes a set of contacts which complete the filament circuit of the quick-heating output tube, and the receiver is put in operating condition. A carrier signal of 0.3 microvolt at the receiver input terminals will cause this circuit to function and operate the relay. An additional set of contacts on the relay serves to feed voltage from the limiter through the relay coil, thus holding it closed as long as the carrier continues to be received.

When the carrier drops out, the grid voltage of the first limiter tube decreases, of course, to its normally low, no-signal value. Consequently, the relay becomes de-energized, the output tube is cut off, and the receiver is muted. This saves 50% of the standby current. The receiver output is then in a condition to be turned on again by the reception of a carrier of the frequency to which the receiver is tuned.

When the receiver is operated in the selective-calling condition, the same circuit is used with the addition of a vibrating-reed relay, which responds to only one audio frequency. This relay is so connected that the contacts are in series with the voltage from the grid of the first limiter tube and the relay tube.

When a carrier is received with the carrier-switch in the open position, the voltage on the grid of the first limiter tube rises as before but now, since the switch is open, no effect is produced upon the relay tube and the relay does not operate. Thus the final audio amplifier remains inoperative and the receiver continues muted.

If, however, an audio tone of the frequency to which the vibrating reed is tuned is impressed upon the carrier, it will be amplified by the first audio tube from the discriminator output and will actuate the reed of the vibrating-reed relay. When this occurs, contacts on the reed assembly close momentarily and complete the circuit to the relay tube, causing it to operate in the same manner as before and close the relay which turns on the final amplifier tube, thus putting the receiver in an operating condition. The relay is held in this position by the carrier and will, of course, drop out when the carrier is no longer present. Then re-cycling takes place and the receiver is once more muted, ready for the next signal to be received.

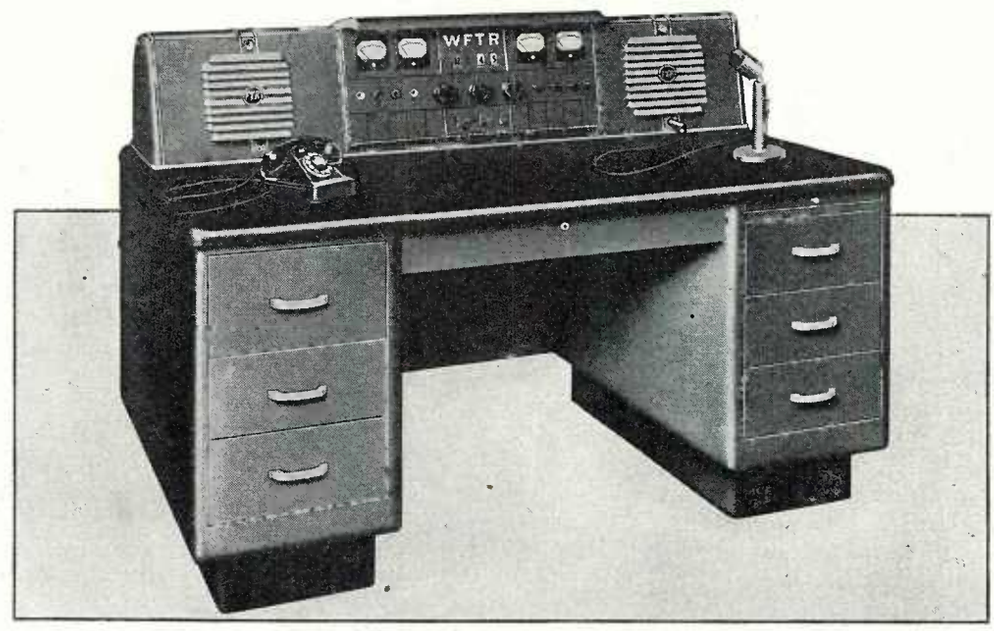


FIG. 7. OPERATOR'S DESK AND CONTROL CONSOLE FOR USE AT HEADQUARTERS

The obvious advantage in using a carrier-induced voltage to hold the relay in an operating position, once it has been closed, is that the audio tone can be discontinued and the output will still remain on. Expensive and bulky filter circuits are thus eliminated, and a positive re-cycling action is assured. The relay controlling the output tube will be kept closed and the output of the receiver will remain on as long as a carrier is being received, and will go off only when the carrier is no longer being transmitted.

In order to provide manual operation of the relay, in cases where the audio tone may not, for some reason, be transmitted, a switch is installed on the dash control box. Since one side of the relay is connected to the receiver plate power supply, this switch merely completes the circuit to ground through a suitable resistor and the relay closes, operating the output tube irrespective of the fact that the audio tone may be lacking, or that no carrier is being

received. In this way, a positive check on receiver action is always available to the operator at a moment's notice and by the mere flick of a switch.

Careful engineering has produced a positive triggering action in this circuit, and a sensitivity of operation is attained that is substantially uniform with the normally-encountered changes of battery voltage and the plate supply voltage.

This system has a unique and interesting advantage in that only a tone of predetermined audio frequency is able to put the receiver into operation.

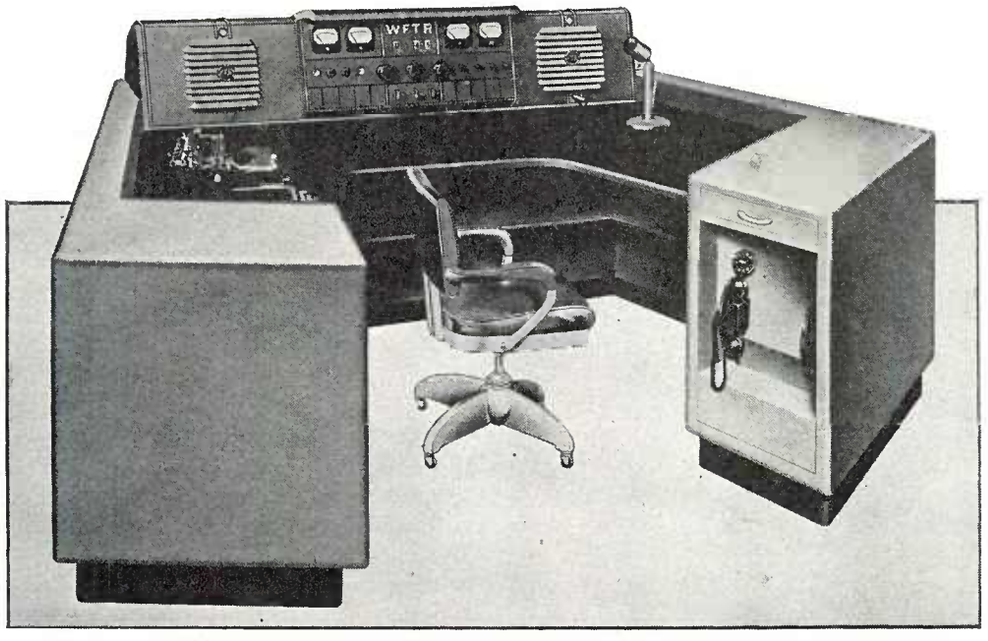


FIG. 8. A MORE ELABORATE CONTROL DESK FOR USE WHERE TRAFFIC IS HEAVY

The Selecto-Call does not necessarily increase the selectivity of a receiver. However, since one of the reasons more selectivity is desired is to help prevent squelch circuit operation by undesired transmissions, it is evident that the Selecto-Call has, at least partially, met the need for increased selectivity.

When two services, such as fire and police, wish to use the same frequency channel without interference, the Selecto-Call system works admirably. It is simply necessary to use reeds tuned to one particular audio frequency for all police car receivers, and reeds tuned to a slightly different frequency — at least 7 or 8 cycles above or below the first — for the fire department receivers. Each service can then call its own cars, and receivers in cars operated by the other service will not respond.

This feature is especially desirable for cities of less than 150,000 population, since the FCC requires these cities to use a single, shared channel for both the police and fire department communications.[1]

Approximately 20 call selections can be made by using vibrating reeds tuned to different frequencies of separate groups of cars. Where several hundred individual selections are required, as in bus or taxi dispatching, a unit having three individually-tuned reeds is plugged into the receiver.

The system permits allocation not only of alternate channels, but also of adjacent channels in the same geographic location. Tests have been conducted which indicate that even identical channels can be allocated in any desired geographical pattern provided the signal received from the wanted station is at least 2-to-1 greater than the unwanted station. For example, let us assume that in a large city an FM communications system is operating on 37.55 kc., using a conventional type of squelch system with an average of 4 microvolts received at the input terminal of the mobile receiver when it is operated on the fringe of the service area, and that in a nearby, small city a frequency of 37.55 kc. is also allocated. The following would happen: Whenever the smaller city's police transmitter went on the air, a signal strength in the large city of as little as one-half a microvolt would open the squelch system and cause interference.

Now let us assume a Selecto-Call installation in the same locations, with the frequency cited above. The police department in the large city would be allocated an audio note of 180 cycles, and 170 cycles to the police department in the small city. Any other combination of frequencies could be used, provided they are spaced 8 or 10 cycles. The police department in the small city could lay down a signal strength in the large city of any magnitude whatsoever and it would not cause their receivers to function. Similarly, transmission from the large city would not be heard from receivers operated by the small city.

[1] See FCC Circular No. 84.

In approaching the problem of battery current drain, extremely heavy in existing mobile receivers, it was found that the output tube accounted for approximately 50% of the total receiver current drain. This problem is partially solved by the Selecto-Call system because, as explained above, the output tube of the receiver is off except when its associated headquarters station is actually on the air. Because of this, an output tube of higher power can be used and still achieve the objective of low average current drain from the car battery.

General Description ★ The complete mobile transmitter and receiver assembly is shown in Fig. 1, with details of the receiver in Figs. 2 and 3, the transmitter in Fig. 6, and the control unit in Fig. 5. The dustproof, shock-mounted case is only 9⅝ ins. wide, 11⅞ ins. high, and 13½ ins. deep. Thus the radio equipment takes up very little floor space in the baggage compartment and, because the case is high, there is less likelihood that chains and other spare gear will be dropped on it.

If space limitations do not allow sufficient height for the standard case, a special design is available in which the receiver and transmitter are carried side-by-side. Such conditions have been encountered in busses and service trucks operated by public utilities.

Either the transmitter or receiver unit can be removed from the case instantly. When the handles on either unit are pulled forward, the spring-loaded locks on each side are released, and the chassis slides out. As shown in Figs. 2, 3, and 6, all connections, including the coaxial antenna lead, run to the female halves of separable connectors at the rear. All inter-unit wiring is inside the case, between the male parts of the connectors, and is permanent.

Thus, if either transmitter or receiver requires servicing, the unit can be removed and another put in its place in a matter of seconds, without the use of tools. The IF transformers and other components of the receiver can be adjusted while the receiver is in place by removing the top of the case. When the cover is removed, a light is switched on automatically, and gives adequate illumination for inspection and servicing. The cover is sealed by a moisture-tight gasket.

Battery and control cables, furnished with the equipment, are securely and permanently fastened to a terminal board which carries the plug-in connections for the antenna, control circuits, and power supply for both the receiver and transmitter. Protective fuses for both units are also located on the terminal board, with extra fuses mounted inside the case. The terminal board can be removed entirely

for servicing, if necessary.

A further aid to quick servicing lies in the use of an automatic polarizing switch on the battery power line. This makes it possible to exchange a unit from a car having the negative side of the battery at ground potential, or vice versa. This automatic polarizing feature is possible because the battery cables are properly connected during the initial installation of the equipment. The automatic polarizing switch, a part of every transmitter chassis, is automatically put in the correct operating position when the chassis is inserted in the housing.

A metering jack and a switch are located on the front panel of each unit, as shown in Fig. 1. To check the alignment of any stage of the receiver or transmitter, a milliammeter is plugged into the jack. The metering switch selects, in turn, the various stages for measurement and test. This feature makes it possible to determine quickly the location of a failure in any circuit.

The sides of the chassis are bent up, unlike conventional designs. All components are easily accessible, because the bottom of each chassis is flat and unobstructed by the sides. A guard rail at the rear, under the chassis, makes it possible to lay each unit on the work bench without damage to the equipment.

The shock mounts upon which the housing rests perform a dual service. In addition to absorbing vibration and shock, they raise the entire assembly off the floor, so that any water seeping into the luggage compartment will have no effect upon the apparatus.

The dash control, Fig. 5, is designed with rounded corners to prevent injury to the driver when entering or leaving the car. The pilot light jewel can be removed to replace the bulb. When the receiver is in operation, the light is dim, but when the push-to-talk button on the microphone is pressed to operate the transmitter, the light becomes brighter. A single cable harness plugs into the dash control, connecting it to the transmitter and receiver terminals.

A switch on the dash control cuts out the Selecto-Call system in case of any failure, and allows the receiver to operate in the conventional manner.

Details of Mobile Transmitter ★ Fig. 6 shows the construction of the transmitter unit. Directly behind the front panel, from left to right, are the oscillator coil, oscillator tube, 1st quadrupler coil, crystal, modulation transformer, and filter condenser.

Next, in front of the shield, are the 1st quadrupler tube, 2nd quadrupler coil, doubler-driver tube, 2nd quadrupler tube, and doubler-driver coil. Following, to the rear, are the RF power amplifier tubes and the antenna-matching network with the antenna relay mounted under the inductance. The remainder of the chassis space is occupied by the dynamotor.

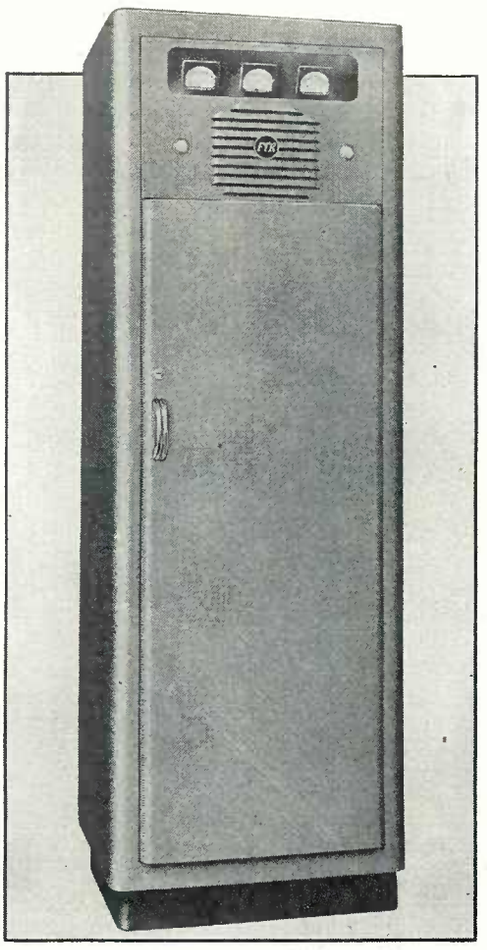


FIG. 9. STANDARD CABINET FOR HEADQUARTERS TRANSMITTER, 50 OR 250 W.

Details of Mobile Receiver ★ In the top view of the receiver chassis, Fig. 2, the components directly behind the front panel are, from left to right: 3rd IF coil 455 kc., 2nd limiter tube, three discriminator coils, discriminator tube, relay tube, 1st audio tube, and audio output tube, with the audio transformer and filter choke to the rear. The large round can contains the vibrating reed, while the square case adjacent is the relay with the Selecto-Call on-off switch on the top. Just at the rear of these parts are the rectifier tube, vibrator, and the power transformer.

Along the other side of the chassis, from front to rear, are: 1st limiter tube, 2nd IF coil 455 kc., 1st IF tube, 1st IF coil 455 kc., converter tube, 2nd IF coil 4.3 mc., 1st IF tube, 1st IF coil 4.3 mc., oscillator tube, mixer tube, 1st RF coil and tube, and antenna tuning condenser and inductance. The oscillator coil is adjacent to the square transformer case. Two plug-in crystals can be seen in the central part of the chassis.

The bottom view, Fig. 3, shows the advantage, from the point of view of service, in turning the sides of the chassis up, in contrast to the conventional practice. When the chassis is put down on the bench, the components are protected by the guard rail at the rear.

Headquarters Equipment ★ Two types of control desks are available, as shown in Figs. 7 and 8. The first is a standard steel desk with a disappearing typewriter mounting and a built-in radio control console. Panels at the lower center section are for Selecto-Call operation, in accordance with the requirements of the system.

The second desk, Fig. 8, has a similar console, but additional facilities for handling a greater volume of message traffic.

The transmitter cabinet, Fig. 9, is designed to house a standard receiver unit, Fig. 2, and the 50-watt transmitter, Fig. 6, with an added 250-watt output stage and power supply if required. All the radio units and the console controls for headquarters operation provide maximum flexibility of design so that, without special or expensive modifications, the Selecto-Call system can be suited to the requirements of the simplest or the most elaborate communications systems.

The usual arrangement can be employed to operate headquarters transmitter by remote control over wires or radio link circuits.

TELEVISION ALLOCATIONS

AT THIS time of writing, the FCC hearing on the television allocations proposal of September 20th and the October 3rd revision has ended, but no final action has been taken by the Commission.

Arguments at the hearing centered around the question as to whether the use of the lower television band can be considered permanent or only temporary. On this point, Dr. Allen B. DuMont said:

"We believe that the T.B.A. allocation plan (for the lower band) will provide a truly nationwide television service . . . the plan provides more stations for both the larger and smaller cities than the FCC plan. . . . I hesitate to go ahead on the present premise unless the Commission assures the public and the industry that the proposed allocations will remain for at least 10 years."

