COMMUNICATIONS

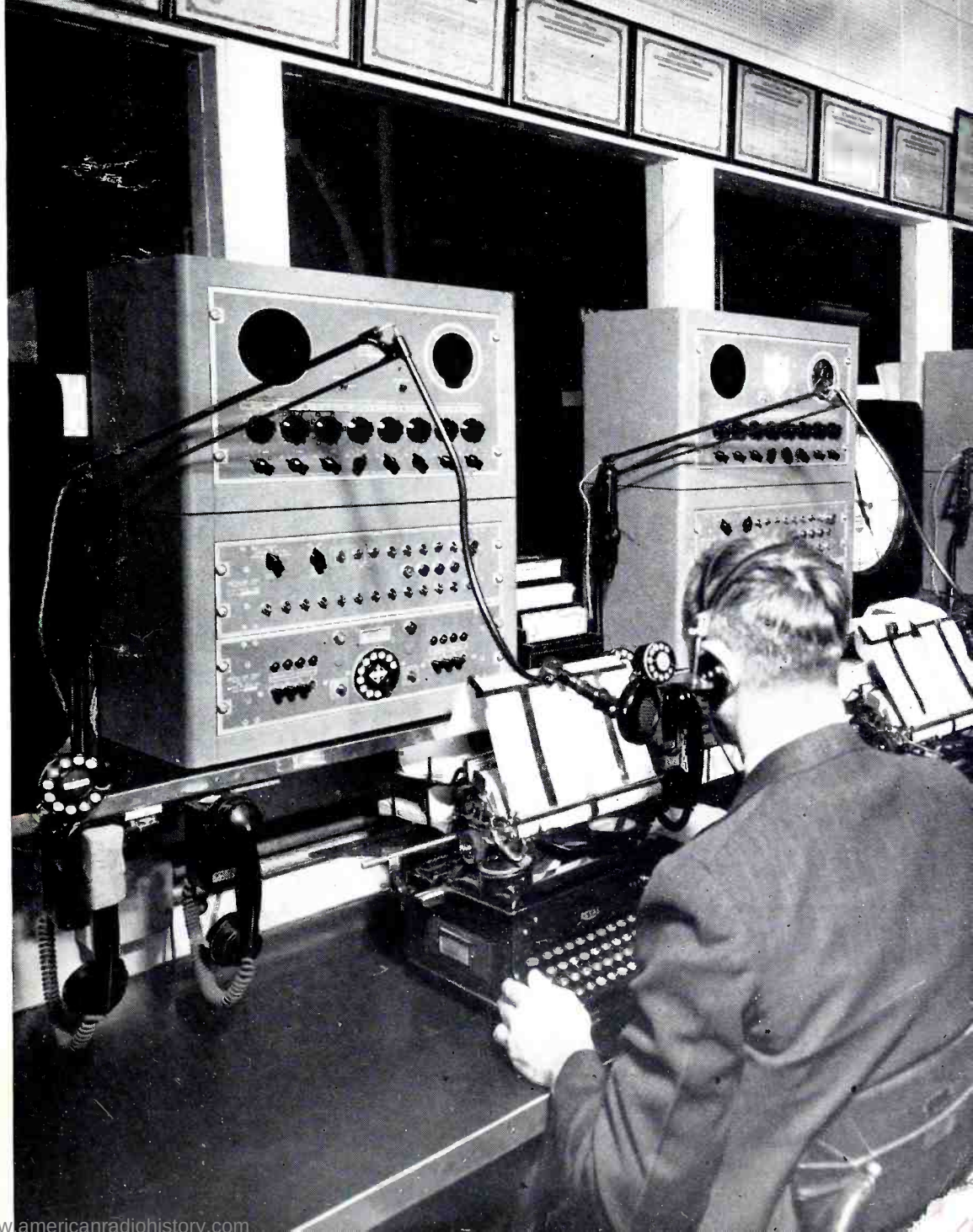
NAB CONVENTION

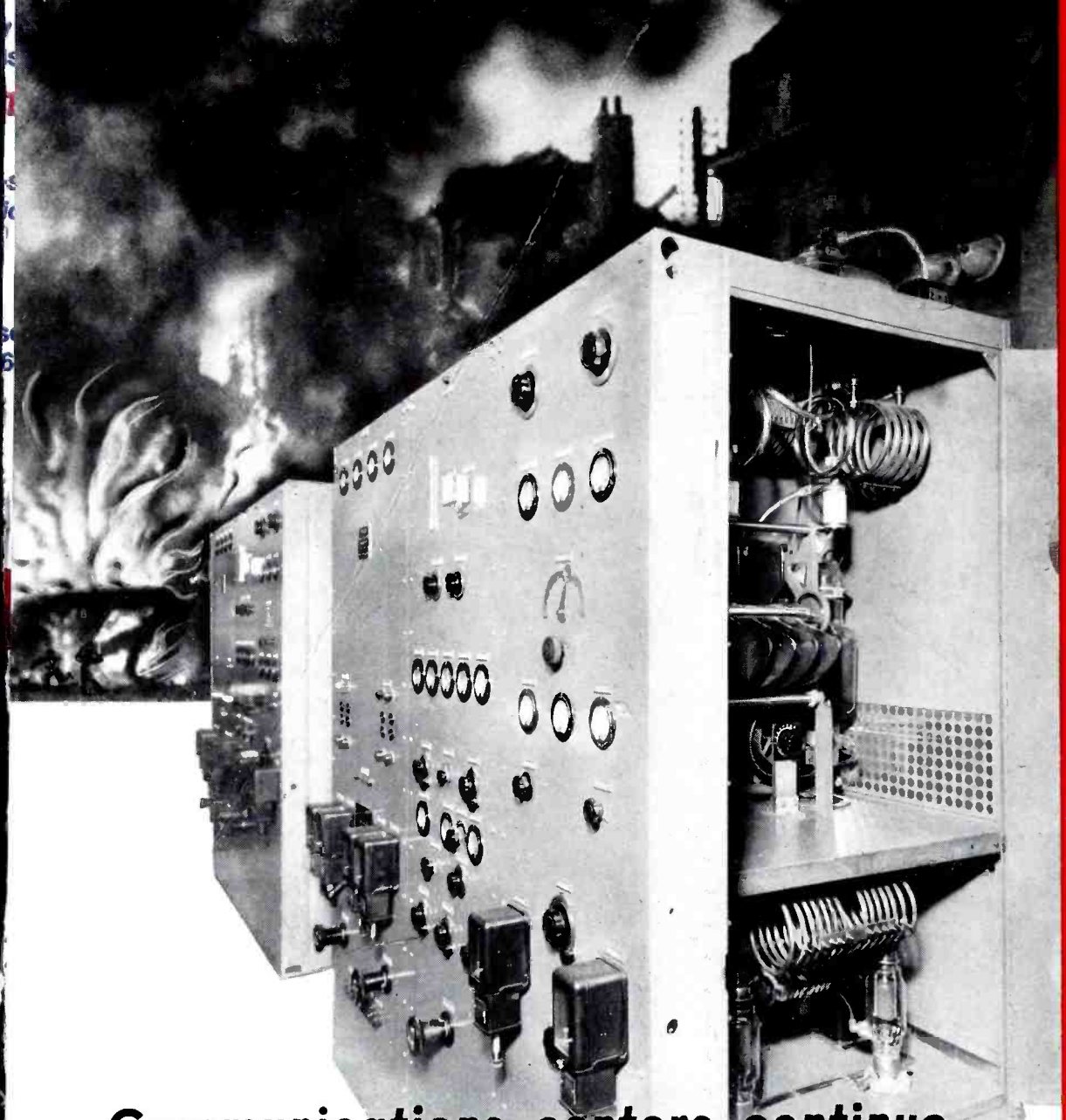
FREQUENCY MODULATION

TELEVISION

MAY

1941





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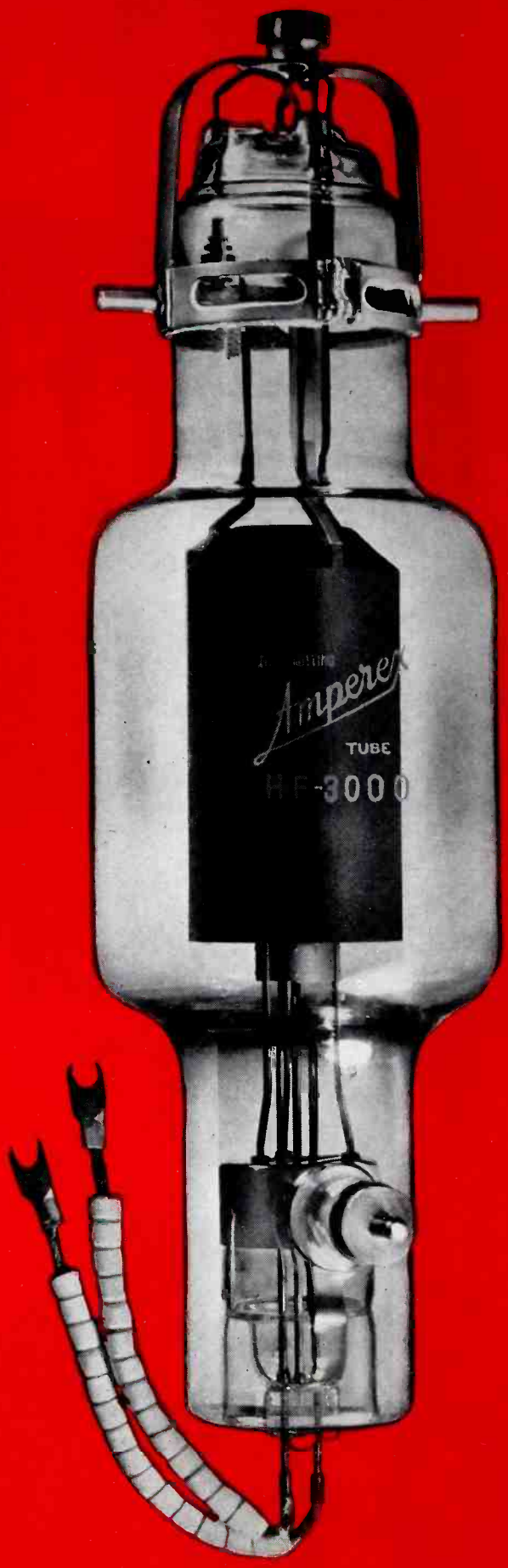