Paul Kesten of CBS held forth at much length on the temporary nature of transmission on the lower band. He said:

"In fact, I would not be sincere if I did not add that any testimony I have offered on the proposed requirements in the lower frequencies has been presented

(CONCLUDED ON PAGE 79)

RADIO DESIGNER'S ITEMS

Notes on Methods and Products of Importance to Design Engineers

Tube Sockets: A series of tube sockets with bases of mica ceramic high-frequency insulation has been developed by Electronic Mechanics, Inc., 72–74 Clifton Blvd., Clifton, N. J. Fig. 1 shows six sockets in the series which includes types for standard bases of 4, 5, 6, and 7 pins, octal and loctal sockets for multi-pin tubes, sockets for 5- and 7-pin acorn tubes, and a heavy-duty type for 50-watters.

These sockets, produced by compression molding, are of 1-piece construction with flat upper surfaces, so that they can be mounted directly on the underside of

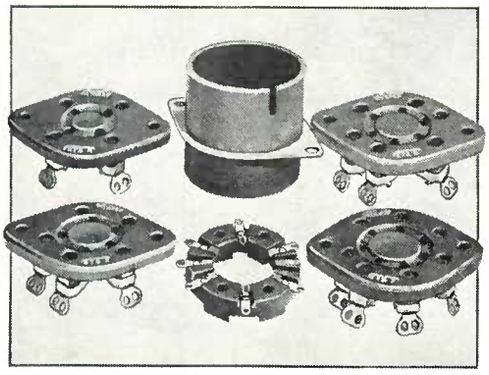


FIG. 1. SERIES OF CERAMIC-BASE SOCKETS

a steel chassis. The Mykroy insulation does not carbonize or deteriorate from arcs or flash-overs, and can be drilled, tapped, or machined by conventional methods if any modification of the socket base is required. Dimension drawings and other data are available on request.

New Catalog: A new catalog has been issued by General Cement Manufacturing Company, Rockford, Ill. Included are cements, chemicals, hardware, cabinet repair kits, repair parts, and special tools for radio use.

Amplifier Equipment: Two new items for use with their 102 series of amplifiers have been announced by the Langevin Company, Inc., 37 W. 65th St., New York 23.

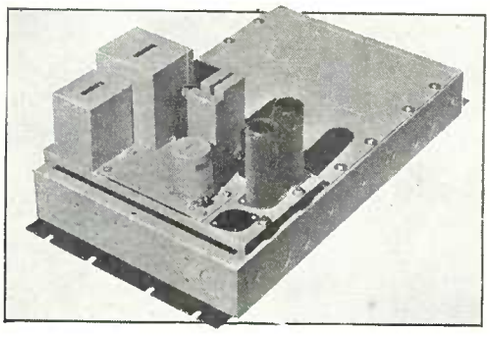


FIG. 2. AMPLIFIER MOUNTING FRAME

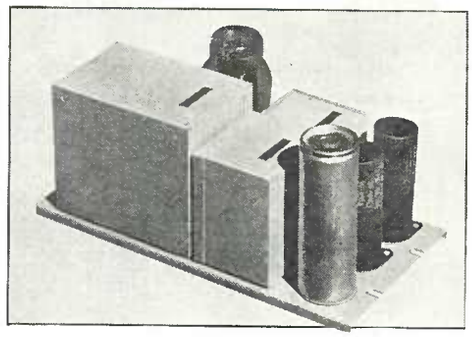


FIG. 3. POWER SUPPLY FOR AMPLIFIERS

The first is the 3A mounting frame, shown in Fig. 2, which accommodates up to three amplifier units. Only 10½ ins. of rack space is required for the mounting. The unit can be used in a horizontal position, also.

The second item, Fig. 3, is a rectifier designed to furnish filament and plate current to line amplifiers such as the type 102, and can be used on the 3A mounting frame. Type 201-A delivers 275 volts at 75 milliamperes, and 6.3 volts at 8 amperes. Type 201-B is similar except that an additional filter is provided for use with quiet pre-amplifiers.

HF Oscillator: Fig. 4 shows a new portable, battery-operated oscillator for 49 to 154

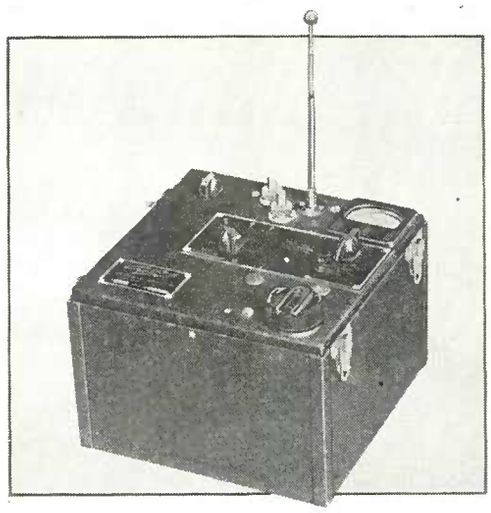


FIG. 4. BATTERY-OPERATED OSCILLATOR

mc., produced by Andrew Company, Chicago 19, Ill. Although it is designed particularly for checking aircraft receivers, it has a wide range of uses in the field and in the laboratory. Modulation frequencies are provided of 70, 90, 400, 1,300, and 3,000 cycles. There are two coaxial terminals for low- and high-level outputs.

Selenium Rectifier: Production of selenium rectifiers capable of withstanding a 100-hour salt spray test has been announced by Selenium Corporation of America, 1719 W. Pico Boulevard, Los Angeles 15. Although outwardly conventional in appearance, these units are described as employing a radically different assembly method, and a coating which protects the selenium barrier layers from fungi and corrosive fumes as well as salt spray.

The tests through which the units have been put consist of 3-minute spray with 20% salt solution at 55° C., followed by a 3-minute airblast at the same temperature. This cycle is repeated for 100 hours. A strong ultra-violet light is played on the rectifiers continuously during the tests.

Meter Tester: A multi-range instrument for checking and calibrating DC meters, made

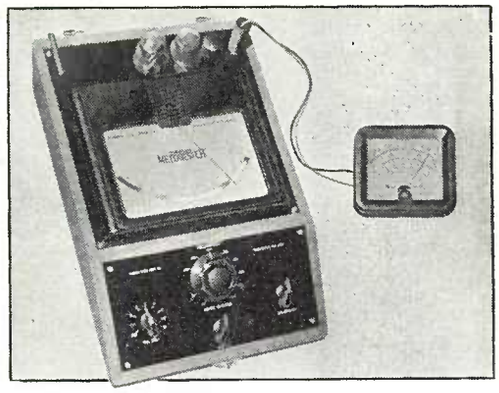


FIG. 5. DC METER CALIBRATOR

by Marion Electrical Instrument Company, Manchester, N. H., is illustrated in Fig. 5. Full-scale ranges from 0–25 microamperes to 10 milliamperes, and 0–100 volts can be obtained by the selector switch. Accuracy is rated at better than .5%, for the meter tester is hand-calibrated by the potentiometer standard-cell method on equipment certified by the Bureau of Standards. Internal resistors are of manganin wire, wound on ceramic forms.

Operating current is obtained from 110 volts, 60 cycles, supplying a self-contained, regulated power supply using a 6X6 rectifier tube and a 6N7 as a grid-controlled variable resistor.

This instrument is distributed by the Electrical Instrument Distributing Company, 458 Broadway, New York City.

Transformer Cases: Prompt delivery through the use of standardized size is promised on transformer cases manufactured by Olympic Tool & Mfg. Company, Inc., 39 Chambers Street, New York 7. Stock sizes range from 1¾ by 1⅝ by 2 3/16 ins. to 5⅞ by 4¾ by 6 19/32 ins. They can be furnished with or without studs, pierced covers, brackets, and channels. Cases are made with a folded side seam.

FACTORY REPRESENTATIVES & PARTS JOBBERS

Trade Directory of Factory Representatives and Their Lines, and Jobbers Specializing in Tubes and Compounds

The greatest care hos been taken to make this Directory accurate ond os complete os possible. In this, we hove hod the caoperotion of the radio ports monufocturers. This Directory, with complete revisions to keep it up-to-dote, will be published again in aur Moy, 1946 issue.

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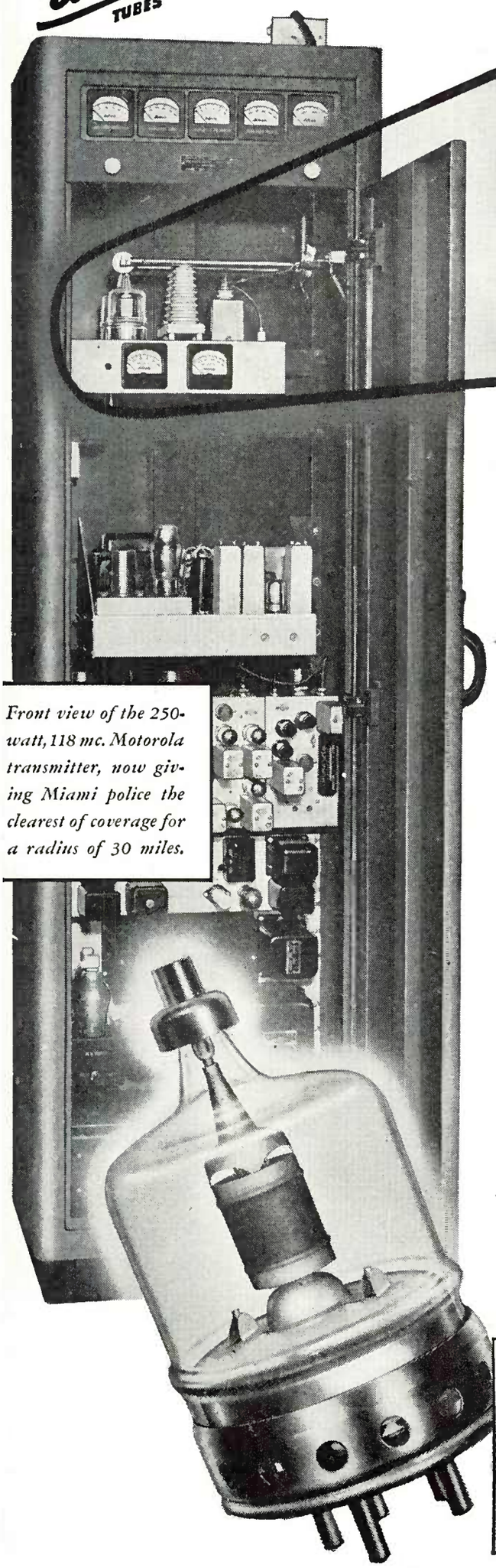
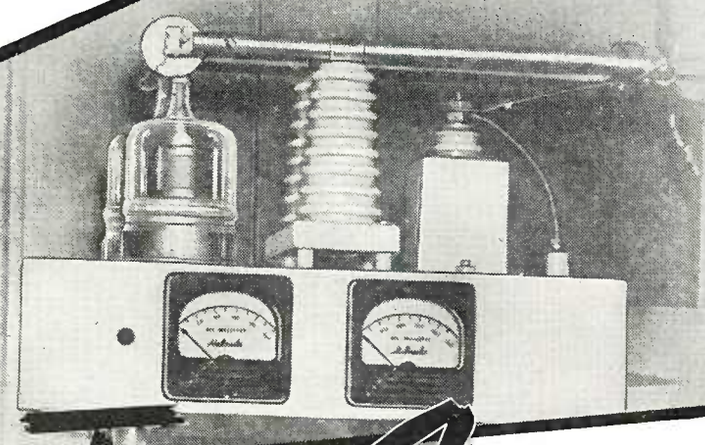
Solar
Gibhard, Harry W. 737 N. Michigan Ave.
Lectrohm

Eimac TUBES — THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT





Top Spot

IN FM POLICE SYSTEMS

EIMAC TETRODE 4-125A

Front view of the 250-watt, 118 mc. Motorola transmitter, now giving Miami police the clearest of coverage for a radius of 30 miles.

Top honors to Galvin Manufacturing Corporation for building it, and a salute to the police and fire departments of Miami, Florida, for putting it to work in spite of the skeptics! It's the first two-way police radiotelephone system in the United States on frequencies *above 100 mc.* Twenty-four hours a day, 12 patrol cars in Miami's busy area tune in on signals as solid as a dinner-table conversation from this Motorola 250 watt, 118 mc. FM transmitter.

From the earliest experimental stages of FM broadcasting, Eimac tubes have been lending a hand. Naturally, there are Eimac 4-125A tetrodes (pictured above) in the vital power output stage of Galvin's new Motorola success. Eimac 4-125A's were a logical choice for this transmitter because of their superlative high frequency performance capabilities and their low driving power requirements.

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Eimac REG. U.S. PAT. OFF. TUBES

Ask for your copy of Electronic Telesis, the 64-page booklet giving the fundamentals of electronics. It will help electronic engineers explain the subject to laymen. Available in English and Spanish. No obligation, of course.

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Export Agents: Frazar & Hansen, 301 Clay St., San Francisca 11, Calif., U. S. A.

1074

ELECTRICAL CHARACTERISTICS - 4-125A TETRODE

Filament: Thoriated Tungsten
Voltage . . . . 5.0 volts
Current . . 6.2 amperes

Plate Dissipation (Maximum) 125 watts

Direct Interelectrode Capacitances (Average)
Grid-Plate (Without shielding, base grounded) . . . . 0.03 μμfd.
Input . . . . . 10.3 μμfd.
Output . . . . . 3.0 μμfd.

Transcanductance (i_B = 50 ma., E_B = 2500 v., E_{c2} = 400 v.) . 2450 umhas

Factory Representatives, Cont.

General Electric Co. 840 South Canal St.
GE Sales Office
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Racon, Radio Merch., Simpson. Tel. App.
Halinton, Inc., H. 612 N. Michigan Ave.
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Hamilton Assoc., Inc. 64r N. Mich. Ave.
Acro
Higgins, Royal 600 S. Michigan Ave.
DeJur, Elmac, Premax, Turner, Radio Mfg. Eng.
Hill & Gray 1 N. Crawford Ave.
Gothard, Heintz & Kaufman
Hill, Dormand S. 347 N. Justine St.
Supreme Inst.
Hill, John C. 308 W. Washington St.
Shure, Simpson
Holst, W. L. 43 East Ohio St.
East. Mike-Stand.
Hunter, T. B. Co. 4753 Broadway
Centralab
Instrument Sales Co. 325 W. Huron St.
Cardwell, J-B-T, Schauer, Schott, Triplett
Kahan, Irving J. 333 N. Michigan Ave.
Amperite, Sprague
Karet, R. M. 1631 W. Pratt Blvd.
Utah
Knodell, Al 5746 N. Arteslan Ave.
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McCarthy, L. C. 100 S. Jefferson St.
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Miles, P. H. 333 N. Michigan Blvd.
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Nelson, A. G. 20 N. Wacker Dr.
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Oritz, Manuel, Jr. 1753 Howard St.
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Peel Sales Engrg. Co. 154 E. Erie St.
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Potter, Geo. R. 540 N. Michigan Ave.
Cornish
REL Equip. Sales, Inc. 612 N. Mich. Blvd. REL
Ritter, R. B. 612 N. Michigan Ave.
Cornell-Dubilier, Supreme Inst.
Royal, A. & R. 21 E. Van Buren St.
Alpha Wire, Atlas Sound, Browning
Ryan, Gerold G. Co. 549 W. Wash. Blvd.
B & W, Drake Elec., Gold-Moody, Karr, Millen, Price, Recordisc, Thermador
Sales, J. G. 325 W. Huron St.
Bogan
Signal Elec. Mfg. Co. 600 W. Jackson Blvd.
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Edw. Singer & Assoc. 1722 W. Arcade Pl.
Astatic
Smiley, R. E. 903 Merchandise Mart.
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Erwood, Racon, Shure
Smith, O. P. 660 N. Dearborn St.
Amer. T & R, Dumont Elec., Arcturus
Strauss, Mae, Mrs. 425 Surf St.
Ind. Cond.
Surpless, Dunn & Co. 34 No. Clinton St.
Drake Elec.
Taylor, Robert F. 308 W. Washington St.
Gen. Hwdre., Rek-O-Kut, Wirt
Victory Mfg. Co. 1722–24 W. Arcade Pl.
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Glen Ellyn

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Belden

Norwaad Park

Anderson, Peter 4308 N. Ottawa
Utah

Oak Park

Radford, P. C. 1123 Washington Blvd.
Utah

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General Electric Co. 127 W. Berry St.
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Southern, Chas. 1135 Lincoln Tower
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Indianapalis

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Wright, James L. 5260 N. Meridan St.
Rek-O-Kut

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Stancor

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Southern Sellers 918 Union St.
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Shreveport

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Loukata, D. H. & Co. PO Box 6766
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DeJur, Elec. Ent.
Lane, Henry M. 350 Lake St.
Presto Record.
Reynolds, Harrison 34 Bay State Rd.
Sprague

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Halldorson, Thermador, Ward Leonard, Solar
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Jackson Elect. Inst.
Chamberlin, H. A. 31 Milk St.
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Clawson, Ralph H. 857 Boylston St.
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Coakley, Tim 11 Beacon St.
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Cowperthwait & Brodhead 126 Newbury
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Aerovox, Alpha Wire, Cinaud, Millen, Racon, Radio Ess., UTC, Universal Mic.
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GE District Mgr.
Harris, Stanley A. Co. 126 State St.
Cont. Elec., Guardian Elec., Schott
Kimhall, Hasmer R. 176 Federal St.
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Sangamo
Ray Perron & Co. 131 Clarendon St.
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Segal, Henry P. 143 Newbury St.
Bud, Drake Elec., Gen. Cement, National Fab., Simpson, Supreme Inst., Turner, University Labs.
Sturgeon, Paul R. 25 Huntington Ave.
Alliance, Drake Mfg., Heintz & Kaufman, Johnson, Karp, Ohmite, Premax, Selenium, Simpson
White Co., Charles D. 589 Atlantic Ave.
Signal

Braakline

Harris, Wm. 197 Rowson Rd.
Gen. Hdwre.

Needham

Marshall, Frank E. Rm. 1 PO Bldg.
Gothard, Price

Scituate Center

Hendrickson, W. A. First Parish Rd.
National Union

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Amer. T & R

Sa. Hadley

Mack, Co., P. W. 7 Hadley St.
Precision App.

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Sola Elec.

Warcester

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Sangamo
Braisted & Bair New Center Bldg.
Roller-Smith
Cawthorne, T. S. 312 Boulevard Bldg.
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Ecclestone & Son 525 Free Press Bldg.
Sola
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Amperite, Clarostat, Jones, Precision, Rauland, Sprague, Vaco
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Bud, Shure
Lee, W. S. 2033 Park Ave.
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J-B-T, Triplett
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Swank-Liddle 18925 Grand River Ave.
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Selenium, Trimm

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Jacksan

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Sangamo
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Signal
Day, P. M. 518 Dwight Bldg.
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Duluth

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Roller-Smith
Elliott Equipt. Co. 708 6th Ave. S.
Centralab
Foster Co. Hotel Andrews
Alliance, Simpson, UTC, Worner
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Astatic, Bell Sound
Geescka, R. F. 552 Plymouth Bldg.
Sangamo, Weston
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Hill, F. B. 256 First Ave. N.
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Weston
Langager, T. O. 2401 Grand Ave. S.
Mueller
Oszman, E. W. 125 S. 5th St.
Vaco
Pope, Co., J. C. 8 S. 13th St.
Wirt
Van Krevelan, E. H. 88 S. 10th St.
Presto

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Bensch, Earl R. 2645 University Ave.
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Kennedy, F. C. 2324 University Ave.
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McCarthy, J. U. 1725 Hillcrest Ave.
Amperite, Cornell-Dubilier, Gould-Moody, IRC, Meissner, Recordisc, Schott, Stancor
Olsen, A. E. 119 Lane Pl.
Price

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Kansas City

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Farris, R. W. 406 West 34th St.
Amer. T & R, Arcturus, Drake Elec., Jensen Ind., National Fab., Universal Mic., Vaco, Wirt
General Electric Co. 106 W. 14th St.
G.E. Sales Office
Hofman, H. PO Box 265
Belden
Kay, J. P. 409 Reliance Bldg.
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McGrade, E. W. 34th & Broadway
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GE District Mgr.
Milbank, C. A. 411–413 West 10th St.
Sangamo
Miller, A. G. Dwight Bldg.
Roller-Smith
Missouri Aviation Corp. 416 Admiral Blvd.
Drake
Mundy, R. J. 3940 E. 68th St.
Cont. Carbon, Kainer, Logan
Reid & Co. C. W.
IRC
Roes, H. A. 1805 Grand Ave.
Amer. Mic., Amphenol, Conant, Gould-Moody, Heintz & Kaufman, J-B-T, Johnson, Ohmite, Recordisc, Triplett
Somers, F. C. 18th & Grand
Allied Con., Astatic, Bogen, Bud, Elec. Ent., Elec. Labs., Gothard, Lectrohm, Mueller, Park, Schott, Solar, Supreme Inst., Technical App., University Labs.
Terry, C. E. 309 Reliance Bldg.
Presto
Trans West. Accessories, Mfgrs. Ex. Bldg.
Alliance Mfg.
Zimmerman, M. H. 5520 Westover Rd.
Thermador

Kirkwood

Maynard, L. 204 Thomas St.
Erwood, Halldorson, National Union, Precision, Radio Mfg.

St. Jaseph

Reid, L. E. 116 North 4th St.
Sangamo

St. Lauis

Beneke, J. W. 593 Arcade Bldg.
Aerovox, J-B-T, Triplett
Borghoff, Wm. 4018 Greer Ave.
Amer. Mic., Bogen, Conant, Cont. Carbon, Stancor, University Labs.
Bullivant, F. J. 1913 Washington Ave.
Sigma
Chelson, C. 1906 Boatmen's Bank Bldg.
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Hellmann, O. E. 1706 Olive St.
Jackson
Kathrinus, Norman W. 1218 Olive St.
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Lohr, C. P. 235 Rooseveit Bldg.
Roller-Smith
McGary, W. T. 4030 Chauteau Ave.
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Piekson, G. W. 3020 Olive St.
Cornell-Dubilier
Schmidt, E. A. Shell Bldg.
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Derry Village

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Audio Devices

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Price, Centralab

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Blazer, C. M. 816 Merrick Ave.
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Clarostat

Livingstan

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National Union

Madisan

Rau, O. C. PO Box 141
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Halldorson

River Edge

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Solar

Teaneck

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Allied Con.

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Sangamo
Schlefer Electrio Co. 100 S. State St.
Weston

Binghamtan

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Simpson, Ward Leonard
Fillmore & Fillmore I222 Lib. Bnk. Bldg.
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Price
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Segar, Harry B. Ellicott Sq. Bldg.
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Shlefer Elec. Co. 527 Ellicott St.
Weston
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Vawter, J. H.
Raytheon
Wulfetange, J. F., Jr. 891 Ellicott Sq.
Sangamo

Braaklyn

Baum, Sydney H. 1142 E. 24th St.
Solar

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Wolfe, Michael 65–66 Booth St.
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New Yark

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Blair-Steinberg 395 Broadway
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Presto
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Rutt, Wm. 401 Broadway
Sprague
Saftler, Perry 53 Park Place
Cinaud.
Scharp, Wesley 67 West 44th St.
Alllance, Astatic, Bell Sound, Centralab
Schmitt Co., F. E. 136 Liberty St.
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Simberkoff, S. W. 347 Fifth Ave.
Duotone, Racon, Schott, Shure.
Simons & Son M. 25 Warren St.
Gothard, Johnson
Skidmore, W. K. 20 Vesey St.
Conant
Smith, F. V. L. 265 West 14th St.
Cont. Elec.
Smith, H. F. 259 West 14th St.
Drake Mfg., Johnson, Trimm, Universal Mic.
Sonkin, David 220 East 2rd St.
Aerovox, Bradley
Surpless, Dunn & Co. 74 Murray St.
Drake Eleo.
Toblas, David 30 Church St.
J-B-T, Racon, Schaur, Triplett

Next Month

DIRECTORY OF MANUFACTURERS

Our Navember issue will carry the Directary af Manufacturers, with names af the general managers and chief engineers. It will be an all-industry directary, listing manufacturers af radia apparatus, tubes, labaratary and test equipment, campanents, materials, and supplies. Names and addresses will be checked and braught up ta date far the pastwar service af aur readers.

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Breur Co., R. E. 250 West 57th St.
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DeJur
Carduner, Wm. 401 Broadway
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Cooper-DiBlasi Co. 259 West 14th St.
Drake Elec., Millen, Lectrohm, Price
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Signal
Dunn & Bryan 44 Murray St.
Hexacon
Egert, Samuel S. 27 Park Pl.
Browning, Jensen Ind., Rauland, Utah
Electronic Labs. 13 East 40th St.
Elec. Labs.
Finlay, Robert 11 Warren St.
Hallicrafters
Fixel, P. R. 420 Lexington Ave.
National Fab.
Forshay, John M. 27 Park Pl.
Cont. Carbon, Davies Molding, Ind. Cond., Selenium, Simpson Elec.
Furman, Nat. 395 Broadway
Gen. Cement.
Gal, Nicholas I56 Waverly Pl.
Solar
General Electric Co. 570 Lexington Ave.
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Ginsbury, Sylvan 55 West 42nd St.
Guardian
Gold, William 53 Park Pl.
Premax, Turner
Hardwick, A. H. 165 Broadway Rm. 1438
IRC
Jensen Radio Mfg. Co. 220 E. 23rd St.
Jensen Radio
Jesselson, Ray 4915 Broadway
Park
Joseph, Ben 258 Broadway
Mueller
J. T. L. Sales Co. 53 Park Place
Middletown
Kaelber & Mack 1270 Broadway
Rek-O-Kut, Wirt
Kahant, C. G. 11 Park Pl.
Roller-Smith
Karns, Jack 258 Broadway
Duotone
Kinsey, F. S. 40 Wall St.
Westinghouse Dist. Office
Lewis & Sachs Co. Empire State Bldg.
Amer. T & R, Jones
Linter & Son, H. M. 50 Warren St.
Thermador
Lynch, Arthur H. 136 Liberty St.
National
Masin, O. F. 17 East 42nd St.
Acro, Ohmite
Moncrief & Graf 120 West 18th St.
Sola
Muller & Phippe I Park Ave.
Atlas Air.
Nehls, Herbert E. 60 East 42nd St.
Sangamo
Newman, Charles 53 Park Pl.
Stancor
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University Labs.
Plasencia, Joseph 401 Broadway
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Weston Elec. Inst. Corp. 50 Church St.
Weston

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Rachester

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Allied Con.
Electronic Associates 135 Spring St.
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GE Sales Office
Guslason, Gilbert 610 Case Bldg.
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Schlefer, H. J., Jr. 31 Alexander St.
Sangamo, Weston

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Sangamo
General Electric Co. 113 S. Salina St.
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Schlefer Elec. Co. 204 State Tower Bldg.
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Sangamo

Hendersanville

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Darusmont, A. 462 Wood Ave.
Premax
General Electric Co. 215 W. Third St.
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McKenzie Co., S. M. Temple Bar Bldg.
Signal
Miles Engineer Co. 709 Temple Bar Bldg.
Allied Con.

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Dietrich, E. S. 320 Hanna Bldg.
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Scott, Ernest P. 1836 Euclid Ave.
Amperite, Cont. Elec., Drake Elec. Jones, Meissner, Presto
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Wall, E. J. I836 Euclid Ave.
Millen, Price

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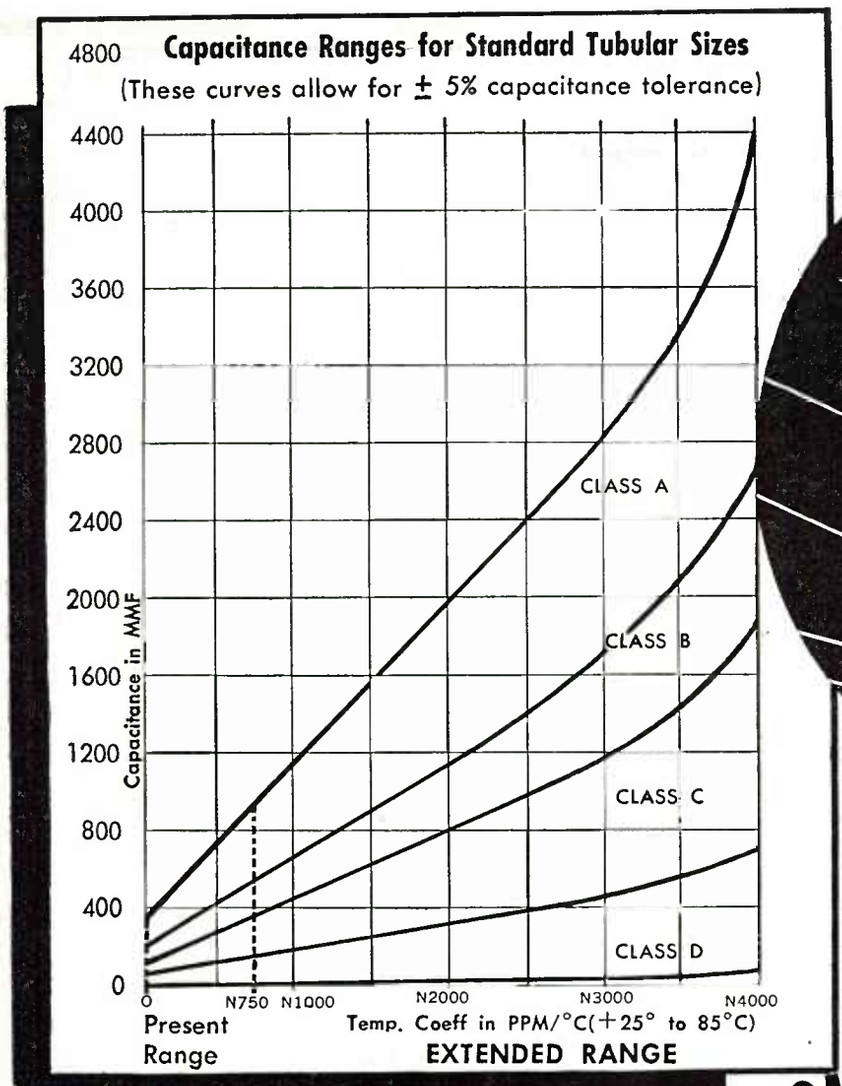

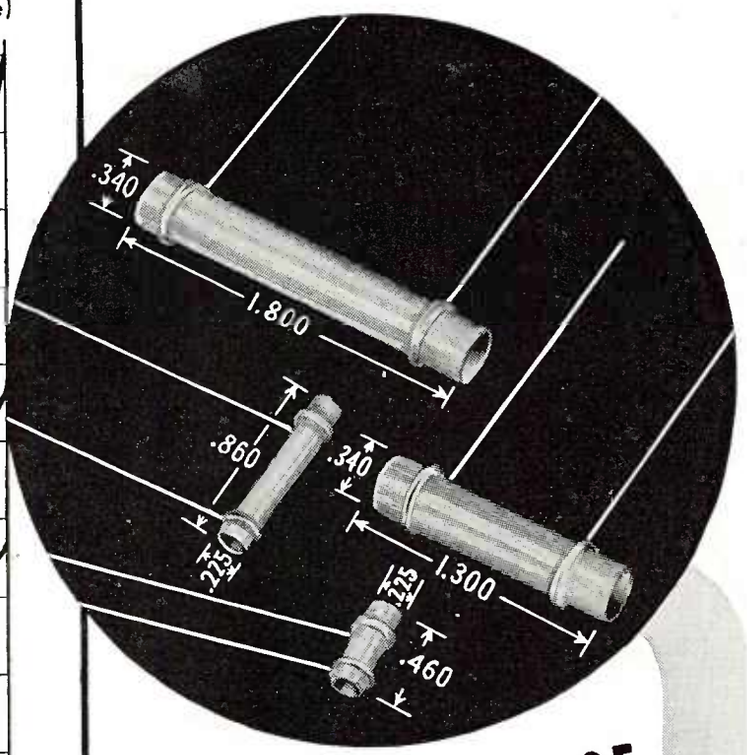

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Cement, Gen. Trans.
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Fowler, W. C. Texas Hotel
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General Electric Co. 408 W. 7th St.
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Trimm

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Brockenbrough & Sanders 313 Service
Mutual Bldg.
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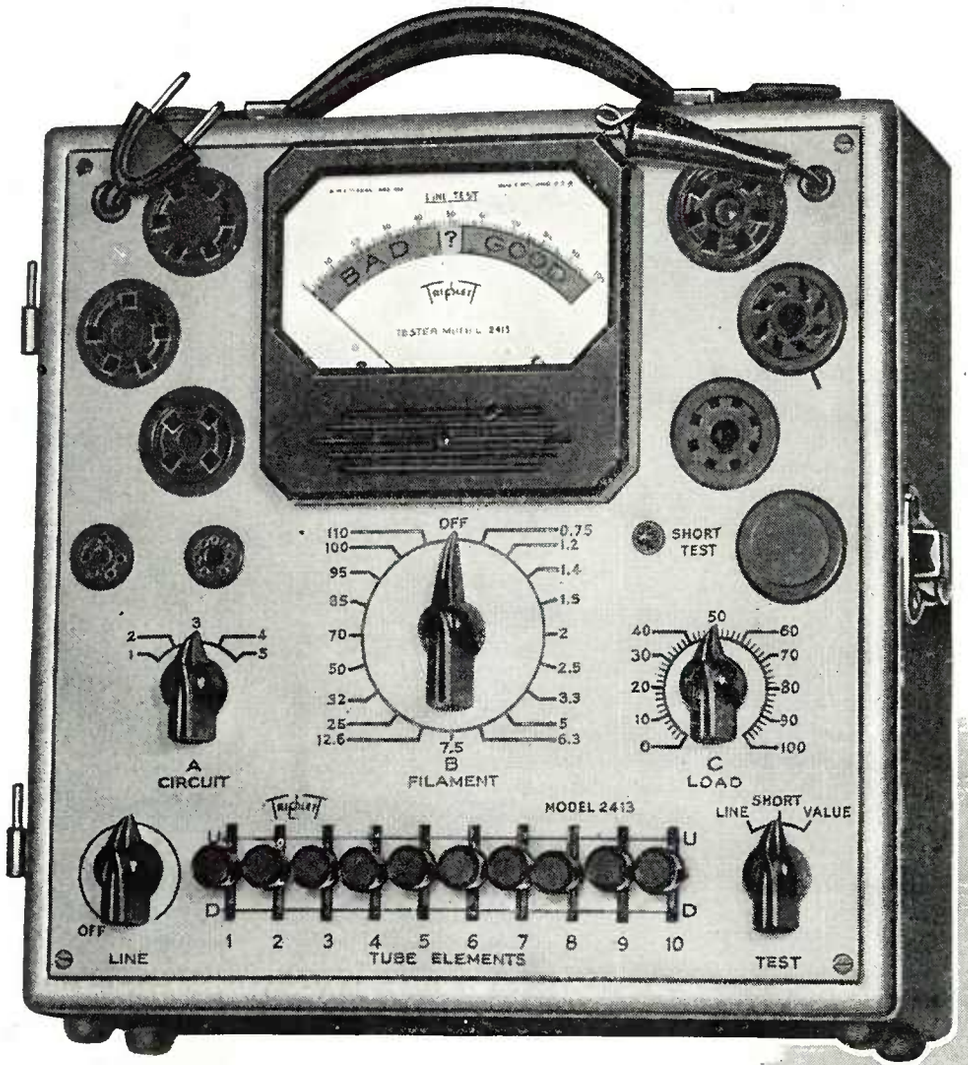

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Utah

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Precision

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Carter
Jimenez, Casa Angeles No. 13
Precision
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Alpha Wire, Clarostat, Gen. Cement

Dominican Republic, Ciudad Trujillo

Cazes, M. PO Box 714
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Walther Bros. Co. 115 Commerce St

TUSCALOOSA
Allen & Jemison Co.