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$300

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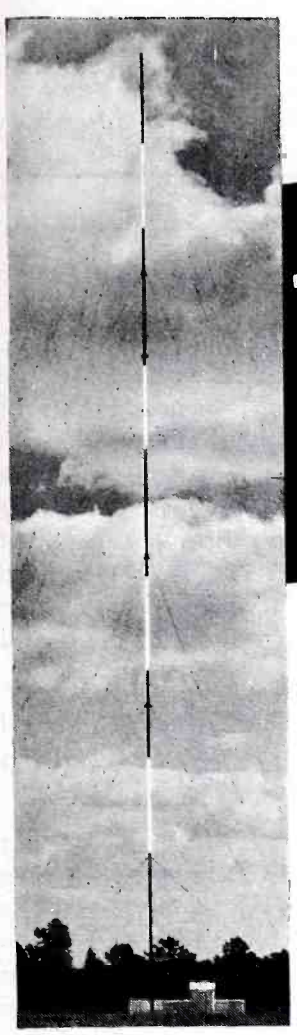

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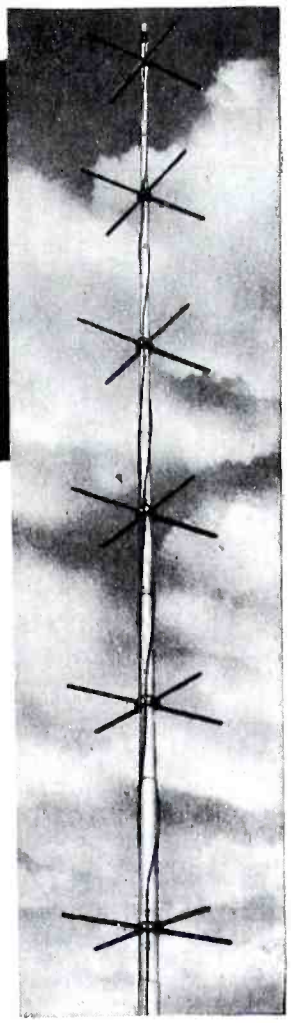

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Don't take the selection of your antenna for granted! In the past few years new standards have been introduced that can save you valuable dollars and step up the efficiency of your station.

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• Moderate initial cost • Exceptional high efficiency • Low maintenance cost • Unexcelled stability • Five year insurance protection • Single responsibility for constructing and erecting.

Our engineering staff will be pleased to supply you with technical details as they apply in your own particular case—without obligation, of course. In writing please give location, power and frequency of station.

JOHN E. LINGO & SON, Inc.

The First and Only Antenna of its Kind in the Industry!

The first Lingo Turnstile Radiator was furnished even prior to the Lingo Turnstile installations at the birthplace of FM at W2XMN, Alpine, New Jersey.

The improved, patented design now available offers new features with exclusive advantages—

- Antenna radiates a horizontal polarized signal with uniform circular field pattern.
- Antennas are custom built, and factory adjusted to the operating frequency, making no field adjustments necessary.
- Improved, simplified method of feeding and coupling.
- Turnstile elements fed by coaxial lines, no open turnstile wires used.
- Available with 2, 4, 6, 8 or 10 layers of turnstile elements depending upon desired gain.

Quotations available now for stations up to 50 KW and include essential tubular steel mounting pole, turnstile elements, coupling equipment, transmission lines feeding the elements, etc. Climbing steps, lighting equipment and sleet melting units are also available as optional equipment. Write today for complete facts and please indicate your proposed frequency, power and location.

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COMMUNICATIONS

MAY
1941

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VOLUME 21
NUMBER 5

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

Always in operation, the communications system of United Air Lines has this type equipment at its center in Chicago. Constantly in touch with Mainliners aloft, these men keep accurate records of all two-way conversations. Radio equipment installed in the Communications Center and a new combination receiver and transmitter for planes were built under the cooperation of United's own engineers and those of an outside radio manufacturer.

• Comments •

• • • • Initial steps are being taken to field test the CBS system of color television. The production of color television receivers has been discussed with various manufacturers, and it is possible that the necessary receivers may be available by June 1. The proposed field test should serve to determine the most practical design of home receivers for commercial production, the additional standards required for color television, as well as relative appeal of color and black-and-white images.

• • • • Data on the Annual NAB Convention will be found on page 10. This event is being held at the New Jefferson Hotel, St. Louis, Mo., May 12-15.

• • • • It is interesting to note that six leading organizations in the field of international broadcasting are voluntarily coordinating their short-wave stations for national defense and the promotion of international good will. Involved in the coordination plan are nine stations located in Boston, Cincinnati, New York City, San Francisco and Schenectady. The companies cooperating in this project are Westinghouse, General Electric, Crosley, NBC, CBS, and World Wide Broadcasting Foundation.

• • • • The organization of a nationwide network of frequency-modulation broadcast stations is the purpose of The American Network, Inc., recently formed in New York. This organization has elected permanent officers, adopted a standard rate card structure, decided upon representation of member stations in spot sales and established a uniform discount structure. Some 42 groups are now included in The American Network plans which, it is believed, will in time lead to the actual operation of a coast-to-coast f-m web on a cooperative basis.

• • • • A recent paper presented by J. H. Little and F. X. Rettenmeyer before the New York Section of the IRE, pointed out that there are a number of localities in the United States that are without reliable daytime broadcast reception. As was mentioned, the reception of short-wave stations seems to be the answer to this situation.

(Please turn to page 25)

BRYAN S. DAVIS
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A LOOK AT THE RECORD

PRESTO

Five years ago, Presto offered the first high fidelity instantaneous recording equipment to radio stations. Today, more radio stations use Presto recording equipment than any other make.

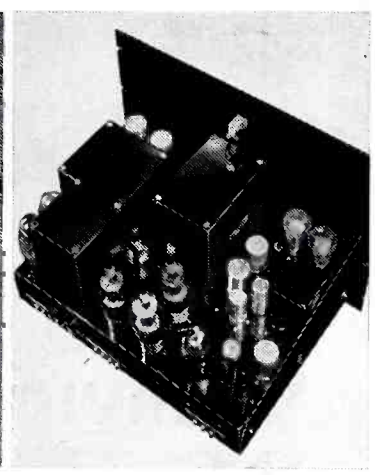
Today, radio stations have a larger investment in Presto equipment than in all other makes of recording equipment combined.

We want to express our thanks to the hundreds of broadcast engineers whose endorsement of Presto equipment has given us this outstanding position in the recording field. More particularly, we want to thank those engineers whose practical suggestions have helped us adapt Presto equipment to the exacting requirements of station operation.

Shown here are some new Presto developments which will further improve the performance of your recording installation.

1. Presto 1-C cutter gives wider response range, higher playback level from Presto recordings. Can exchange for Presto 1-B cutter at low cost.

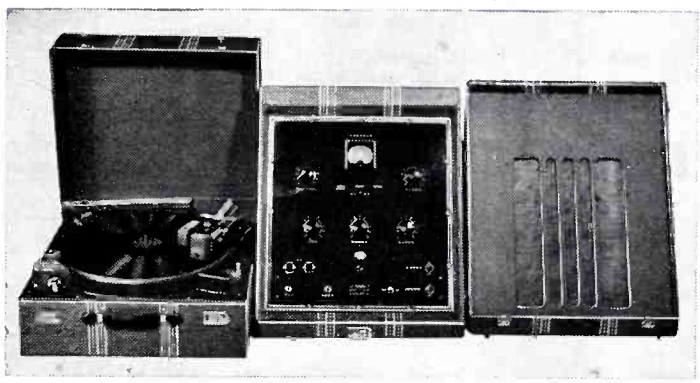
2. Presto 6-N recording turntable for portable or fixed recording installations. A great improvement over the standard 6-D table, less vibration, wider frequency response.



3. Presto 88-A, 50 watt recording amplifier. Selector switch pre-emphasizes high-frequency response to record NBC Orthacoustic or standard high fidelity lateral characteristic. Gain 85 db, 1% distortion.

4. Presto 8-N recorder, the finest recording turntable made by Presto. Used by the larger stations in U. S. and Canada. Records made on the 8-N reproduce uniformly range 50-9000 C. P. S. Noise level −50 db.

5. Presto 62-A transcription table, called by leading engineers the quietest, steadiest table on the market. Selector switch adjusts pickup response instantly for any type lateral recording.