ARIZONA

PHOENIX
Radio Parts of Arizona 36 W. Madison
Radio Specialties Co. 407 W. Jackson St
Southwest Radio & App. Co. 122 S. 3rd

TUCSON
Tucson Radio Supp. Co. 418 N. 4th St

ARKANSAS

LITTLE ROCK
Southern Radio Supply 409 W. 3rd St
Tanner Radio & Elec. Co. 906 Main St

FORT SMITH
Johnson Radio Co. 2213 N. B St
Williams Hdwe. Co. Rogers & 4th St
Wise Radio Supply 914 Towson St

PINE BLUFF
White Radio Service & Supply

CALIFORNIA

BAKERSFIELD
Bakersfield Radio Sup. Co. 2808 Chester Av
Valley Radio Supply

BERKELEY
Dealers Supply 2101 Grove St

FRESNO
Billings Whisle. Radio 2234 Tulare St
Davis Radio Co. 2501 Tulare St
DeJarnett, B. J. 1260 Van Ness Ave

HOLLYWOOD
Yale Radio Elec. Co. 6600 Sunset Blvd

LONG BEACH
Fred S. Dean Co. 313 E. 4th St.
Scott Radio Supply Co. 266 Alamitos Av

LOS ANGELES
Figart Radio Sup. Co. 6320 Comm. Sloat Dr
Kleruff & Co. 1839 Flower St
Meyberg Co., Leo J. 2027 S. Figuera St
Radio Equip. Dist. 709 S. Main St
Radio Products Sales 238 W. 15th St
Radio Specialties Co. 1956 S. Figuera St
Radio Tel. Sup. Co. 1701 S. Grand Ave
Ravenscroft, Inc., A. E. S. Hill St
Shelly Radio Co. 645 S. Sepulveda
United Radio Sup. Co. 1356 S. Flower St
Universal Radio Sup. Co. 3338 City Terrace

OAKLAND
W. D. Brill Co. 1015 Jackson St
Miller Co., Wave 188 12th St
Sacramento Elec. Sup. Co. 1915 Jackson St
Wanger Co., E. C. 1450 Harrison St

PASADENA
Dow Radio Sup. Co. 1759 E. Colorado St
Pasadena Radio Sup. Co. 30 W. Colorado St

SACRAMENTO
Henderson Brothers 1501 K St
Lester Dist. Co. 1800 16th St
Sacramento Elec. Sup. Co. 711 Capitol Ave

SAN BERNARDINO
George H. Bagley Co. 1216 D St

SAN DIEGO
Coast Elec. Co. 744 G St
Darcy Radio Co., A. B. 932 8th Ave
Davis Co., Roy 1228 Second Ave
Electronic Equip. Dist. 1228 2nd Ave
Western Radio & Elec. Co. 1000 B St

SAN FRANCISCO
Assoc. Radio Dist. 271 Seventh St
Brown Co. C. C. 26 Ninth St
Kaemper-Barrett 246 S. Van Ness Ave
Mayberg Co., Leo J. 70 10th St
Offenbach 1452 Market St
Pacific Wholesale Co. 116 Ninth St
San Francisco Radio & Sup. Co. 1282 Market
Wholesale Radio 140 Ninth St
Zack Radio Sup. Co. 1426 Market St

SAN JOSE
Frank Quement Co. 156 San Fernando St W.

SANTA ANA
Radio & Tel. Equip. Co. 207 Oak St

SANTA BARBARA
Radio Electronic Supply Co.

STOCKTON
De Jarnett Co., B. J.

COLORADO

ALAMOSA
Gumper, H. A. 629 Main St

CANNON CITY
Sig's Auto Supply 722 Main St

COLORADO SPRINGS
Crandall-Bryan Co. 120 N. Weber St
Modern Radio Service 10 E. Colorado Ave

DEL NORTE
Valley Music & Elec. Co.

DENVER
Auto Equipment Co.
Electric Accessories Co.
Inter-State Radio & Sup. Co. 1639 Tremont
McGee Radio & Elec. Co. 1130 Broadway
Niles Radio Co. 505 14th St
Radio Equipment Co.
Radio Products Sales Co. 1237 16th St

PUEBLO
Radio & Tel. Supply Co. 808 Euclid Ave
Walker Radio Co., L. B. 809 N. Main St

CONNECTICUT

BRIDGEPORT
Coastal Radio Ser. 1529 Stratford Ave
D'Ella Elec. Co. 1330 Fairfield Ave
Hatry & Young 117 Cannon St

HARTFORD
Hatry & Young 203 Ann St
Sceli Co., R. C. 227 Assylum St

NEW BRITAIN
United Radio Service 616 Main St
Universal Radio Service 49 E. Main St

NEW HAVEN
Brown, Thomas H. 106 State St
Congress Radio Co. 207 Congress Ave
Electronic Sales Co. 152 Temple St
Hatry & Young 1172 Chapel St

NEW LONDON
W. E. Aikins 384 Bank St
Hatry and Young

STAMFORD
Hatry & Young

WATERBURY
Hatry and Young

DELAWARE

WILMINGTON
Radio Elec. Service 219 W. 9th St
Wilmington Elec. Spec., Inc.

DIST. OF COLUMBIA

American Ampli. & Tel. 1111 19th St
Capitol Radio Whol. 2120 14th St N.W.
Columbia Wholesalers, Inc. 1146 19th St
Emerson Radio of Wash. 1209 13th St NW
G. E. Sup. Corp. 1330 N. Y. Ave. N.W.
Jowdy Radio Co.
Rucker Radio Whol. 1312 14th St N.W.
Southern Whslrs., Inc. 1519 L St NW

FLORIDA

JACKSONVILLE
Kinkade Radio Co. 1412 Main St
Radio Parts Co. 712 N. Main St
Thurow Radio Dist. 806 Main St

MIAMI
Elec. Eng. & Supply Co. 400 N.E. 2nd Av
Electrical Equip. Co. 44 N.W. 4th St
Elec. Sales & Serv. Co. 1555 N.E. 2nd Av
Electronic Sup. Co. 1145 N.E. 2nd Ave
Thurow Radio Dist. 518-20 W. Flagler
Walder Radio & App. Co. 1809 N.E. 2nd Av

ORLANDO
Thurow Radio Dist. 131 S. Court St
Radio Accessories Co. 71 E. Church St

PENSACOLA
Gulf Elec. Sup. Co. 115 E. Gregory St

SARASOTA
Morley Radio Co. 922 E. Main St

ST. PETERSBURG
Cooper Radio Co. 648 2nd Ave S.
Welch Radio Sup. Co. 408 S. 9th St

TALLAHASSEE
Thurow Radio Dist. 213 E. Tennessee St

TAMPA
Kinkade Radio Sup. 1323 Franklin St
Thurow Radio Dist. 115 S. Franklin St

WEST PALM BEACH
Thurow Radio Dist. Olive & First Sts
Vaughn & Wright Co. 309 1st St

GEORGIA

ATLANTA
Atlanta Phono. Co. 27 Pryor St S.W.
Concord Radio Corp. 263 Peachtree St N.E.
Garvin Elec. Co. 69 Forsyth N.W.
Georgia App. Co. 533 Whitehall St
Lafayette Radio Co.
Southeastern Rad. Pts. Co. 422 W. P'chtree
Specialty Dist. Co. 425 Peachtree St
Yancy & Co. 303 Peachtree St N.W.

COLUMBUS
Radio Sales & Service Co. 1316 1st Ave

MACON
White Radio, Guy 654 Mulberry St
Specialty Dist. Co. 459 Mulberry St

SAVANNAH
Specialty Dist. Co. 221 E. Broughton St
Southeastern Rad. Pts Co. 38 Montgomery

IDAHO

BOISE
Electronic Engineering Service

POCATELLO
Ross, S. R. 222 E. Center St

ILLINOIS

BELLEVILLE
Lurtz Electric Co. 210 N. Illinois St

BLOOMINGTON
Alverson Sales Co. 208 E. Front St

CHICAGO
Allied Radio 833 W. Jackson Blvd
Aschbach, L. H. 152 W. Huron St
Bass, J. E. 572 W. Randolph St
Braun Co., W. C. 601 W. Randolph St
Chicago Radio App. Co. 4155 S. Dearborn St
Chicago Radio Prod. 5453 S. Halsted St
Concord Radio Corp. 901 W. Jackson Blvd
Grant Radio Co. Inc. 6521 S. Halstead
Green Mill Radio Sup. Co.
Lafayette Radio Corp. 901 W. Jackson Blvd
Lukko Sales Corp. 5024 Irving Park Rd
Newark Electric Co.
Radio Equip. Co. 1935 W. North Ave
Radio Parts Co. 612 W. Randolph St
R. & L. Electr. Corp. 731 W. Wash. Blvd
Schulman Co., S.E. 801 S. Wabash Ave
Walker-Jimleson, Inc. 311 S. Western Av

DANVILLE
Allen Electric Co. 115 N. Vermilion St

DIXON
Illinois App. Co. 407 W. 1st St

ELGIN
Fox Electric Sup. Co. 67 N. State St

MOLINE
Anderson Radio Labs 402 15th St

PEORIA
Herberger Radio 136 First St
Klaus Radio & Elec. Co. Main St
Seltzer Co. 604 Fulton St

QUINCY
Cooper Radio Sup. 935 Main St

ROCKFORD
Mid-West Associated Dist. 506 Walnut

ROCK ISLAND
Tri-City Radio Sup. 1919 4th Ave

SPRINGFIELD
Bruce, Harold 303 E. Monroe St
Wilson Supply Co.

INDIANA

ANDERSON
Seybert's Radio Ser. Inc. 11 E. 12th St

ANGOLA
Lakeland Radio Supply Co.

BLOOMINGTON
Stansiter Radio Ser. 343 S. Rogers St

COLUMBUS
Williams Co., H. A. 334 5th St

EVANSVILLE
Castrup Radio Co. 1014 W. Franklin
Moutouz Auto & Mach. Co. 511 Locust
Ohio Valley Sound Ser. 2227 W. Iowa St
Wesco Radio Parts Ninth & Main Sts

FORT WAYNE
Pembleton Labs. 919 Broadway
Protective Elec. Sup. Co. 130 W. Columbia Ave
Ross Engineering Co. 236 W. Main St
Wall Dist. Co. 241 Pearl St
Wayne Lamp Co., Anthony 2732 B'way

GARY
Cosmopolitan Radio 524 Washington St

INDIANAPOLIS
Ger-Bar, Inc. 442 N. Illinois St
Hoosier Radio Co. 701 N. Illinois St
Kiefer-Stewart Co. 124 S. Senate St
Radio Distributing Co.
Radio Equip. Co. 1219 N. Meridian St
Rodfeld Co. 614 N. Capitol Ave
Van Sickle Radio Co. 34 W. Ohio

KOKOMO
George's Radio & Auto Sup. 116 S. Buskeye

LAFAYETTE
Anderson Co., Peter 6th & Alabama

RICHMOND
Fox Sound Equip. Co. 435 S. 5th St
Rodefeld Co.

SOUTH BEND
Comm. Sound & Radio Co. 528 E. Colfax
Radio Dist. Co. 432 Carroll
South Bend Elec. Co. 437 E. Colfax

TERRE HAUTE
Archer & Evinger 1349 Wabash
Terre Haute Radio & Pub. Add. Co. 501 Ohio St.

VINCENNES
Wheeler Bat. Serv. Sta. 26 S. 6th St

IOWA

BURLINGTON
Bennett Co.
Ewinger & Sons Co., John
Gerst Radio Co.
Union Supply Co. 4th & Washington Sts

CEDAR RAPIDS
Checker Electric Supply Co.
Gifford-Brown, Inc. 106 S.W. First St
Stanley Reeder Auto Co. 118 Sixth St
Terry-Durin Co. 415 7th Ave

COUNCIL BLUFFS
Wholesale Radio Lab. 746 W. Broadway

DAVENPORT
Midwest-Timmerman Co. 114 Western Av

DES MOINES
Gifford-Brown, Inc. 1215 W. Grand Ave
Iowa Radio Corp. 1212 Grand Ave
Midwest-Timmerman Co.
Radio Trade Supply Co. 1117 Grand Av
H. E. Sorenson Co. 912 Locust St

DUBUQUE
Renier Radio & Tel. Co. 531 Main St

FORT DODGE
Radio & Electr. Sup. Co. 23 1st Ave. S.E.

MONONA
Benzing Radio Service

OTTUMWA
Friday-Perry Co. 117 S. Wash. St

SIOUX CITY
Duke's Radio 114 W. 4th St
Warren Elec. Co.

WATERLOO
Standard Batt. & Elec. Ser. 217 W. 5th St

KANSAS

PITTSBURGH
Pittsburgh Radio Sup. Co. 103 N. B'way

TOPEKA
Acme Radio Sup. Co. 632 Quincy St
Overton Electric Co. 522 Jackson St

WICHITA
Interstate Dist. 1236 E. Douglas St
Radio Supply Co. 1219 E. Douglas St

KENTUCKY

HOPKINSVILLE
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Radio Equipment Co. 377 E. Main St

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'Ole Miss Supply 901 Carondelet St
Radio Parts, Inc. 807 Howard Ave
Shuler Supply Co. 902 Poydras St
Southern Radio Supply 407 S. Roman St
Walther Brothers 714 Howard St

SHREVEPORT
Baggett Radio Co. 620 Louisiana Ave
Chain Batt. & Equip. Co. 728 Marshall
Interstate Elec. Co. 616 Spring St

MAINE

AUBURN
Royal Amusement Co. 28 Cross St

BANGOR
Radio Service Labs. 45 Haymarket Sq.

PORTLAND
Radio Service Labs. 45A Free St

MARYLAND

BALTIMORE
Berman, Henry O. 12 E. Lombard St
D & H Dist. Co. 202 S. Pulaski St
Hunt & Co., J. R. Calvert & Saratoga
Maynard E. Harp 917 Cathedral St
Lytron Dist. Co. 3535 Hayward Ave
Radio Elec. Service 3 N. Howard St
A. R. Spartana 818 Gay St
Wholesale Radio Parts 312 Redwood W.
J. M. Zamoiski 110 S. Paca St

CUMBERLAND
Radio Electrical Supply Service Co.
Zimmerman Whol. 301 Baltimore Ave

HAGERSTOWN
Zimmerman Radio. 114 E. Washington St

SALISBURY
Eastern Elec. Sup. Co. 325 Main St

MASSACHUSETTS

BOSTON
Demambro Radio Sup. Co. 1111 Com. Av
Electric Supply Co. 1739 Mass. Ave
Gerber Radio Sales
Herman Co., Louis 885 Boyiston St
Mayer, A. W. 895 Boylston St
Radio Shack Corp. 167 Washington St
Radio Wire Television, Inc. 110 Federal
Sager Electrical Sup. 203 Congress St
Selden Radio Co. 198 Washington St
Wholesale Radio Labs. 782 Com. Ave

BROCKTON
Ware Radio Suppiy Co. 913 Center St

CAMBRIDGE
Eastern Co.
Electrical Supply Corp. 1739 Mass. Ave

GREAT BARRINGTON
Blake Radio Equip. Co. 264 Main St

MELROSE
Melrose Sales Co. 407 Ranklin St

NEW BEDFORD
Beckman Co., C. E. 11–35 Commercial St

PITTSFIELD
Pittsfield Radio Co. 44 West St

QUINCY
Dewey Radio Dist. Co. 1554 Hancock St

SPRINGFIELD
Cushing, T. F. 354 Worthington St
Springfield Radio Co. 405 Dwight St

WORCESTER
Radio Electronic Sales 46 Chandler St
Radio Maintenance Sup. Co. 78 Harrison

MICHIGAN

ANN ARBOR
Purchase Radio & Camera Shop
Wedemeyer Co., Geo. 221 E. Liberty

BATTLE CREEK
Wedemeyer Electronic Sup. Co.

BAY CITY
Kinde Dist. Co. Washington St

DETROIT
Duffy Co., M. N. 2040 Grand River Ave
Ferguson Radio Sup. 4214 Woodward Ave
Radio Electronic Supply Co. 1112 W Warren
Radio Specialties Co. 325 E. Jefferson Av
Radio Supply & Eng. 129 Selden Ave

ESCANABA
Browne Radio Co. 1620 Ludington St

FLINT
Radio Tube Merch. 508 Clifford St
Shand Radio Spec. Co. 203 W. Dearsley

GRAND RAPIDS
Radio Electr. Sup. Co. 443 S. Division
Wholesale Radio Co. 317 Division St

JACKSON
Fulton Radio Supply 707 S. Blackstone

KALAMAZOO
Green Radio Sales 1356 Portage St
Raiph Ralston Park and Water Sts

LANSING
Budd's Music House
Electric Prod. Sales Co. 427 E. Mich. St
Offenhauer, Inc. 227 W. Washtenaw St

MUSKEGON
Fitzpatrick Elec. Sup. Co. 42 Concord St
Industrial Elec. Sup. Co. 1839 Peck St

PONTIAC
Electronic Supply 232 E. Pike St

SAGINAW
Orem & Son 710 Genesee St
Radio Parts Co. 234 S. 2nd St

MINNESOTA

DULUTH
Heule Bros. Co. 324 E. Superior St
Northwest Radio Co. 109 East 1st St

FERGUSON FALLS
Bristol's Wholesaie Radio Co.

MANKATO
Southern Minn. Sup. Co. 2nd & Main Sts

MINNEAPOLIS
Bauman Co. 711 W. Lake St
Bonn, Lew 1211 La Salle St
Northwest Radio Sup. Co. 204 S. 10th
Radio Maint. Co. 3016½ 27th St
Stark Radio Sup. Co. 71 S. 12th St

ST. PAUL
Bonn Co., Lew 506 Robert St
Hall Electric Co. 386 Minnesota St

THIEF RIVER FALLS
Larson Co.

MISSISSIPPI

JACKSON
Orgill Bros Co.

MERIDIAN
Griffin Radio Service 809 22nd Ave

MISSOURI

BUTLER
Henry Radio Co.

CAPE GIRARDEAU
Suedekum & Sons 620 Good Hope St

JOPLIN
Brotherson, M. 515 N. Byers St
Mardick Tire & Appliance 521 Virginia St

KANSAS CITY
ABC Electi. Ser. 3619 Troost Ave
Burnstein-Appiebee 1011 McGee St
Manhatton Corp. 2008 Grand Ave
McGee Radio Co. 1225 McGee St
Radiolab 1515 Grand Ave

SPRINGFIELD
Ozark Motor & Sup. Co. 308 S. Jefferson Ave
Reed Sup. Co., 1124 Boonville Ave

ST. LOUIS
Ashe Radio Co., Walter 1125 Pine St
Brown Radio Co. Tom 3924 Wash. Blvd
Ebinger Radio & Sup. Co. 2211 Gravois Ave
Harry's Radio Parts Co. 5050 Easton Av
Hollander & Co. 3900 W. Pine
Interstate Supply Co. 28 S. 10th St
Radionics 5040 Easton Ave
Van Sickle Radio Co. 1100 Pine St

MONTANA

BILLINGS
Billings Elec. Sup. Co.
Northwestern Auto Suppiy Co.

GLASGOW
Lindgren & Co., Geo.

NEBRASKA

LINCOLN
Hick's Radio Co. 1422 O St
Leuck Electric Co. 240 S. 12th St
Walt & Sons, Edw. J.
Wickham Suppiy Co. 1512 N St

OMAHA
All-State Dist. Co. 2857 Farnam St
National Dist. Co. 602 City Nat. Bank Bldg
Noll Co., H. C. 2226 Harney St
Omaha Appliance Co. 18th & St. Marys
Radio Equipment Co. 2822 Farnum Ave

YORK
Radio Suppiy Co.

NEVADA

RENO
Savlus & Son, N. D. West & Second Sts]
Mariner, J. D.

NEW HAMPSHIRE

MANCHESTER
Radio Service Lab. 1191 Elm St

NEW JERSEY

BRIDGETON
Joe's Radio Shop South Pearl St

CAMDEN
General Radio Sup. Co. 205 N. Broadway
Radio Electric Ser. Co. 513 Cooper St

CLIFFSIDE
Nidisco Dist. Co.

HACKENSACK
Trade Radio Service 55 Essex St

JERSEY CITY
Nidisco Dist. Co. 682 Newark Ave

MORRISTOWN
Whol. Radio Sales & Ser. 145 Morris St

NEWARK
Continental Sales Co. 195 Central Ave
Krich-Radisco 422 Elizabeth Ave
Lippman, A. 246 Central Ave
Radio Wire Television 24 Central Ave

PASSAIC
Nidisco Dist. Co.

PHILLIPSBURG
Williams, C. B. 154 S. Main St

RED BANK
Bradley Radio Ser. 9 Newman Springs Rd

TRENTON
Nidisco Dist. Co.

NEW MEXICO

ALBUQUERQUE
Radio Equip. Co. 523 E. Central Ave
Radio Parts Co. 305 S. 2nd St

FARMINGTON
Western Auto Supply

ROSWELL
Supreme Radio Supp. Co. 129 W. 2nd St

NEW YORK

ALBANY
Ft. Orange Radio Dist. Co. 356 B'way
Schwartz & Son, M. 710 Broadway
Taylor & Co., E. E. 264 Central Ave

AMSTERDAM
Adirondack Radio Sup. 68 Lincoln Ave

AUBURN
Dare's Radio. 22 E. Genesee St

BINGHAMTON
Broome Dist. Co.
Federal Radio Sup. 88 State St
L & K Electric Co. 72 State St
Morris Dist. Co., Inc. 25 Henry St
Reynolds Sales & Ser. 5 Sturges St

BROOKLYN
Benray Dist. Co. 507 Coney Island Ave
Green Radio Co. 642 Sutter Ave
Hornbeam Dist. Co. 1639 Bedford Ave
Stan-Burn Radio Co. 558 Coney Island Av

BRONX
Bronx Wholesale 470 E. Fordham Rd
Radio Wire Telev. 542 E. Fordham Rd

BUFFALO
Bars Radio & Electr. Parts 91 Allen St
Dymac, Inc. 27 Barker St
Genesee Radio & Parts Co. 205 Genesee St
Radop Elec. Prod. Inc. 677 Michigan Ave
Radio Equip. Corp. 326 Elm St
Scheller Radio Parts 263 Oak St

DONGAN HILLS, S.I.
Supreme Radio Ser. 128 Seaview Ave

ELMIRA
Barker, Ross & Kimball, Inc. 511 Baidwin
Harrison, Fred C. 108 W. Church St

FREDONIA
C. R. Barker 41 E. Main St

GLOVERSVILLE
Fulton County Dist. Co.

ITHACA
Stallman of Ithaca 210 N. Tioga St

JAMAICA
Chanrose Radio Co. 170–16 Jamaica Ave
Harrison Radio Co. 170 Hillside Ave
Peerless Radio Co. 92–26 Merrick Rd

MIDDLETOWN
L & S Radio Sales 128 North St
Roskin Bros. 23 W. Main St

MT. VERNON
Davis Radio Dist. 50 E. 3rd St

NEW YORK
Arrow Radio Co. 82 Cortland St
Bruno-New York, Inc. 460 W. 34th St
Com. Radio-Sound Corp. 570 Lex. Ave
Dalis, Inc., H. L. 17 Union Sq.
Douglas Radio Co. 891 Cortland St
Eagle Radio Co. 84 Cortland St
E R S A 460 4th Ave
Federated Purchasers, Inc. 80 Park Pl
Fischer Dist. Co. 222 Fulton St
Grand Central Radio 124 E. 44th St
Harrison Radio Co. 12 W. Broadway
Harvey Radio Co. 103 W. 43rd St
Leeds Radio Co. 75 Vessey St
Newark Electric Co. 115 W. 45 St
O & W 141 Cedar St
Radio Wire Television 100 6th Ave
Roburn Agencies 115 Fulton St
Sanford Electronics Corp. 136 Liberty St
Sun Radio Co. 212 Fulton St
Sylvian Wellington 353 Canal St
Taylor, E. E. 264 Central Ave
Terminal Radio Corp. 68 W. 45th St

NIAGARA FALLS
Niagara Radio Parts Co. 1518 Main St

NORTH TONAWANDA
Block Co., L. C. 76 Main St

ONEONTA
Crouch Radio Co. 202 Main St

ROCHESTER
Beaucaire, Inc. 228 Broadway
Masline Radio Parts 192 Clinton Ave N
Radio Parts & Equip. 244 Clinton Ave N
Rochester Radio & Supl. Co. 114 St. Paul

SCHENECTADY
Schwartz & Son, M.

SYRACUSE
Berndt, W. E. 655 S. Warren St
Morris Dist. Co. 412 S. Clinton St
Stage, Roy C.
Stewart W. Smith 1051 S. Saline St
Syracuse Radio Sup. Co. 238 W. Willow

TROY
Trojan Radio Co. Inc. 426 River St

UTICA
Beacon Radio Dist. 218 Pearl St
Vaeth, C. P. 35 Genesee St

WHITE PLAINS
Westchester Elec. Sup. Co. 333 Mamaroneck Ave

NORTH CAROLINA

ASHVILLE
Freck Radio Sup. Co. 38 Baltimore St

CHARLOTTE
Allison-Grice Co. 208 N. College St
Dick & Co., H. V. 1513 Camden Rd
Dixie Radio Sup. Co. 912 S. Tryon St
Shaw Dist. Co. 205 W. 1st St

CONCORD
Question Shop 83 S. Spring St

FAYETTEVILLE
Eastern Radio Supply Co. 459 Hay St

GASTONIA
Moore & Stewart Co.

GOLDSBORO
Signal Radio Supply Co. 124 S. James St

GREENSBORO
Dixie Radio Sup. Co. 415 W. Market St
Johannensen Elec. Co. 312 N. Eugene St
Southern Elec. Inc. 255 N. Greene St

RALEIGH
Southeast Rad. Sup. Co. 411 Hillsboro St

WILMINGTON
French Radio Co.
Denuek Radio Co. I304 Market St

WINSTON-SALEM
Noland Co. 636 W. 4th St
Williams Radio Co., R. C. 211 S. Liberty

NORTH DAKOTA

FARGO
Radio Equip. Co. 620 Second Ave
Reinhard Bros., Inc. 109 Roberts St

MINOT
Reinhard Bros.

WILLISTON
Maytag Electric Co.

OHIO

AKRON
Brighton Sptg. Goods Corp. 110 E. Mkt.
Olson Bros. Radio Sup. 362 Wooster Ave
Warren Radio Co. 1013 N. Main St

ASHTABULA
Morrison's Radio Sup. 331 Center St

CANTON
Armstrong Radio Co. 226 Second St SE
Burroughs Radio Co. 620 Tuscarowas St W

CHILICOTHE
Spetnagel Hdwe. Co. 21 E. Second St

CINCINNATI
Chambers Radio Supply Co. 1104 B'way
Herrlinger Dist. Co. 1436 Vine St
Radio Supply Co. 1220 Jackston St
Schister Electric Co. 321 Sycamore St
Steinberg's, Inc. 633 Walnut St
United Radio Co. 1103 Vine St

CLEVELAND
B'way Electric Sup. Co. 6209 B'way S.E.
Goldhamer, Inc. 610 Huron Rd
Northern Ohio Labs. 2073 W. 85th St
Progress Radio Sup. 413 Horn Rd
Radio & Elec. Parts Corp. 519 Huron Rd
Radio Servicemen's Supply
Winterradio, Inc. I468 W. 25th St

COLUMBUS
Bell Radio Parts Co. 219 N. 4th St
Hughes Peters 111 E. Long St
Thompson Radio Sup. Co. 107 E. Long
Whitehead Radio Co. 120 E. Long St

DAYTON
Copp Radio Labs. 333 W. Monument Av
Standard Radio & Elec. Prod. Co.
Standard Radio Parts 135 E. 2nd St

EAST LIVERPOOL
Hausfeld Radio Ser. 414 E. 5th St

ELYRIA
Electric App. Co. 584 W. Broad St

GRANVILLE
Clark Radio Co.

KENT
Kiadag Radio Lahs. 105 Erie St

LIMA
Lima Radio Parts Co. 641 N. Main St
Northwestern Radio Co. 116 W. Spring
Warren Radio Co. Elizabeth & Spring Sts

MANSFIELD
Burroughs Radio Co. 43 S. Diamond St

MARION
Bell Radio Supply Co. 527 N. Main St

MASSILLON
Martin Sound Systems 50 Charles Av SE

SANDUSKY
Jamison, Robert 902 4th St

SPRINGFIELD
Eberle Gar. & Radio Yellow Springs Rd
Stand. Radio & Elec. Prod. Co. I19 W. Main

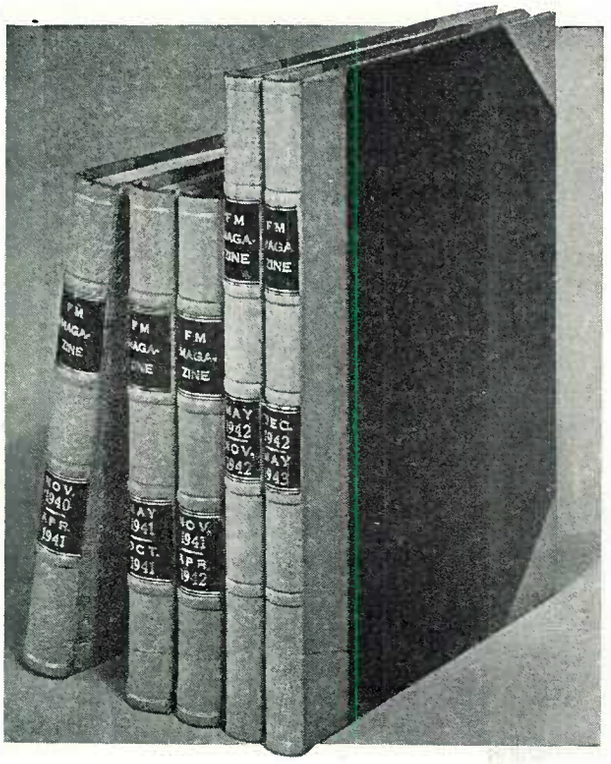
STEUBENVILLE
D & R Radio Sup. Co. 156 S. 3rd St
Hausfeld Radio Sup. Co. 230 N. 4th St

TOLEDO
H & W Auto Access. Co. 713 Adams St
Toledo Radio Spec. Jackson & 13th Sts
Warren Radio 1320 Maidson Ave

WARREN
Radio Spec. 125 Pine Ave S.E.

YOUNGSTOWN
Appl. Wholesalers, Inc. 807 Market St
Ross Radio Co. 325 W. Federal St

ZANESVILLE
Thompson Radio · 135 S. 6th St



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Radio Atlas

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

tember 21, 1945. Here is the complete text:

The Zenith Radio Corporation has received the Commission's notice of Septemer 12, 1945, indicating the new assignment for FM Radio Station WWZR. This assignment consists of a frequency of 98.5 mc. and the equivalent of 12 kw. of radiated power with an antenna height of 611 feet.

We hereby wish to register objection to this assignment. We do not object to the specific frequency assignment as compared to any others in the new band, but we do wish to object to the assignment of 12 kw. of power. As the Commission's records will indicate, WWZR is now licensed for a radiated power of 50 kw., which was allocated on the basis of the trading area for the region in which WWZR is located. This service area is 10,800 square miles, representing a radius of about 70 miles from the transmitter. We know and have evidence to indicate that WWZR on its present assignment of 45.1 mc. with 50,000 watts of radiated power does deliver an entirely satisfactory service throughout its service area. We know that at 70 miles it is delivering the best broadcasting service obtainable from any station, FM or AM, located in or near the City of Chicago. We now have reason to believe that the proposed new assignment will materially reduce this service area, and it is on this point that we wish to register objection.

As we understand the proceedings of the Federal Communications Commission, in shifting the FM band from 50 mc. to 100 mc., the sole purpose to be achieved was the reduction of interference *without* impairing the service area so that throughout its entire service area an FM station could produce interference-free reception at all times. In this respect we wish to quote from the Commission's report of allocations from 44 to 108 mc., dated June 27, 1945, Docket 6651, paragraph two of page three:

"It has been argued that the bulk of the interference anticipated will be found in outlying rural areas which rely upon low-intensity signals for their radio reception and that if these areas be excluded, FM service will be more than 99 percent perfect. The tables make it clear that urban as well as rural service will be subject to substantial interference on the lower frequencies. This Commission, moreover, is under a statutory duty to make available to *all* people of the United States an efficient nationwide radio service. The Commission's duty is not fulfilled if its provision for FM service is such as to make it impossible for rural areas to enjoy satisfactory FM service."

Coincidental with the Commission's an-

(CONTINUED ON PAGE 65)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 64)

nounced purpose of improving the service rendered by FM stations, its witnesses stated that the range of an FM station on the 100-mc. band would be greater than its range on the 50-mc. band, and we quote herewith the testimony of Dr. K. A. Norton during the period October 28, 1944, to October 30, 1944:

"The question which remains to be answered is how far we should go. Fortunately, from the propagation standpoint, this does not involve a compromise. For the same power input into the transmitting antenna I would expect slightly larger FM service areas on frequencies between 130 and 200 mcs. than on 45 mcs. even if all of the listeners use receiving antennas which are built into their receivers."

We have reason to believe that these statements do not represent conditions as they actually exist and that specifically the service range will be reduced.

As the Commission is aware, at the time of the informal engineering conference held by the Commission's Chief Engineer in the early summer of this year, *The Milwaukee Journal* volunteered to run comparative tests from its FM stations WMFM operating on its assigned frequency of 45.5 mc. and an experimental station W9XK operating on 91 mc. *The Milwaukee Journal* asked the Zenith Radio Corporation to participate in these tests to the extent of recording the transmissions. This has been done for the past approximately three months under the most careful conditions at a receiving station specially set up at Deerfield, Illinois, a distance of 76.3 miles from WMFM and W9XK.