6. Presto model Y recorder, used by scores of stations for outside pickups. Makes high quality 16" transcriptions suitable for broadcasting.

7. Presto recording discs, greatly improved by new manufacturing process to have more uniform coating, lower surface noise, wider frequency range, higher playback level.

8. Presto model L portable playback, lightweight, simple to operate, gives perfect reproduction of all types of lateral recordings. Ideal for time salesmen and agency executives.

PRESTO EQUIPT FOR SOUND RECORDING

KALE	KPHO	WCOL	WKAQ
KANS	KPO	WCOU	WKBZ
KBTM	KPQ	WDAN	WKPT
KCMO	KRGV	WDAY	WLAK
KDKA	KRIS	WDBJ	WLBC
KDYL	KRLC	WDBO	WLBZ
KEVR	KSD	WDGY	WLEU
KFBK	KSEI	WDZ	WLLH
KFKA	KSL	WEAF	WLOL
KFH	KSRO	WEBC	WLTH
KFI	KSUN	WEEI	WMAL
KFJI	KTFI	WFAS	WMAZ
KFJM	KTKC	WFBG	WMBD
KFNF	KTRB	WFBL	WMBI
KFPW	KTUC	WFIG	WMBO
KFPY	KUJ	WFMD	WMC
KFUO	KUTA	WFTC	WMFG
KFWB	KVOO	WGAC	WMIN
KGA	KVOS	WGBR	WMPC
KGDE	KVOX	WGH	WMSD
KGER	KVSF	WGL	WNBH
KGGF	KWSC	WGN	WNLC
KGGM	KXRO	WGTM	WOR
KGHF	KXYZ	WHAM	WORL
KGIR	KYA	WHEB	WOW
KGKO	WAAT	WHEC	WOWO
KGMB	WAGM	WHKC	WPAX
KGNO	WAIM	WHO	WPIC
KGO	WAIR	WHP	WPRO
KGVO	WBAP	WIBW	WRC
KHQ	WBLK	WIBX	WSAV
KIDO	WBNS	WICA	WSB
KIEM	WBNY	WICC	WSM
KITE	WBOC	WIL	WSFA
KIUN	WBRB	WING	WSOC
KLAH	WBRC	WINN	WSOO
KLZ	WBRK	WIRE	WSTV
KMBC	WBRW	WISN	WTAM
KMOX	WBT	WJAC	WTAQ
KMPC	WBTM	WJBC	WTCN
KOA	WCAP	WJLS	WTHT
KOIN	WCAU	WJNO	WTIC
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World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs

...AFTER A YEAR OF PRACTICAL FIELD SERVICE

After passing every conceivable laboratory and field test in the months since this tube was announced, RCA engineers now have given the "go ahead" signal on the RCA-815. This is consistent with the RCA policy against ever asking the customer to be the subject of experiment. Production facilities are now being expanded in an earnest effort to meet the great demand for this spectacular tube.

Compact, inexpensive and providing push-pull beam power within one tube envelope, the RCA-815 will deliver an output of over 40 watts (class C telegraphy) on all frequencies up to 150 Mc. It requires a plate voltage of only 400 to 500 volts, needs less than one-half watt of grid drive and generally requires no neutralization on *any* frequency.

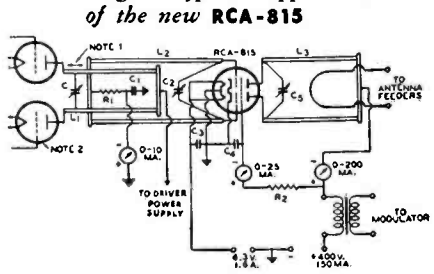
Operated at frequencies as high as 150 Mc, a single RCA-815 in push-pull class C telegraph service at CCS Ratings is capable of handling 60 watts with only 0.23 watt of driving power. It operates satisfactorily at reduced input up to 225 Mc. Total maximum plate dissipation is 20 watts.

A new glass button-type stem structure permits compactness of design best illustrated by the tube's overall length of only 4 9/16". The 815 has excellent shielding, close electrode spacing and short leads with consequent assurance of low lead inductance. The large-wafer octal type base with metal-shell has low-loss "Micanol" insulation.

While providing greater efficiency and economy for present day applications, the RCA-815 also is of particular interest to the engineer who buys today with an eye to the more exacting UHF requirements of tomorrow. Ask your RCA Tube and Equipment Distributor for the bulletin on this tube, or write direct to the Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N. J.

150-Mc R-F POWER AMPLIFIER

Illustrating a Typical Application of the new **RCA-815**



C=See L_1

$C_1C_3C_4$=1" x 1½" copper sheet insulated from chassis by mica sheet 0.002" thick, or 0.0005-uf "postage stamp" mica condensers soldered to chassis with shortest practicable leads.

C_2C_5=Copper discs, 1/16" x 1½".

R_1=15000 ohms, 0.5 watt.

R_2=15000 ohms, 25 watts, adjustable.

L_1=½" dia. copper tubing. Length of tubing and capacitance of C depend upon driver tubes employed

L_2=½" dia. copper tubing, 12½" long and spaced approx. ⅞" between centers.

L_3=½" dia. copper tubing, 13" long and spaced approx. ⅞" between centers.

NOTES

(1) The i-f driver stage should be able to deliver about one watt of useful r-f power, to insure ample grid excitation for the 815.

(2) Adjust coupling between L_1 and L_2 and tuning of C and C_2 for recommended d-c grid current of the 815.

(3) L_1 and L_2 should be effectively shielded from L_3 by a metal chassis, or by a vertical metal baffle plate used to mount the 815.

(4) Adjust coupling of "hairpin" antenna coil to L_3 so that the amplifier is properly loaded.

(5) A small lumped inductance can be substituted for the amplifier grid lines, if desired. Such a grid coil is preferably tuned by varying its inductance, rather than by means of a variable condenser.

Maximum Ratings for class C telegraph service
(All values are for both units)

	CCS	ICAS		CCS	ICAS
D-C PLATE VOLTAGE	400	500 Volts	D-C GRID CURRENT	6	6 Ma.
D-C SCREEN VOLTAGE	200	200 Volts	PLATE INPUT	60	75 Watts
D-C PLATE CURRENT	150	150 Ma.	SCREEN INPUT	4	4 Watts

PLATE DISSIPATION . . 20 Watts CCS . . . 25 Watts ICAS

RCA BROADCAST EQUIPMENT
From microphone to antenna

RCA Transmitting Tubes
PROVED IN COMMUNICATION'S MOST EXACTING APPLICATIONS
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Operating problems in FREQUENCY-MODULATION TRANSMITTERS

Part I

By I. R. WEIR
Transmitter Eng. Dept.
General Electric Co.

"PROVE all things and hold fast to that which is good" was written many hundreds of years ago, but the statement is equally applicable today in designing frequency-modulation broadcast transmitters.

Every successful manufacturer of radio broadcast transmitters bases his designs not only upon technical knowledge and measurements, but on actual operating experience as well. Recognizing this fact, General Electric early located its f-m station in the Helderberg Mountains—twelve miles from its Schenectady manufacturing plant, where operating problems of f-m are being studied and coordinated with technical considerations to design equipment meeting actual operating requirements. The ultimate aim, of course, is to offer you better and more complete service.

Proving grounds as such are not new. Automobile manufacturers, for example, have used them for years to develop better cars. Similarly, in 1924, we established our South Schenectady development station as a proving ground for standard broadcast transmitters. In fact, the original 50-kw broadcast transmitter with its rope and pulley controls, wood and pipe framework, is still there and available for emergency service. Modern high-power standard broadcast transmitters stand as monumental evidence of the progress made through the use of a proving ground for transmitter development.

Now, I'd like to explain more of what we've found out in our f-m proving grounds. Among other things, I propose to cover W2XOY's f-m system for the New York State Capital District, emphasizing certain problems encountered in f-m transmitters and how we solved them in our own operations. Specific elements in the system to be covered are: (1) Location of transmitter station, (2) transmitter antenna system, (3) f-m transmitter circuit design problems, (4) measuring equipment, (5) studio problems, (6) studio-to-transmitter circuit, and (7) field strength measurements.

Location of Transmitter Station

Economics

One of the first steps necessary in establishing an f-m station is to make a careful study of the economic conditions in a prospective service area. Such a study is essential to justify the necessity of an f-m station and in order to provide the information required for an FCC construction permit.

Thirty-five channels[1] have been allocated by the FCC to commercial f-m broadcasting. Theoretically, 17 of these could be used in any one locality without introducing mutual interference, assuming that alternate channels are assigned. This number of stations will, in most cases, be more than can be economically justified. It is significant to note, therefore, that the matter of economics will be a most important factor in the establishment of f-m stations intended to serve the same area.