WMFM and W9XK are located at the same identical site and use antennas on the same tower. The W9XK antenna is perhaps twenty feet lower in height than the WMFM antenna. The receiving antennas are located at exactly the same site. We have, therefore, a situation under which the signals travel from the transmitters to the receivers under precisely the same conditions.

WMFM has operated throughout this period with very rare exceptions with a radiated power of 35 kw. Using Dr. K. A. Norton's curves as supplied by the Commission, from a theoretical standpoint WMFM should deliver to a receiving antenna thirty feet high at Deerfield, Illinois, on 45.5 mc. a field strength of 31.9 microvolts per meter. Using these same curves under the same conditions, for 91 mc. there should be delivered at Deerfield 28.4 microvolts per meter. The Commission's report of May 25, 1945, on allocations from 25,000 to 30,000,000 kc., Docket 6651, pages 67 to 69, gives certain information on the ranges of stations of various powers with various antenna

(CONTINUED ON PAGE 66)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 65)

heights for frequencies of 46 mc. and 95 mc. These figures indicate that the field strength to be expected on 95 mc. is generally a trifle more than is to be expected on 46 mc. at distances out to 82 miles. Apparently these figures were taken from Dr. Norton's curves, and they appear to us to be in error to the same extent that Dr. Norton's curves seem to be in error.

We have been able to analyze our recorded field strengths from WMFM and W9XK for a part of the duration of the observations on these stations, and we find that the average of field strengths for this period of time, consisting of 12 days, indicates that on 45.5 mc. a field strength of 60 microvolts per meter is received at Deerfield and on 91 mc. an average strength of 16.8 microvolts per meter is received at Deerfield. This is a ratio of about 3½ to 1. Now, an antenna of proper length for 100 mc. will pick up one-half the voltage that will be picked up by an antenna cut for 50 mc. This means a further reduction of signals across the input to an FM receiver of 2 to 1. The combination of this reduction with the ratio of 3½ to 1 results in a difference of 7 to 1 between the signals at the input of a receiver received on 50 mc. as against 100 mc. The 100-mc. signals will be down at the receiver input to one-seventh of what they are at 50 mc., representing a power difference of 49 to 1. It, therefore, appears that the effect of transmissions on 100 mc. as compared to 50 mc. in terms of what the user of a radio receiver will get will be very great, especially in the rural areas, and the 100-mc. service will be much inferior.

We regret that at this moment we do not have a complete analysis of the three months' period of recordings. This is in process and this information will be furnished to the Commission complete in all details, including copies of the recordings and all pertinent information relating to them, to the equipment on which they were made, and to the calibration of this equipment. The calibration of the equipment has been checked and made, among others, by Mr. Roberts of the FCC and by Mr. Stuart L. Bailey of Jansky and Bailey.

On the basis of this information we believe that the service from WWZR is going to be very seriously curtailed and this is the primary basis of our objection. A secondary basis of objection, but of no less importance, is the belief that since the Commission has indicated in its public notice of September 12, 1945, that FM stations in Area No. 1 may not be protected beyond their 1000 microvolt-per-meter contour, the Commission's allocation will very effectively reduce the FM broadcasting service to a strictly metropolitan service offering small possibility of giving the real service which the FM

(CONTINUED ON PAGE 77)

NEW FREQUENCY METER FOR COMMUNICATIONS SERVICE

The first of the new series of BROWNING communications instruments will be a Frequency Meter calibrated at any one to five points in the band between 100 and 500 mc.

The design of this instrument will represent the most advanced practices in precision frequency measuring instruments, developed by the BROWNING LABORATORIES for radar test equipment.

Watch for the announcement of this new meter, designed specifically for the needs of the communications services.

In the meantime, we are continuing to supply the standard crystal-controlled BROWNING Frequency Meters for one to four frequencies between 1.5 and 120 mc.

For details of prices and deliveries, address:

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The Reader's Digest, in its Aug., 1941 issue, ran an article saying that investigators on its staff found that radio service-dealers cheated the public on 64 out of 100 repair jobs. After citing several examples, the article ended with a warning that radio owners should "beware" of the repair man.

SHOULD RADIO SERVICE DEALERS BE LICENSED?

N. Y. HERALD TRIBUNE JANUARY 24, 1945

City License Law Urged For Radio Repair Men

Magistrate James A. Blanchfield declared yesterday in Flatbush Court that he would ask the City Council for a law requiring

bonded in order to do business.

THE NEW YORK TIMES JANUARY 24, 1945

RADIO RACKETEERS ASSAILED BY COURT

Says Repair Men Should Be ... Licenses

N. Y. WORLD-TELEGRAM JANUARY 23, 1945

Irked Magistrate Lashes at Racket in Radio Repairs

Declaring that radio repairmen were fleecing customers by charging all the traffic would bear, Magistrate James A. ... in Flatbush Court, Br... to take up the ... att...

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HAS THE ANSWER!
watch for announcement to be made soon

No intelligent radio service-dealer will deny the fact that the reputation of his industry has suffered in recent years.

Unethical servicemen who have taken advantage of manpower and parts shortages have done great damage to public opinion. They have caused so much adverse publicity in national magazines and influential newspapers that dealer-licensing, federal regulation and even finger-printing are being suggested for the public's protection.

Raytheon began many months ago to *remedy* this situation, and now has the answer in a strong merchandising program to be announced soon.

It will be revolutionary in every respect, enabling the public to tell *which* service-dealers deserve complete trust and confidence.

Dealers who can qualify will immediately have a tremendous competitive advantage. Watch for our announcement!

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Radio Tubes

Listen to
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AMERICAN BROADCASTING CO.
Every Monday Night
Coast to Coast
181 Stations

All Four Divisions Have Been Awarded Army-Navy "E" With Stars

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DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS

NEW INSTANT-HEATING BEAM TETRODE

Ruggedized 2E25 FOR MOBILE OPERATION

Developed for Signal Corps portable, mobile, or emergency communications equipment, the 2E25 r.f. beam tetrode is easy on the battery. The thoriated tungsten filament permits simultaneous application of filament and plate potentials. Precious battery power is conserved during standby periods.

Completely shielded for r.f., the 2E25 requires no neutralization even at its maximum frequency of 100 megacycles. Other features are: low-loss octal base, plate connection to top cap, filament potential centered at 6.0 volts, and extremely rugged construction.

Consider the advantages of the 2E25 as an instant-heating replacement for the 6V6GT or 6L6G in older equipment, or for use in modern equipment such as the new Kaar mobile FM set illustrated. Remember, the versatility of the 2E25 beam tetrode simplifies the spares problem; this one type can power a whole transmitter—R.F. and A.F. Order your engineering samples today.

HYTRON 2E25

Instant-Heating 15-Watt R.F. Beam Tetrode

TENTATIVE ELECTRICAL DATA

Filament Potential	6.0 ± 5% ac or dc volts
Filament Current	0.80 amp.
Plate Potential	450 max. dc volts
Screen Potential	250 max. dc volts
Grid Potential	−125 max. dc volts
Plate Current	75 max. dc ma.
Plate Dissipation	15 max. watts
Screen Dissipation	4 max. watts
Grid Driving Power (Class C)	0.5 watt approx.
Power Output (Class C)	20 watts

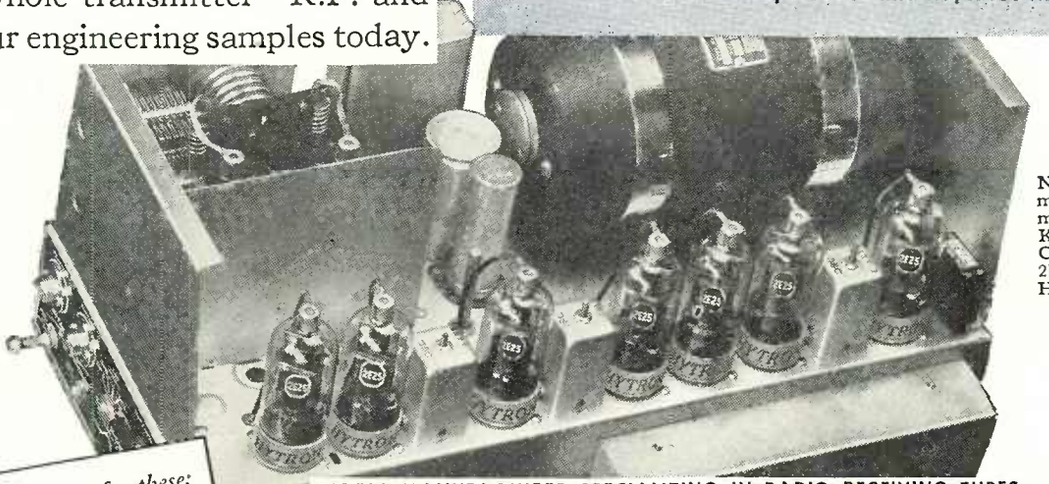
AVERAGE DIRECT INTERELECTRODE CAPACITANCES

Grid to Plate (with external shielding)	0.18 max. mmfd
Input	8.5 mmfd
Output	6.0 mmfd

MECHANICAL DATA

Maximum Overall Length	4 3/16 inches
Maximum Diameter	1 7/16 inches
Bulb	T-11
Cap	Small metal
Base	7-pin med. short shell low-loss octal

The New 2E25 Supersedes and Replaces the HY65



New instant-heating mobile FM transmitter developed by Kaar Engineering Co. uses 7 Hytron 2E25 and 2 Hytron HY69 or HY1269.

ARMY (E) NAVY

WRITE TODAY to Dept. 22 for these: New Hytron transmitting and special purpose tube catalog; 21 x 17 inch sheet illustrating Step-by-Step Assembly of Typical Hytron Tube.

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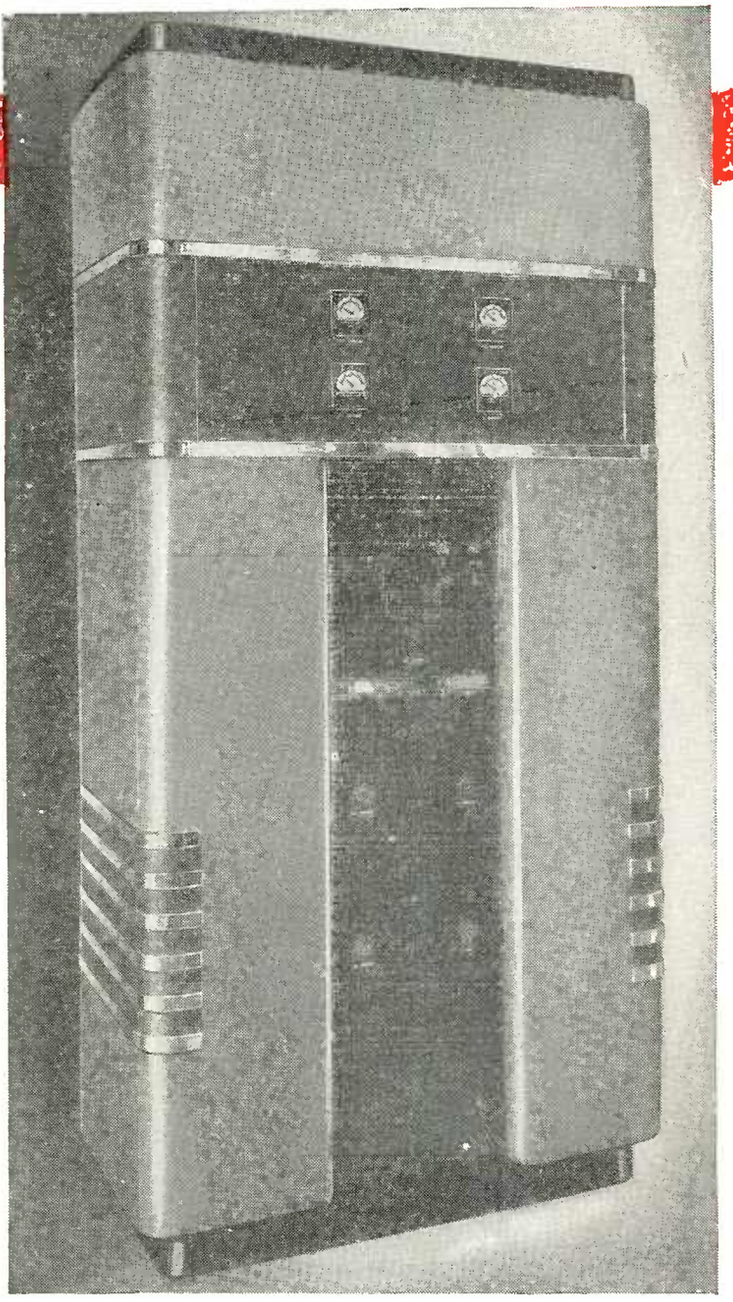


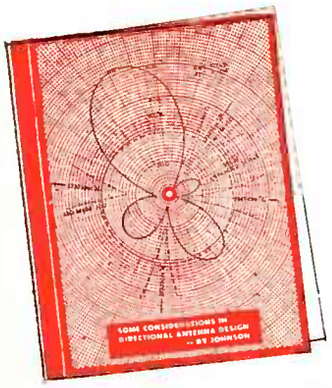
You no longer have to be satisfied with mere planning for better market coverage! Johnson engineers are now ready to tackle your directional antenna problem and to get the Phasing Equipment you need into production.

Phasing equipment by Johnson can be found successfully operating in more than 50 broadcast stations and is backed by over 20 years experience in the manufacture of radio transmitting equipment. All major components used in Johnson Phasing and Antenna coupling equipment are designed and manufactured by Johnson, assuring the best material and workmanship. The quality of the equipment is under control of Johnson engineers at all times.

Shown at right is one of the Johnson installations designed to match existing equipment.

A Johnson Phasing Unit can be made to exactly match your present equipment and thus become an integral part of your station.

Orders for Phasing and Coupling equipment will enter production in the order received. Contact us without delay, directly or through your consulting engineer.



Write for Brochure-

"Some considerations in Directional Antenna Design"

—By Johnson

E. F. JOHNSON COMPANY, Waseca, Minn.

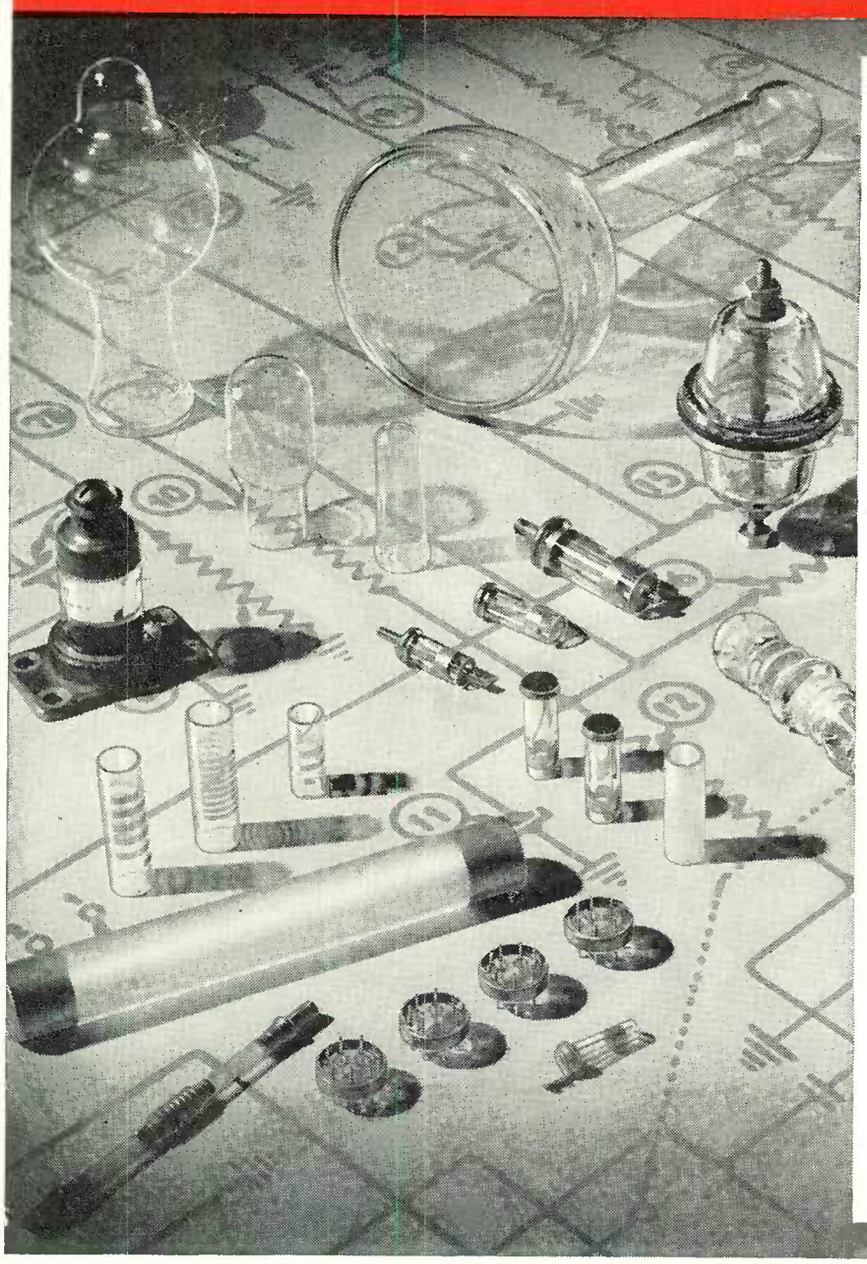
JOHNSON

a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA

WHAT WILL YOU NEED TO PRODUCE BETTER POST-WAR PRODUCTS?

CORNING GLASS GIVES YOU



Special Electrical Qualities
Thermal Endurance
Hermetic Sealing
Mechanical Strength
Corrosion Resistance
Precision
Permanence
Metallizing
Dimensional Stability

High dielectric strength — high resistivity—low power factor—wide range of dielectric constants—low losses at all frequencies.

Permanent hermetic seals against gas, oil and water readily made between glass and metal or glass and glass.

Commercial fabrication to the fine tolerances of precision metal working.

Corning's metallizing process produces metal areas of fixed and exact specification, permanently bonded to glass.

AS YOU plan post-war electronic products, give a thought to versatile glass. We really mean glasses, for Corning has, at its fingertips, 25,000 different glass formulae from which to select those especially suited to your electronic applications. Let us show what glass can do for you. We may already have a solution — or Corning Research can find the answer for you. Address Electronic Sales Dept., F-10 Bulb and Tubing Division, Corning Glass Works, Corning, New York.

CORNING *means* Research in Glass

Electronic Glassware

TRADE MARK VYCOR REG. U.S. PAT. OFF. T.M. REG. CORNING U.S. PAT. OFF. T.M. REG. PYREX U.S. PAT. OFF.

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

20,000 VOLTS IN A 2 3/8" BULB!

ANOTHER "FIRST" BY NATIONAL UNION RESEARCH LABORATORIES

AN example of how war-time research by National Union engineers is helping to lay the foundation for vastly improved post-war Television, FM and radio reception, is this new half wave high vacuum rectifier—the NU 1Z2.

Here is a miniature with the voltage handling capabilities heretofore possible only in full size tubes. For a high voltage rectified supply in the operation of radar and television equipment, the NU 1Z2 saves space—operates with increased efficiency—is exceptionally rugged. Its low filament power consumption suggests many new fields in circuit design and application.

The NU 1Z2 joins a notable group of original electron tube developments by National Union Research Laboratories. For progress through research —count on National Union.

National Union 1Z2
High Voltage Rectifier

Inverse peak anode voltage-max.	20,000 volts
Peak anode Current	10 ma.
DC Output Current	2 ma.
Filament Voltage	1.5 volts
Filament Current	300 ma.

The NU 1Z2 is designed to withstand shocks in excess of 500 G's.

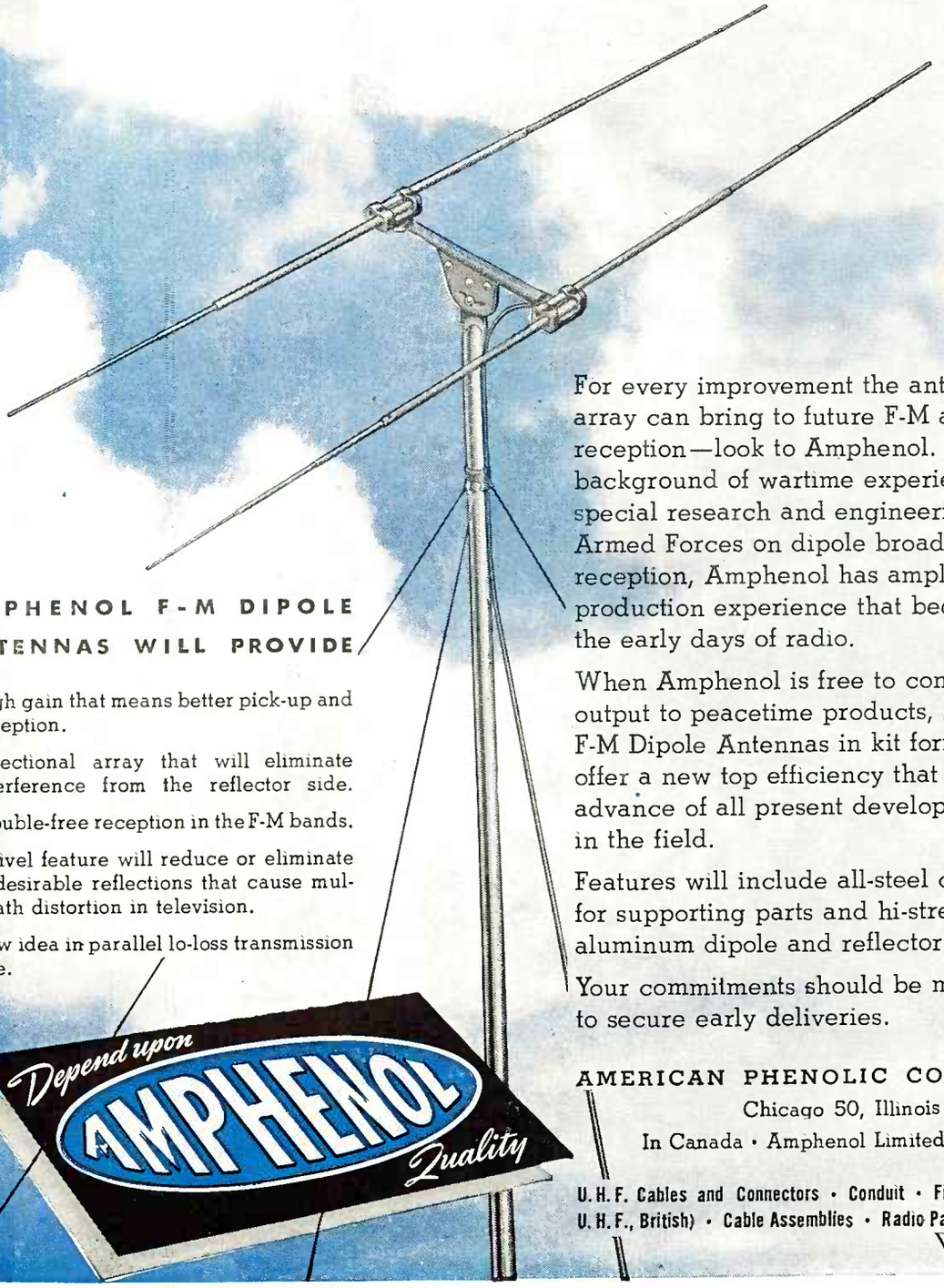
Maximum overall length	2.70"
Maximum seated height	2.37"
Maximum diameter	.75"
Bulb	T5½
Base Miniature Button	7 pin
Mounting position	Any

NATIONAL UNION
RADIO AND ELECTRON TUBES

NATIONAL UNION RADIO CORPORATION · NEWARK 2, N. J.

AMPHENOL ANTENNAS

Promise . . . New Improvements In Postwar F-M and Television Reception



AMPHENOL F-M DIPOLE ANTENNAS WILL PROVIDE

- High gain that means better pick-up and reception.
- Directional array that will eliminate interference from the reflector side.
- Trouble-free reception in the F-M bands.
- Swivel feature will reduce or eliminate undesirable reflections that cause multipath distortion in television.
- New idea in parallel lo-loss transmission line.

For every improvement the antenna array can bring to future F-M and television reception—look to Amphenol. With a background of wartime experience in special research and engineering for the Armed Forces on dipole broad band reception, Amphenol has amplified its long production experience that began in the early days of radio.

When Amphenol is free to convert its output to peacetime products, Amphenol's F-M Dipole Antennas in kit form will offer a new top efficiency that is in advance of all present developments in the field.

Features will include all-steel construction for supporting parts and hi-strength aluminum dipole and reflector rods.

Your commitments should be made now to secure early deliveries.

Depend upon AMPHENOL Quality

AMERICAN PHENOLIC CORPORATION

Chicago 50, Illinois

In Canada • Amphenol Limited • Toronto

U. H. F. Cables and Connectors • Conduit • Fittings • Connectors (A-N, U. H. F., British) • Cable Assemblies • Radio Parts • Plastics for Industry

WHEN THE INSULATION GOES—

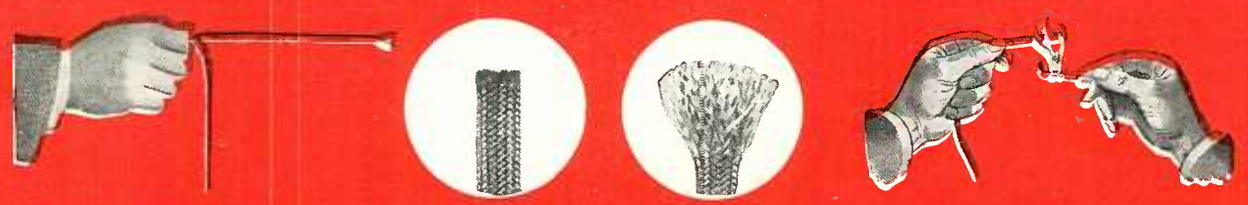
YOUR TROUBLE STARTS!

WHAT does it mean to *you* when Mrs. Smith's electric iron goes *phht?* If electrical insulation is a part of *your* product, whether it's appliance, radio or electrical equipment, you, like the iron manufacturer, run this *risk*. The risk of insulation failure—of inconveniencing customers, jeopardizing good will, and possibly losing sales.

Since your product's performance may depend on a few cents worth of insulation, be sure to use the best. Assure trouble-free service with BH Fiberglas Sleeving, the *original* non-fraying, non-stiffening, non-burning Fiberglas sleeving. An exclusive BH process combines *permanent* freedom from hardening, cracking or rotting with the many advantages of Fiberglas — including high dielectric and tensile strength, resistance to moisture, oil, grease and most chemicals.

Severest wartime uses prove beyond question the superior qualities of all three BH Fiberglas Sleevings in electrical applications for home and industry. One of them may fit your needs to a "T"—*plus!* Write for free BH samples today and put them to the toughest tests your product can dish out!

3 GREAT BH FIBERGLAS SLEEVINGS— *EACH 3 WAYS BETTER!*



NON-STIFFENING* **NON-FRAYING*** **NON-BURNING***

BH *EXTRA FLEXIBLE* FIBERGLAS SLEEVING • BH SPECIAL TREATED FIBERGLAS SLEEVING
BEN-HAR COATED FIBERGLAS SLEEVING

**Ask for sample folder giving degree above characteristics are combined in these three sleevings.*
All standard sizes and colors—available in standard 36-in. lengths and 500-ft. coils.

BH PRODUCTS

ALSO SLOW-BURNING IMPREGNATED MAGNETO TUBING • SLOW-BURNING FLEXIBLE VARNISHED TUBING • SATURATED SLEEVING • A. S. T. M. SPECIFICATIONS

BENTLEY, HARRIS MANUFACTURING CO.

Dept. B Conshohocken, Penna.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 66)

system is capable of doing. The principal trouble with broadcasting in the Standard AM band is that outside of the metropolitan districts, stations are burdened with heterodynes and interference, reducing their value to listeners located in the regions where this takes place. Reduction of protection of FM stations to the 1000 microvolt per meter contour effectively limits the service of the FM systems to about the same order of affairs as now exists in the AM band. The utility of the FM systems will be reduced to a point of parallelism with the AM system, and the great advantages and promise which it appeared to have offered to the public over conventional broadcasting are lost.

In making objection to the power assignment given to WWZR, we do not ask for any more power or any better facilities than any other station in this area. It is our contention that instead of reducing the service area of all of the FM stations concerned, it should be increased, and that other stations in the same area that WWZR serves should be permitted to have equal facilities.

Very truly yours,

ZENITH RADIO CORPORATION
G. E. GUSTAFSON
Vice President in Charge of Engineering

The Commission had ample warning that Kenneth Norton's theoretical conclusions were in error. It is contained in testimony which set forth the practical experience of Messrs. Armstrong, de Mars, Bailey, and Pickard.

As Mr. Gustafson pointed out in the Commissions own words, "The Commission's duty is not fulfilled if its provision for FM service is such as to make it impossible for rural areas to enjoy satisfactory FM service." The only way in which the Commission can fulfill its duty is to return the lower band to permanent use by high-power FM stations. Only then will there be an adequate number of FM channels.

HIGH-FIDELITY

(CONTINUED FROM PAGE 24)

or thereabouts, when Major Armstrong's invention was first attracting wide attention. In the years since then, as we all know, many changes have occurred. Technical advances in inter-city transmission have increased by leaps and bounds. Within the past two years, the telephone company has advised us that, after the war, lines can be made available that carry much higher frequencies — frequencies of 8,000, 10,000 and even 15,000 cycles. Parallel with this, wartime developments in radio relay in the ultra-high frequencies have been remarkable. Four different companies have, I believe, announced plans and have applied to the Commission for the common-carrier use of such frequencies, capable among other things of relaying network radio programs from city to city to city on wider bands, and with a fuller frequency range than any FM transmitter can broadcast or than the finest FM radio set can receive.

"We have discussed this factor carefully with our affiliated stations and have given them the assurance, which I now offer also to the Commission, that if the public wants and if the Commission requires a higher frequency range for FM transmission, it is the Columbia Broadcasting System's intention to provide it, within a reasonable time from the date on which such inter-city facilities become commercially available and reliable.

"In passing, let me add that we know that the Commission is interested in this objective only in the light of public service, and that there are considerable data which indicate that the upper limits of public preference for high frequencies fall considerably short of the theoretical limits technically possible with FM. We have no doubt that set manufacturers will conform their designs to what listeners and purchasers really want and we are confident that the Commission will at no time force broadcasters into wasteful excesses of transmission which could profit only the common-carriers which sold the service, rather than the radio listener."

How Opinions Change ★ We are not concerned, today, with considerations of separate programming for the FM affiliates of AM stations, since the FCC has now decided that it will not be required. But it would be a very serious error to conclude, on the basis of the Chinn-Eisenberg tests, that the upper limits of public preference for high frequencies fall considerably short of the full audio capabilities of FM.

Today, the majority of AM listeners have not yet heard FM reception. Of FM receivers now in use, a considerable number afford neither high-quality reproduction nor noise elimination. And, for the past four years, practically all FM transmission has been limited to low-fidelity, narrow-range network programs and recordings, with the volume range held to very narrow limits.

At least the public will have a chance to choose between narrow-range and wide range transmission and reception for, even though the networks cling to present low-fidelity circuits and equipment, and strain their FM programs through AM limiters, the independent FM stations will offer high-fidelity and full dynamic range. Then receivers of adequate audio capabilities will enable listeners to decide between the two types of transmission. That choice will, of course, be reflected in the purchase of receiving sets.

Next Month . . .

THE SECRET FM HEARING

BY PAUL A. DE MARS

In the November, 1945 issue of *FM* AND TELEVISION, Paul A. de Mars will discuss the testimony given at the FCC's secret FM hearing, recently declassified. As former vice president in charge of engineering for the Yankee Network during the period when the Paxton and Mt. Washington FM stations were installed, and until recently a Lieutenant Commander in the U. S. Navy, his practical knowledge of the facts involved in the secret hearing make this discussion of extraordinary interest to every engineer and executive in the radio industry.

DON'T MISS THIS IMPORTANT ARTICLE NEXT MONTH.

HIGH-FIDELITY

(CONTINUED FROM PAGE 77)

The extent to which the opinions and policies of network executives have changed is indicated by comparing testimony of FM and television given before the FCC in March, 1940, by Paul A. Porter, then attorney for the Columbia Broadcasting System, with Mr. Kesten's statement of July, 1945.

In 1940, Mr. Porter testified that, in the opinion of CBS, if there was any allocations conflict between FM and television, "preference should be given to the new public service of television rather than an additional system of oral broadcasting."[3]

Yet Mr. Kesten, in his statement to the FCC on July 30, 1945, prefaced his remarks with these words: "May I say first of all that I believe the issues before the Commission at this hearing probably exceed in total importance to the public and to the broadcaster those of any hearing I can remember before this Commission or before its predecessor, the Federal Radio Commission. I say this because I believe that FM is not merely one aspect of the future of audio broadcasting — but that it contains in itself almost the whole future of audio broadcasting. Most of us at CBS have believed, from the very early days of FM, that except in certain rural areas, FM was technically destined to replace AM transmission, as surely and inevitably as the tungsten lamp was destined to replace the old carbon filament."

This right-about-face of the CBS attitude toward FM shows the danger of freezing plans for radio facilities, or limiting broadcast service at any level below the point of maximum quality.

MILTON B. SLEEPER

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[3] The full text of Mr. Porter's testimony before the FCC in March, 1940, when he was attorney for CBS follows: "Mr. Chairman, and gentlemen of the Commission, the Columbia Broadcasting System is the licensee of three ultra-high frequency broadcast stations that operate with a system of amplitude modulation. In recognizing the desirability or the probable desirabilities of the frequency modulation system we have pending two applications for modification of licenses to employ the system of frequency modulation. Pending actual field experience, Columbia is reserving any final conclusions as to the relative merits of the two systems. We stated in our notice of appearance that we propose to examine certain data which had been accumulated with reference to our experience in the high frequency bands and that if it appeared that that data was pertinent to the issues enumerated, witnesses would be offered. Because of the fact that we have had no actual operating experience in the field in frequency modulation, we do not propose to offer any direct testimony. One observation which is probably in the nature of an opinion, if I may be permitted to make, I have been requested to do so, and that is if there is a conflict, as there appears to be, in the allocation problem with respect to television and frequency modulation, it is the opinion of the Columbia Broadcasting System that preference should be given to the new public service of television rather than an additional system of oral broadcasting. Finally, I would like to reserve the right or the privilege, if it be accorded to others, to file any statements or memorandum based upon the record at the conclusion of the hearing, and we have no testimony that we propose to offer."