The operating expenses of an f-m broadcast station must first be considered. They are so nearly the same as for a standard broadcast station that most station managers will have no difficulty in making their own estimates. Such estimates have been published by David.[2]

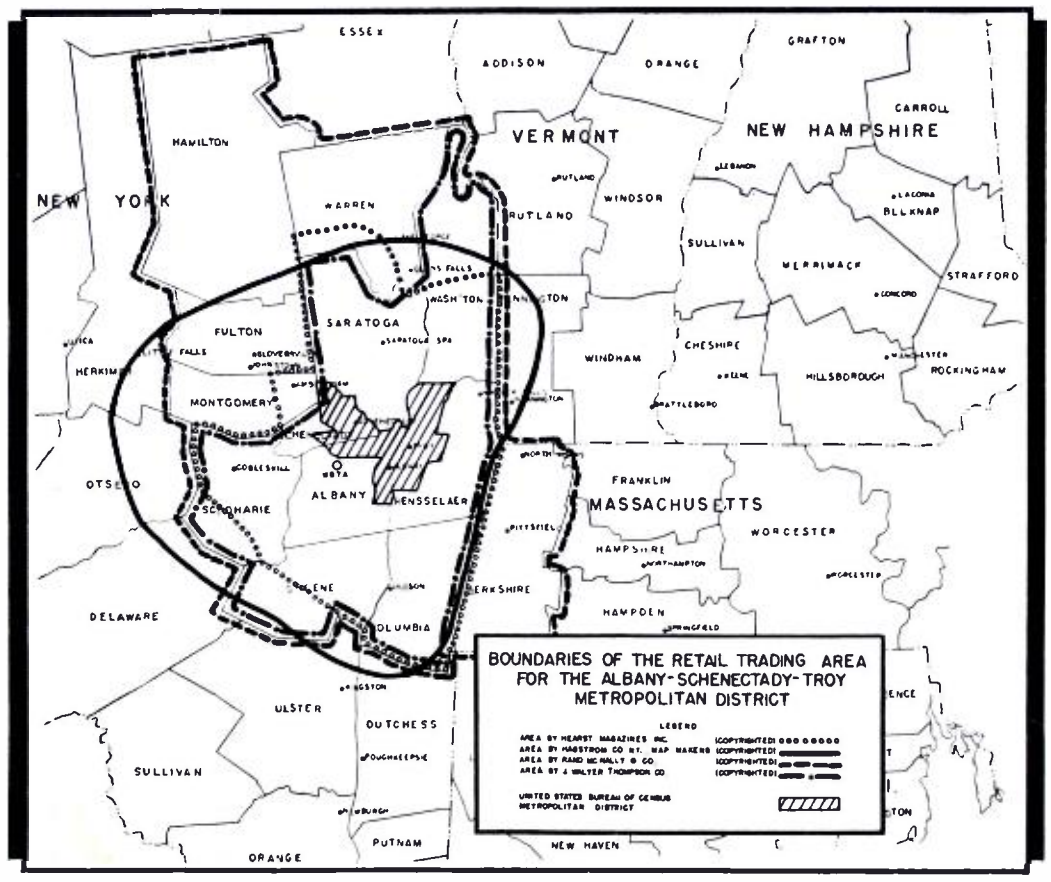
Your next step is to determine if the possible advertising revenue in the proposed service area is sufficient to justify a new station. This analysis requires careful consideration of many factors, some of which are:

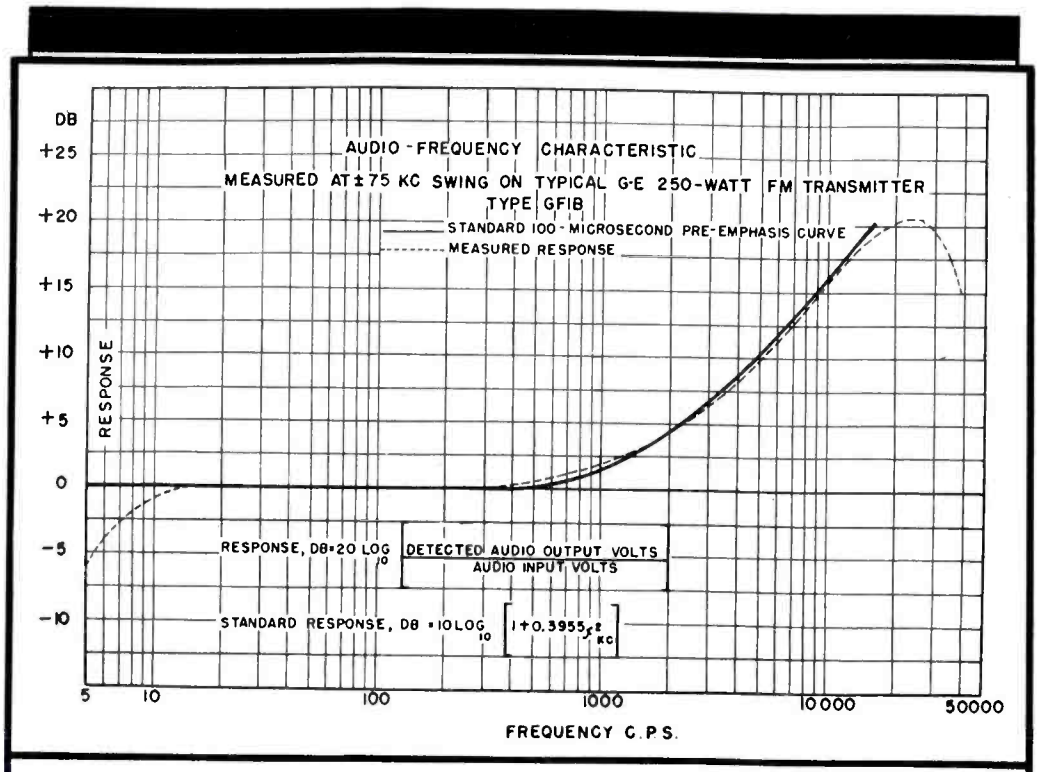
(1) General business activity, wholesale and retail.

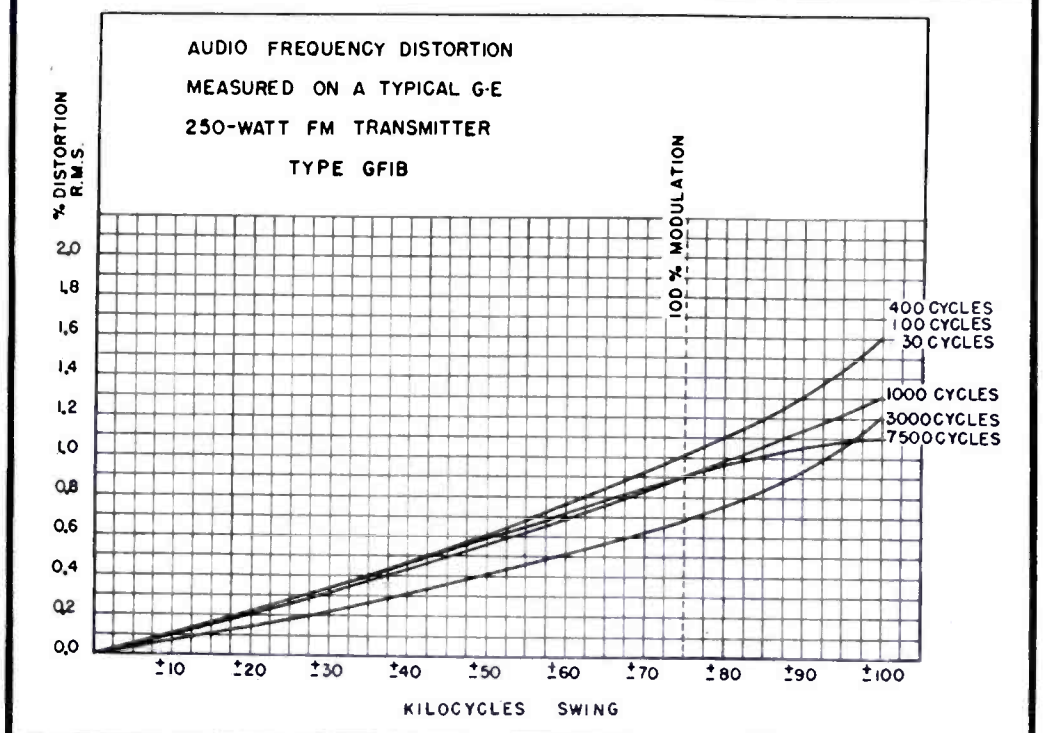
[1]Non-commercial educational broadcasting has five additional f-m station channels.

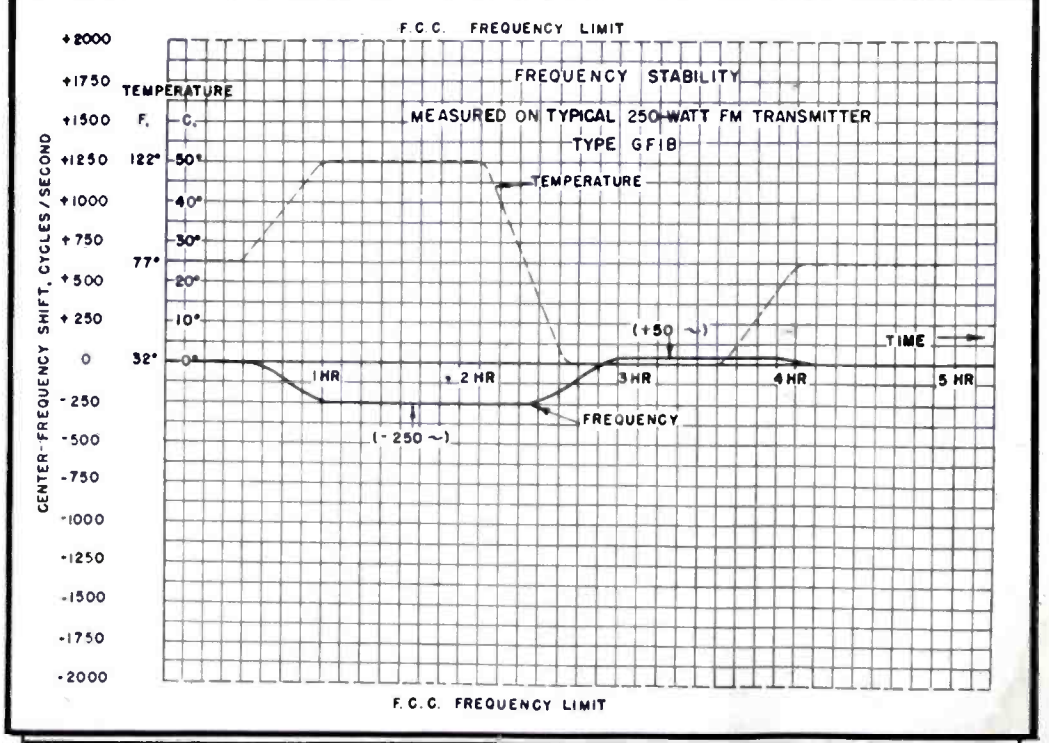
[2]W. R. David, "Planning an FM Station," *FM Magazine*, Vol. I, No. 4, Page 20; February, 1941.