TELEVISION ALLOCATIONS

(CONTINUED FROM PAGE 48)

with the troubled conviction that it is, or soon will be, irrevelant — as though, at this hearing, we were all speaking the lines and rehearsing the parts for a play that will never really open, or will close down almost as soon as it opens. I have in mind, of course, the future use of the higher television frequencies which will ring the curtain down abruptly on the stage we are setting here."

It appears that the future of low-band television depends principally on the FCC's answer as to the permanence of operations in that band.

This is an embarrassing situation for both the industry and the FCC, because the Commission is put in the position of having to decide if low-band television reception is good enough to perform a commercially useful public service and, what is even more difficult, if upper-band reception is going to be so much superior as to render the other obsolete.

Full-speed development on both systems has been under way for so short a time that we do not yet know the ultimate of low-band performanee. As for the upper band, only CBS has made any statements of actual accomplishment. On this point, Paul Kesten testified on October 11th:

"We, at CBS, adopted the rule of saying as little as possible on this controversial subject until we could show actual results. But I feel compelled, as a matter of responsibility to the Commission, to break that silence here and now. Although we are not yet ready to show to the public the miracle of these new pictures, I wish to disclose at this time three pertinent facts:

"1. Just three weeks ago today, on September 27th, I saw these new pictures, in magnificent color, in a laboratory over a closed circuit. Although nominally 525-line pictures, each completed picture contained 1575 imperceptible lines of beautifully detailed color, and the circuit was complete from the seanning device to the actual receiver.

"2. Later on the same day, I saw the same pictures actually broadcast, still in the laboratory, but with a transmitter at one end of the room and a receiver at the other. They were just as perfect as the closed circuit images.

"3. Only yesterday, October 10th, I saw these television pictures successfully broadcast across the crowded New York skyline and received many blocks away with superb clarity — demonstrating the actual use of the ultra-high frequencies and the modulation of a 10-megacycle video band — two of the things so many were so sure could not be done."

It is not possible to estimate the significance of these remarks now. They may indicate actual accomplishments which will influence the immediate future of television, or they may be more of the Kesten smoke-screen maneuvering to protect CBS.

SPOT NEWS NOTES

(CONTINUED FROM PAGE 38)

plastics molding facilities of American Phenolic Corporation. Equipment is being installed for injection, extrusion and compression modling. The new building adjoins the main Amphenol plant at 1830 S. 54th Avenue.

New Directors: Of Finch Telecommunications, Inc. are Vincent Stanley, former president of Gamewell Company, fire-alarm equipment manufacturers, and Herbert L. Petty, executive director of WHN and former secretary of the FCC.

Yankee Network: With Paxton reduced to 9.5-kw. radiated power on 101.7 mc., Yankee plans to spend $285,000 on 4 new stations in Boston, Bridgeport, Hartford, and Providence, and modification of the Paxton station, near Worcester. Mt. Washington station WMTW, now programmed by radio link from the Boston studio, will be served from Portland, Me.

All transmitters will be of 10-kw. design, with 20-kw. effective radiated power. Paxton, cut to 9.5-kw. radiated power, will operate on 101.7 mc., with studios in Worcester.

Applications call for Boston studios at 21 Brookline Avenue, with transmitter on 92.9 mc. at Lynnfield; Bridgeport studios will be in Hotel Stratfield, with transmitter on 102.3 mc. at Trumbull; Hartford transmitter, on 93.9 mc., will be on Avon Mountain; Providence studios will be at Crown Hotel, with transmitter on 96.5 mc. at Bristol.

ENGINEERING SALES

(CONTINUED FROM PAGE 8)

Zenith: General Manager of Zenith Radio Distributing Corp., Chicago, is James H. Hickey, a Zenith district sales manager since 1935. Sales manager of this Zenith-owned subsidiary is Charles F. Parson, Jr. who, during the war, supervised Zenith military contracts.

Echophone: New sales manager of Echophone division of Hallicrafters is Paul H. Eckstein, former assistant sales manager of home radio sales for Westinghouse.

Chicago: Newark Electric has enlarged its quarters at 323 West Madison Avenue. Some 2,000 square feet will be devoted to booths for demonstrating new equipment, and 5,000 square feet will be added to the mail order department.

Russell Electric: Has appointed A. O. Seehafer as general sales manager for record-charger motors, phono drives, and small motors.

New York City: Paul E. Moss, former sales manager of Bendix International division, has opened offices in the Empire State Building, where he will act act as international trade supervisor for U. S. manufacturers.

An Announcement to Advertisers

Effective January 1, 1946, rates for advertising in *FM* AND TELEVISION will be increased about 20%. At that time, the trim size will be enlarged again to 8¾ x 11⅝ ins., and we shall resume the use of 70-pound coated stock for text and advertising, and 100-pound coated stock for the cover.

This will again afford readers and advertisers the superior quality of printing which characterized *FM* AND TELEVISION prior to wartime restrictions.

The present advertising rates were set in 1940, on the basis of a type page 5½ x 8 ins., and 5,000 circulation.

In May, 1942, the type page was increased to the standard size of 7 x 10 ins. The 1940 space rates were unchanged.

In October, 1944, an increase in our paper allotment permitted us to increase the circulation to 6,000. Since space rates were not changed, this represented a 20% circulation bonus to advertisers.

Since V-E Day, subscriptions to *FM* AND TELEVISION have been increasing in such numbers as to assure a large increase during 1946 over the present circulation.

Practically all plans for postwar radio expansion are centered around the two fields to which FM AND TELEVISION *is devoted. This explains the greater effectiveness of advertising in this publication, and its increasing circulation, which amply justify the adjustment of space rates.*

However, there will be no increase of rates for the year 1946 on contracts placed prior to December 31, 1945. All contracts placed after that date will take the new rates.

FM AND TELEVISION

511 FIFTH AVENUE, NEW YORK 17, N. Y.

BOOK REVIEW

TELEVISION PROGRAMMING AND PRODUCTION, by Richard Hubbel. 203 pages, profusely illustrated, cloth bound, 6¼ by 9¼ ins. Published by Murray Hill Books, Inc., 232-F Madison Ave., New York 16, N. Y. Price $3.00.

Richard Hubbel's book is a refreshing addition to radio literature, not only because the material presented in it is completely new and, therefore, interesting to read, but because he has made the most of his opportunity in writing the first book on an important subject.

As the author points out, no background of experience has been made available previously and, in consequence, telecasters have been forced to operate on a trial-and-error basis, often repeating costly mistakes already made by others.

Therefore, this book, evaluating and presenting the fundamentals established by experiences at American television studios, has much to offer broadcasters, advertising men, writers, directors, actors, designers, technicians, and students. Since members of these groups are very much individualists, there may not be unanimous agreement with Mr. Hubbel's ideas. However, they do command respectful consideration, for he has had ten years of television experience, first as a member of the original CBS television staff, then as an independent television consultant, and now as production manager and television consultant for the Crosley Corporation.

FCC FM STANDARDS

(CONTINUED FROM PAGE 37)

sidered on the basis of data submitted by the manufacturer. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details (two sworn copies).

The specifications that the modulation monitor shall meet before it will be approved by the Commission are as follows:[11]

A. ADJUSTMENT: A device for setting the transmitter input to the modulation monitor.

B. MODULATION PEAK INDICATING DEVICE: A modulation peak indicating device that can be set at any predetermined value from 50 to 120% modulation (± 75 kc. swing is defined as 100% modulation) and for either positive or negative swings (i.e., either above or below transmitter center frequency).

C. VU METER: An indicator using a

(CONCLUDED ON PAGE 83)

[11] In connection with its type approval of FM equipment, the Commission may send a representative to observe tests made of such equipment by the manufacturer.

FCC FM STANDARDS

(CONTINUED FROM PAGE 82)

meter having the characteristics and scale of a standard VU meter. A switch shall be provided so this meter will reach either positive or negative swings. The accuracy of reading of percentage of modulation shall be within ± 5% modulation percentage at any percentage of modulation up to 100% modulation.

D. Frequency Characteristic Limits: The frequency characteristic curve shall not depart from a straight line more than ± 1/2 db from 50 to 15,000 cycles. Distortion shall be kept to a minimum.

E. Power Absorption: The monitor shall not absorb appreciable power from the transmitter.

F. Effect on Transmitter: Operation of the monitor shall have no deleterious effect on the operation of the transmitter.

G. Design Requirements: General design, construction and operation shall be in accordance with good engineering practice.

16. Approved Transmitters.[12]

17. Approved Frequency Monitors.[12]

18. Approved Modulation Monitors.[12]

19. FM Broadcast Application Forms

FCC Form No. 314 — Application for Consent to Assignment of Radio Broadcast Station Construction Permit of License. (See Rules Section 3.223.)

FCC Form No. 315 — Application for Consent to Transfer of Control of Corporation Holding Construction Permit or Station License. (See Rules Section 3.223.)

FCC Form No. 316 — Inventory of Station Property to be submitted with Forms FCC No. 314 and 315.

FCC Form No. 319 — Application for New FM Broadcast Station Construction Permit.

FCC Form No. 320 — Application for FM Broadcast Station License.

FCC Form No. 322 — Application for Construction Permit, Modification of Construction Permit, or Modification of License for an Existing FM Broadcast Station.

FCC Form No. 328 — Income Statement to be submitted with Forms FCC No. 314 and 315.

FCC Form No. 340 — Application for New Noncommercial Educational Broadcast Station Construction Permit.

FCC Form No. 701 — Application for Additional Time to Construct Radio Station.

Additional forms and revisions of the above forms are being prepared. The appropriate forms to be employed may be obtained from the Commission upon request.

[12] Lists of approved equipment will be issued from time to time for incorporation in these Standards.

for the Finest in . . . **FM**

THE TWO CHANNEL PHASE-SHIFT MODULATOR IS STILL THE BEST

REL is the pioneer builder of the phase-shift modulators and transmitters for the Armstrong wide band FM system of radio signaling. The modulators include the original design and the greatly improved two channel design described by Major Armstrong before the Institute of Radio Engineers on November 5, 1941. Modulators built by this company have been in constant reliable operation throughout the country since 1938. And on Mt. Washington, inaccessible for months each year, the two channel modulator has performed without a flaw.

The basic electrical characteristics of the two channel modulator now in the field leave little opportunity for improvement but we have learned how to add to the modulator's reliability through improvements in its mechanical and component design. REL takes pride in announcing that the improvements are substantial and that they are incorporated in REL FM broadcasting transmitters shortly to be made available to the industry.

REL

Sales Representatives

MICHIGAN	MIDWEST	PACIFIC COAST
M. N. Duffy & Co., Inc.	REL Equipment Sales, Inc.	Normon B. Neely Enterprises
2040 Grand River Ave. W.	612 N. Michigan Blvd.	7422 Melrose Avenue
Detroit, Mich.	Chicago, Ill.	Hollywood 46, Col.

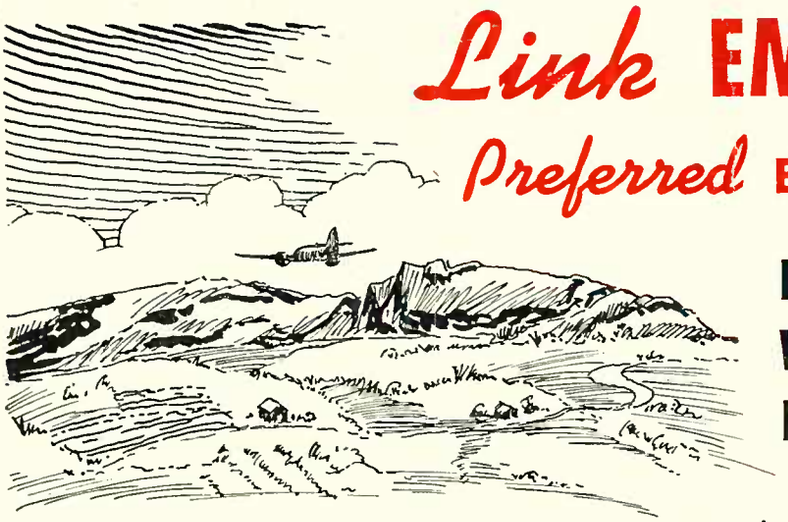
PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

RADIO ENGINEERING LABS., INC.

Long Island City, N.Y.

Link EMERGENCY RADIO

Preferred BY Proven Performance

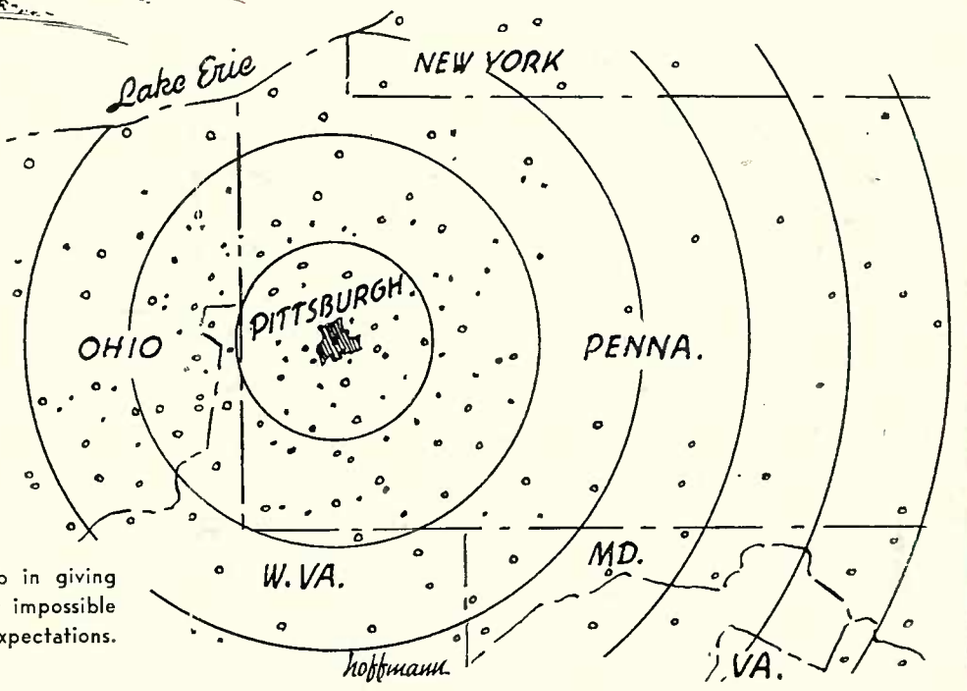


IN PITTSBURGH, PA. AREA--WHERE WORST OPERATING CONDITIONS IN THE COUNTRY PREVAIL

The rugged Alleghany Mountains with their tall peaks and deep valleys and harboring untold quantities of mineral and ore deposits, are truly "Radio's Graveyard". It is conceded that the worst communication conditions encountered anywhere in the country prevail in this area.

Fanning out from Pittsburgh in widening circles are hundreds of Link installations in six states. These include State, County, Township, Borough, City, Utility, Commercial, Forestry, Park, Highway and other emergency radio applications.

Considering these unfavorable conditions, it is significant that wherever Link equipment is installed, it is doing an outstanding job in giving trouble-free performance. A job believed almost impossible by some and always cited as surpassing all expectations.



PARTIAL LIST of LINK RADIO USERS IN THIS AREA

PENNSYLVANIA

Police

Altoona
Ambridge
Baldwin Twsp.
Beaver
Beaver Falls
Bethel Twsp.
Brentwood
Charleroi
Crafton
Dormont
Fox Chapel
Hanover
Indiana Twsp.
Ingram
Latrobe
McKees Rocks
Monnessan
Monongahela
Mt. Lebanon Twsp.
New Castle
O'Hara Twsp.
Penn Twsp.
Pennsburg
Pittsburgh
Pottsville
Scranton
Shaler Twsp.
Sharon
Sharpsburg
Uniontown
Warren
Washington
West Mifflin
West View

Utilities

Duquesne Light Co.
Peoples Natural Gas Co.
Pittsburgh Railways Co.
Penna. Electric Co.
Penna. Power & Lt. Co.
W Penn Power Co.

Commercial

Homestead Steel

OHIO

Police

Alliance
Ashtabula
Barberton
Bellaire
Cambridge
Campbell
Canton
Chillicothe
Circleville
Coshocton
Dayton
Euclid
Galion
Geneva
Girard
Indian Hills
Jackson
Lima
London
Lowellville
Madison County
Mahoney County
Mansfield
Massillon
Niles
Port Columbus
Portsmouth
Ravenna
Richland County
Rocky River
St. Clairsville
Salem
Sandusky
Sebring
Springfield
Stark County
State Hway. Ptl.
Toledo
Trumbull County
Uhrichsville
Warren
Wayne County
Wellsville
Wooster
Youngstown

Utilities

Dayton Pwr. & Lt. Co.
Ohio Power Co.
Ohio Public Service Co.
Ohio Edison Co.
Toledo Edison Co.

Commercial

Curtiss-Wright Corp.
Ravenna Ordnance
Plum Brook Ordnance

NEW YORK

Police

Amherst
Binghampton
Broome County
Canton
Endicott
Johnson City
Lockport
State Police

Utilities

Home Gas Co.
N.Y. State Natural Gas Co.

Commercial

Bell Aircraft Corp.
Curtiss-Wright Corp.

WEST VIRGINIA

Police

Charleston
Hollidays Cove
Moundsville
State Police
Weirton
Wheeling

MARYLAND

Police

Cumberland
State Police

VIRGINIA

State Police

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