Fig. 1. Trade area map for New York State Capital district.









Top to bottom: (Fig. 5) audio-frequency, (Fig. 6) audio-frequency distortion, and (Fig. 8) frequency stability characteristics.

(2) Transportation facilities.
(3) Population.
(4) Number of a-m receiving sets.
(5) Number and level of individual incomes.
(6) Cultural status of audience.
(7) Yearly advertising revenue obtained by newspapers and standard broadcast stations.
(8) Year's expenditures for new set.

Trade Areas

The terms "basic trade area" and "limited trade area" are used by the FCC to define and establish the area served by f-m stations. Rural areas are also recognized as service areas.

"Basic" and "limited" trade areas have been selected as the best means of defining the coverage of f-m stations, since the propagation characteristics of ultra-high-frequencies confine the signal to a definite area in the locality of the transmitter.

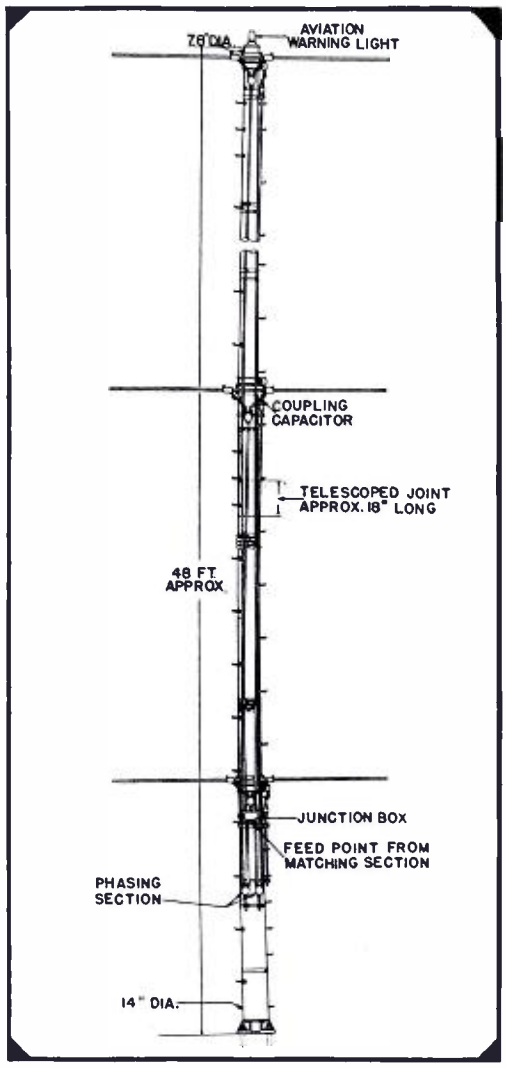
There are in the order of 625 "basic trade areas" in the United States, although most of their boundaries are yet to be definitely established. It is presumed that the FCC will eventually define these boundaries on the basis of applicants' data and government economic radio analyses. Each basic-trade-area station must cover the entire area.

"Limited trade areas" are being established to provide service to certain cities (and their trade areas) which are not listed as "principal cities" of "basic trade areas." Generally these "limited trade areas" are much smaller than the "basic trade areas" and do not follow any uniform pattern.

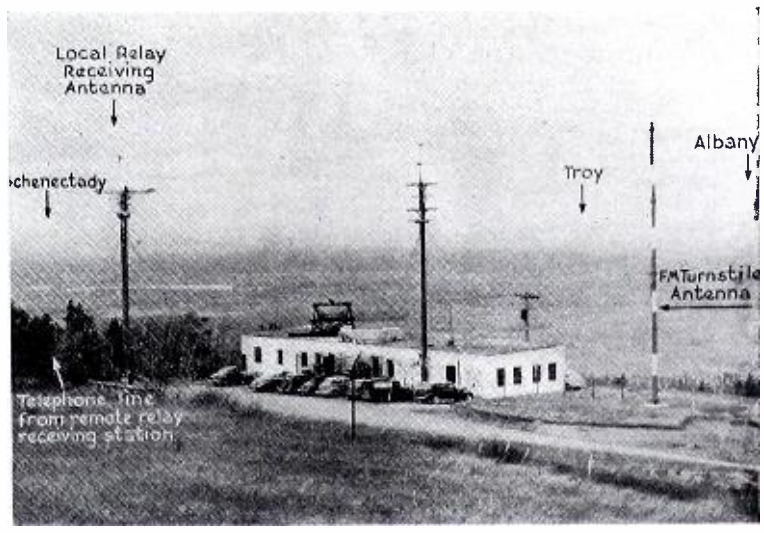
Twenty-two channels have been allocated to stations serving basic and limited trade areas where the city near which the station is located has a population of over 25,000. Six channels are reserved for the basic and limited trade areas where the city near which the station is located has a population less than 25,000.

The seven remaining channels have been allocated to stations primarily serving large rural areas, which cannot be covered satisfactorily by other stations serving basic or limited trade areas, due to technical or economical limitations. Ordinarily a station assigned to one of these seven channels will be located at a high elevation so as to cover a rural area which must be at least 15,000 square miles.

There is a fourth FCC classification for stations which will serve areas having substantially different characterstics (social, cultural, or economic) from the three just described. If the applicant desires to have his station placed in this classification because of



Left: Fig. 3. Three-bay turnstile antenna 42 to 50 mc.



Right: Fig. 2. General Electric's f-m station in the Helderberg Mountains.

unusual conditions, he must show that a need (which cannot be supplied by a station serving areas under those three described for the proposed service, both program and technical) exists which makes the establishment of the special service area in public interest, convenience, and necessity.

Anyone desiring to establish an f-m station should make a thorough study of the trade area in which the proposed station is to be located. Reference should be made to trade-area maps prepared by four authorities[3] or others. Through a study of these maps, the classification of the f-m station can generally be determined. If an f-m station has already been authorized in a proposed trade area, then the trade area has been already determined, since all stations in a given trade area must provide substantially the same signal coverage.

In determining our trade area known as the New York State Capital District, including Albany, Schenectady, and Troy, reference was made to the four maps and a composite map was plotted. (Fig. 1.) The trade area to be covered is roughly defined by the general boundary agreement shown and presumably will be specifically defined by the FCC.

General Considerations

The transmitter location should be as near the center of the proposed trading area as possible, consistent with the ability to find a site with sufficient elevation to provide service throughout the area. The location for the transmitter and antenna should be at the highest practicable elevation so that a minimum "shadow effect" on propagation will be obtained in the service area.

The location of a station with respect to existing roads, power lines, water supply and telephone lines is a vital consideration. In many cases, if the transmitter station is not accessible to these facilities, the cost is prohibitive.

The General Electric station is located in the Helderberg Mountains about twelve miles south of Schenectady and approximately equi-distant from Troy, Albany, and Schenectady collectively defined as the "principal city." Its elevation is about 1500 feet above the surrounding trade area. Fig. 2 shows how this station overlooks a large relatively flat rural territory. This area extends to the Adirondack Mountains in the north, the Berkshire Mountains in the east, the Catskill Mountains in the south, and the Mohawk Valley in the west.

Technical Consideration

When the station site has been tentatively located after considering economics and trade areas, the type of antenna, its height, and the transmitter power output must be considered.

The FCC requires the proposed station to provide a signal strength of at least 1000 microvolts in urban areas

[3]J. Walter Thompson (Retail Shopping Area). Hearst Magazine Inc. (Consumer Trading Area). Rand McNally Map Co. (Trading Areas). Hagstrom Map Company (Retail Trading Area Map).

Left: Fig. 4. Schematic block diagram of 250-watt f-m transmitter.
Right: Fig. 7. Frequency stability vs. line voltage.

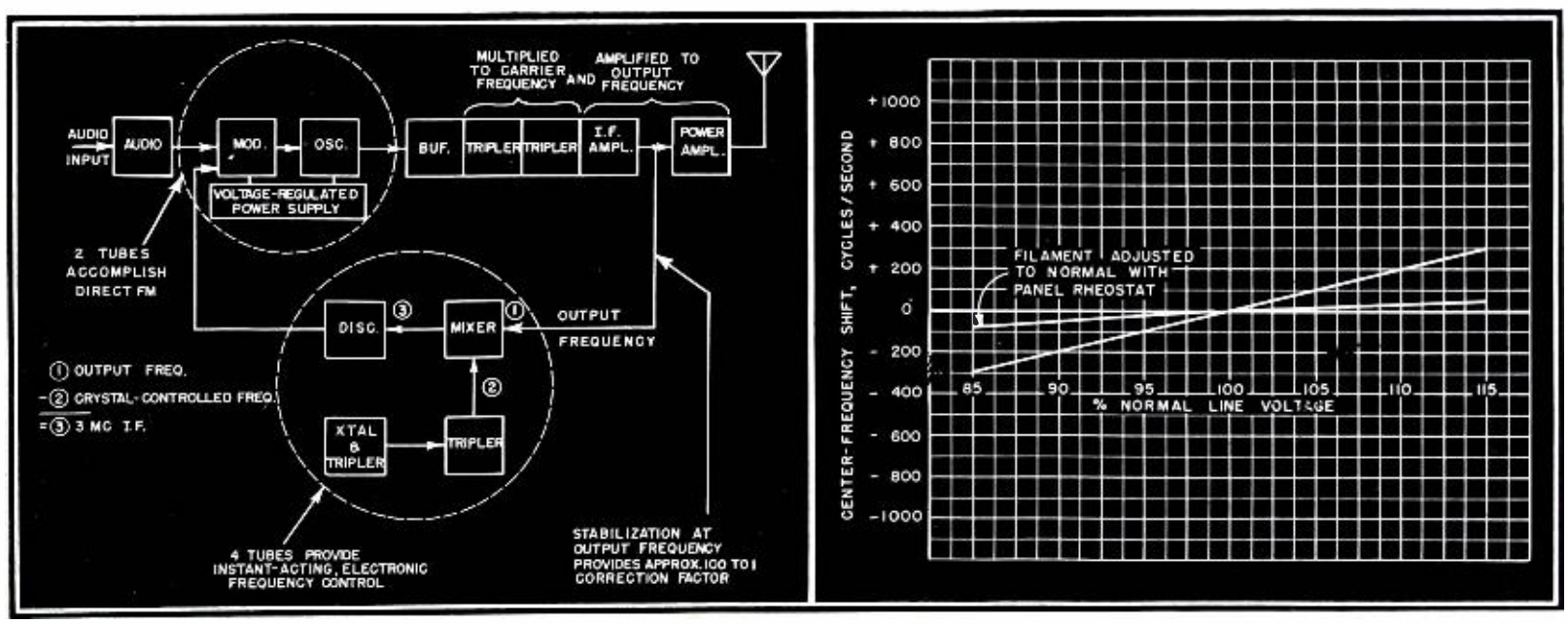
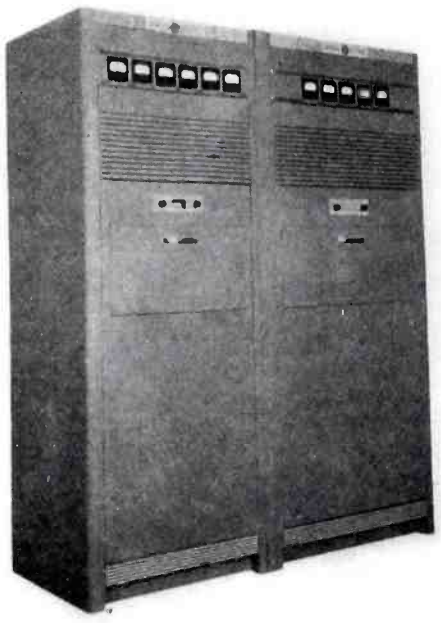


Fig. 10. Front view of a G-E 3000-watt frequency-modulation transmitter.



and 50 microvolts in rural areas, when measured with a receiving antenna having an effective height of 30 feet. These field strength contours are first based upon calculations.

You must then determine what antenna type, antenna height and transmitter power output will be needed to meet the FCC requirements in regard to covering the proposed trade area. Usually some economic balance can be obtained from studying these three variables. The height of the antenna is usually determined by economic or aircraft safety considerations.

After the station is in operation, measurements must be made to prove that the required signal strength is actually obtained.

Transmitter Antenna System

Radiating System

The requirements for a frequency-modulation antenna system are somewhat similar to those used for other high-frequency services in that the antenna operates within the 40 to 50-mc band, and the propagation of the radio waves is of a quasi-optical nature.

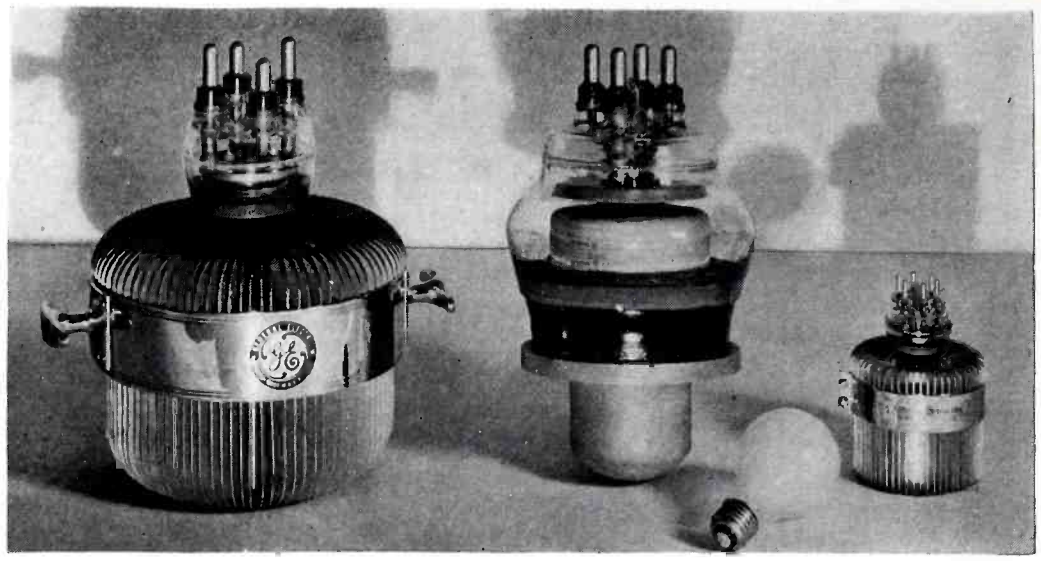


Fig. 12. G-E high-frequency transmitting tubes. (L to R): GL-889-R, GL-880, GL-8002-R. Note 75-watt lamp.

Therefore, the antenna should be mounted as high as practicable above the surrounding territory.

The FCC has not yet standardized the type of polarization for f-m transmission. Both vertical and horizontal polarization are now being used and a number of reasons can be advanced for using either type. General Electric uses a horiontally-polarized antenna, since this permits the use of a high-gain radiating system having a relatively simple mechanical construction. A further advantage of horizontal polarization in the New York State Capital District is that the same antenna may successfully be used for both f-m and television reception in the home. When the field strength is strong and either horizontally or vertically polarized, any simple receiving antenna, constructed without regard to polarization, will prove satisfactory.

For frequency modulation, it is not necessary to take any elaborate precautions to provide a wide-band antenna. Therefore, we can concentrate our efforts on designing for high radiation efficiency in the horizontal plane. This is accomplished by using a vertical stack of horizontal antenna elements operated in phase to produce low-angle radiation; that is, increase uniform radiation in the horizontal plane.

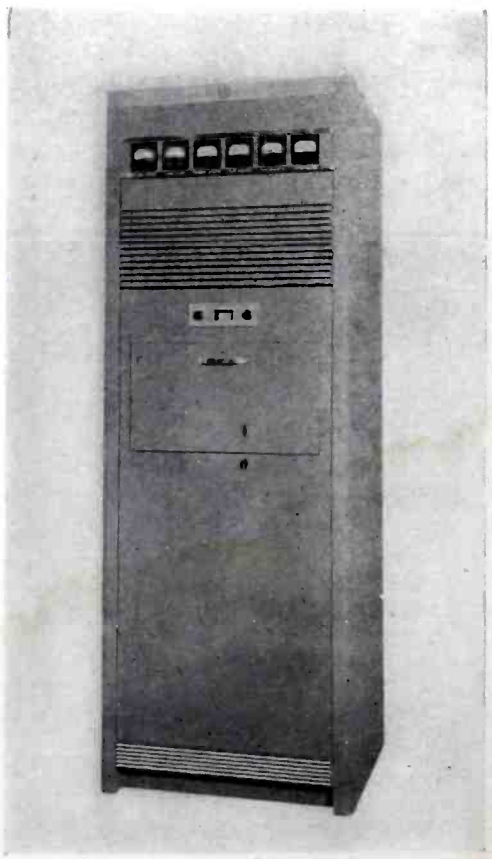
The antenna designed for use at the General Electric proving ground is mounted on a vertical, unguyed steel mast and consists of three "turnstile bays" of horizontal radiating elements spaced vertically 270 electrical degrees. (Fig. 3.) Each "bay" consists of four quarter-wave radiators spaced at 90-degree intervals around the mast in a horizontal plane and connected electrically to the mast. Each pair of radiating elements is shunt excited by the two inner conductors of a balanced twin-conductor concentric transmission line. Each radiating element is connected to its line through a series capacitor adjacent to the mast.

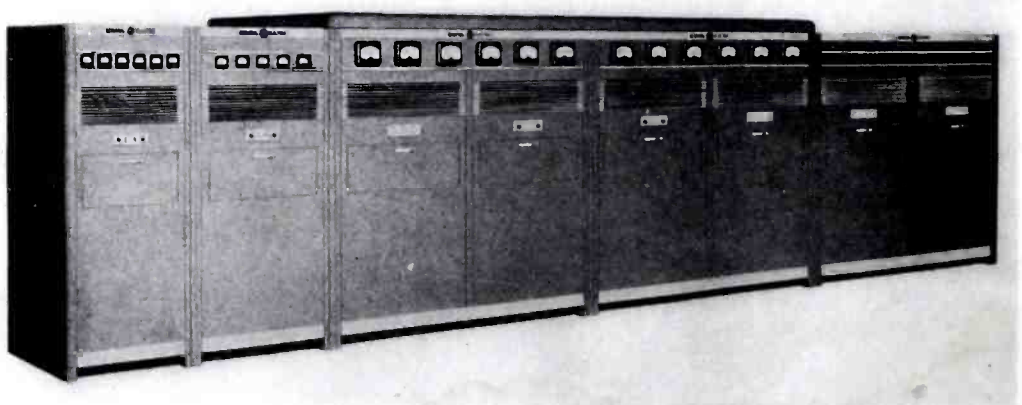
The correct phase relations and current distribution among the various an-

(F-M—continued on page 33)

Right: Fig. 9. A 250-watt f-m transmitter.

Below: Fig. 11. G-E 50,000-watt f-m transmitter.





Antennas at Empire State

• The third and concluding article of a series on the antennas and transmission lines at the Empire State television station.

By N. E. LINDENBLAD
RCA Communications, Inc.

1. *Vertical Dipoles*

THE first antenna system, used at the Empire State Building television station, consisted of two separate vertical dipoles, one for vision and one for sound, Fig. 21. The two dipoles were located as far apart as the dimensions of the building dome permitted. They were connected to separate transmission lines which extended perpendicularly through the roof for a distance of approximately half a wave. The dipoles themselves were simply formed by half-wave extensions of the transmission line center conductors, beyond the ends of the outer conductors of the transmission lines. The input impedance into one end of a half-wave radiator is very high and did not, therefore, corresepond to the characteristic impedance of the transmission lines. This mismatch was, however, corrected by adding suitable shunt reactance to each line at a properly selected point under the roof. These shunt reactances

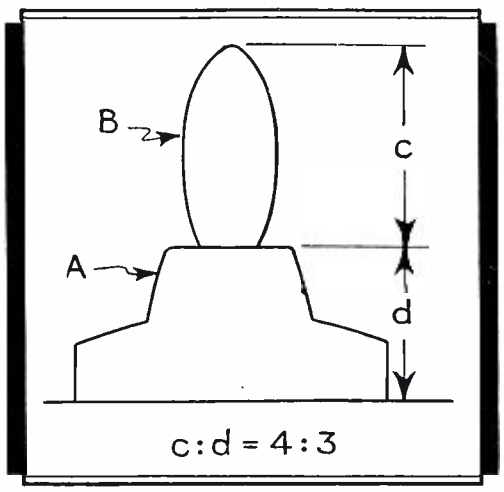


Fig. 28. General relative dimensions of model composite radiator element for turnstile combination.

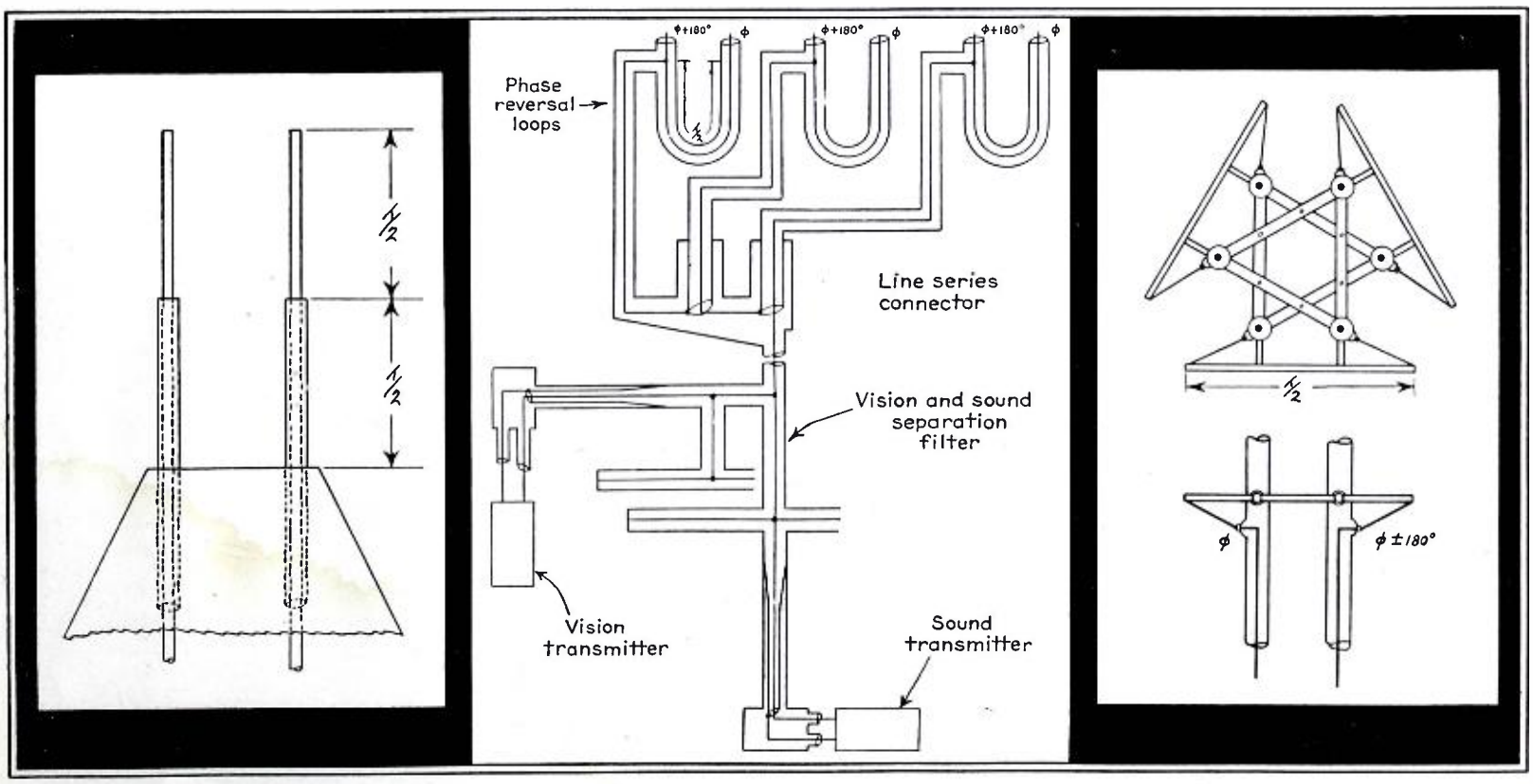
were made in the form of short transmission-line sections or stubs.

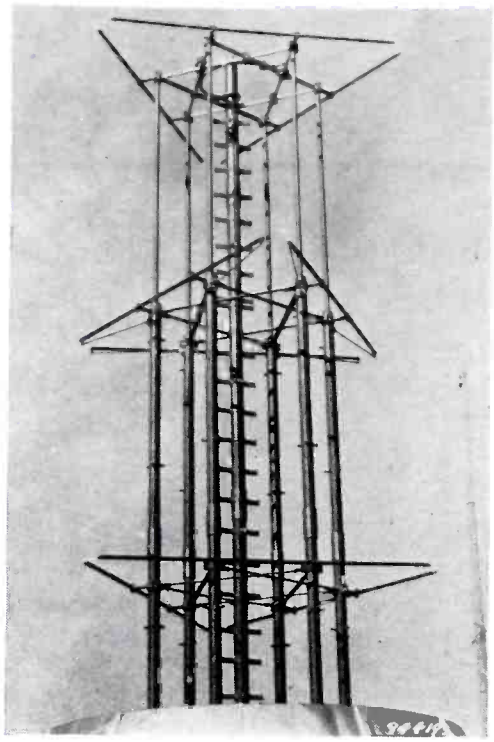
The transmitter room is located on the 85th floor and the distance from this location to the roof is approximately 275 feet. The diameters of the outer and inner conductors of the transmission lines were 5 and 1.5 inches respectively. This diameter ratio corresponds to a characteristic impedance of 72 ohms. Since the cost of providing a straight path up through the tower did not seem justified at the time these lines were installed, a number of bends had to be tolerated. It has later been proved that the reflection from bends is very slight and can in most cases be neglected if the proper conductor diameter ratio is carefully maintained in the bends. The most convenient insulator, available at this time, for the support of the inner conductor, was of the lead-in type. These insulators possessed considerable capacity. Since no comprehensive research had, as yet, been conducted to determine favorable design factors in respect to transmission lines these insulators were spaced according to mechanical considerations

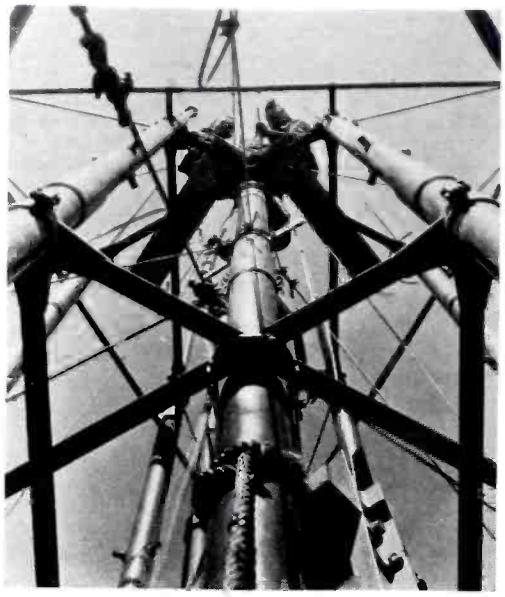
Fig. 21. Vertical dipoles on top of Empire State Building.

Fig. 24. Diagram of connections for triangular loop antenna.

Fig. 22. Schematic of dipole connections for triangular loop antenna.

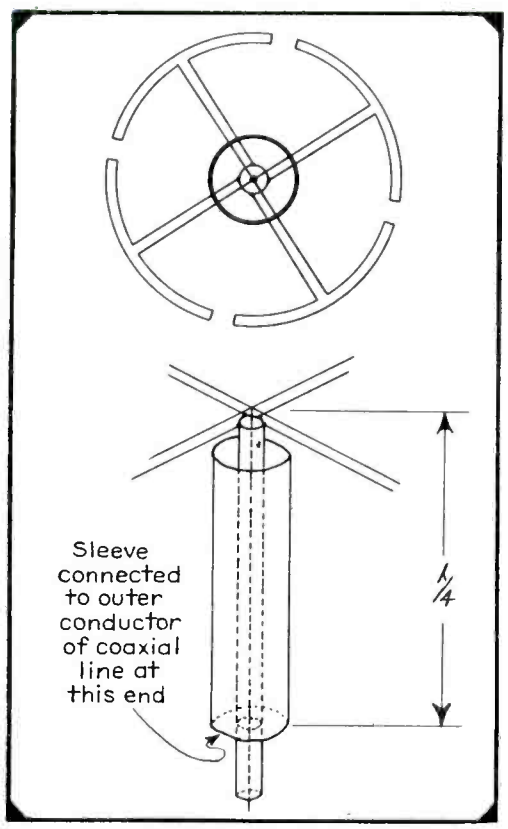






Above: Fig. 23-a (left) Triangular loop antenna for Empire State Building. Fig. 23-b (above) Another view of same antenna.

Left: Fig. 32. Schematic of sound antenna connections including line balance converter.



only. As a result, the reflection effects from the insulators became cumulative and had considerable magnitudes.

This antenna and transmission line system was used during the experimental period between 1931 and 1936.

2. First Horizontally Polarized Antenna

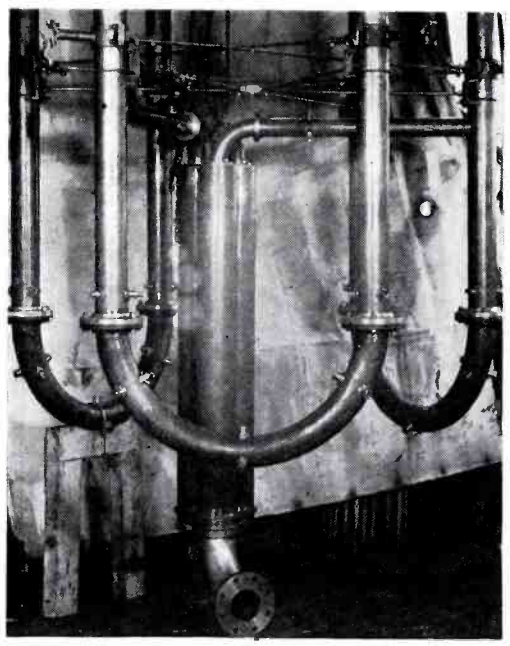
With the advent of the all-electronic method in 1936 and the higher definition of 343-line pictures, the frequency response characteristic of the vision antenna was such that full picture resolution could not be maintained. Since it was also being realized that horizontal polarization gave promise of better propagation characteristics the need of an antenna having characteristics in closer agreement with the new requirements became evident.

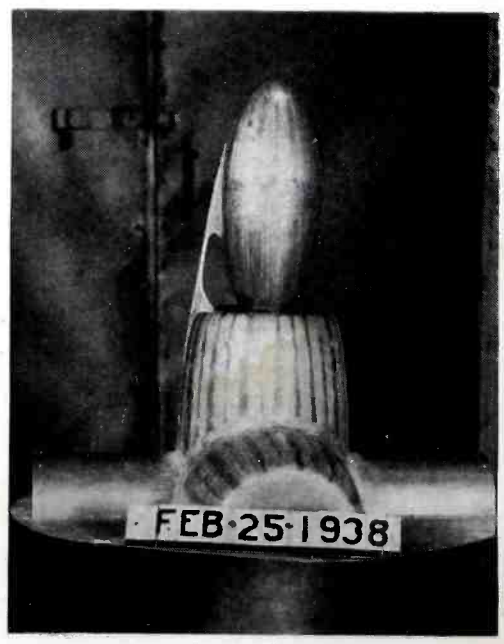
A radiator of uniform, horizontally polarized radiation in all horizontal directions must of necessity consist of several radiating elements in combination.

An analysis of the simpler forms of combination showed that three dipoles arranged to form a triangular loop and energized at the same phase, gave practically uniform radiation in all directions in the plane of the loop. It had also been found that, for shunt-fed dipoles, the least variable, resistive frequency response characteristic, within a frequency band, was obtained when the feeders were connected to the ends of the dipoles. A portion of the feeders then became adjacent and nearly parallel with the dipoles and in combination formed units similar to folded dipoles, Fig. 22.

The vertical directivity of a horizontally located loop, such as described, is very nearly the same as the vertical directivity of a vertical dipole. In further development, three horizontal triangular loops were stacked vertically to form an array of greater vertical directivity than that of a single loop, Fig. 23. The loops were spaced a half wave apart; the lowest one being located at quarter wave distance from the roof. Only the mid-loop was fed directly and had folded dipole feed. The supporting structure for this radiator combination consisted of six vertical pipes forming a hexagon cage, Fig. 23. These pipes also served as outer conductors for six coaxial transmission lines. Adjacent lines were operated in phase opposition. Balanced feed was then obtained for each of the three dipoles by connection to a pair of adjacent lines, Fig. 22. The dipoles of all the loops were, on each side of their midpoints, supported by metallic brackets which were integral with the supporting pipes. In this way the supporting brackets established a connection between a pair of adjacent vertical supporting pipes and a dipole.

Below: Fig. 25 (left) Transmission line connections for triangular loop antenna. Fig. 26 (center) Separation filter for vision and sound. Fig. 27 (right) Model of radiator element for 100-150 mc turnstile combination.

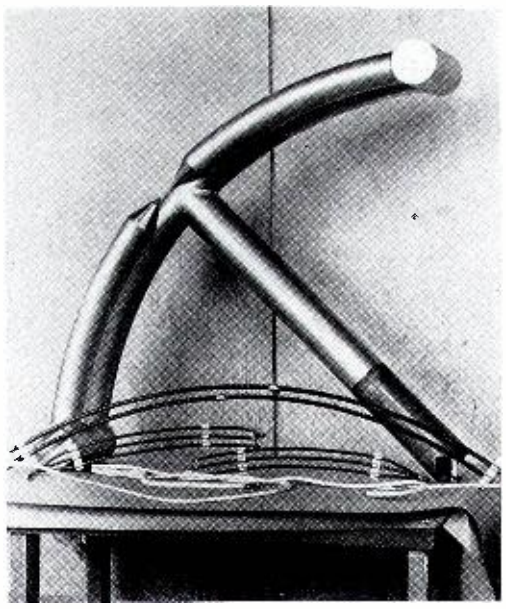




When the mid-loop was energized, the top and bottom loops became energized indirectly through the bracket connections and over the outside of the vertical supporting pipes serving as transmission lines. Analysis showed that the radiation from a cage type transmission line, in which adjacent conductors operate at opposite phase, is negligible even when the diameter of the cage is as much as a quarter wave. It was also found possible to provide bracing straps, Fig. 22 and Fig. 23, between the pipes without introducing enough shunt effect to prevent this form of feed. The dimensions of the pipes and the spacing between them was such that the characteristic impedance between the pipes was in close agreement with the total shunt input impedance of the system formed by the dipoles, brackets and braces of the top and bottom loops.

Since the top and bottom loops were spaced a half wave from the mid-loop, it was necessary to restore the polarity of the top and bottom loops which would be reversed if their components were connected in geometric identity to the same supporting pipes at the components of the mid-loop. This was most easily accomplished by a 60-degree rotation, around the vertical axis, of the top and bottom loops in respect to the mid-loop, Fig. 23.

The alternate phase of adjacent lines was obtained by feeding such lines in pairs in which the two branches of each pair differed in length by a half wave, Fig. 24 and Fig. 25. For maintenance of reasonable conductor diameters and in order to maintain matching it was found most expedient to connect the feeders, to the three branch pairs, in



Above: Fig. 36. Folded dipole unit of sound antenna with associated parts.
Right: Fig. 37. Television antenna during erection for test at Rocky Point Laboratory.

series. This was done by using line balance converters, Fig. 24 and Fig. 25. Several other methods of combination were also tried, but it was found that for the relatively small band width of this antenna the nature of the line connections did not introduce any material handicaps.

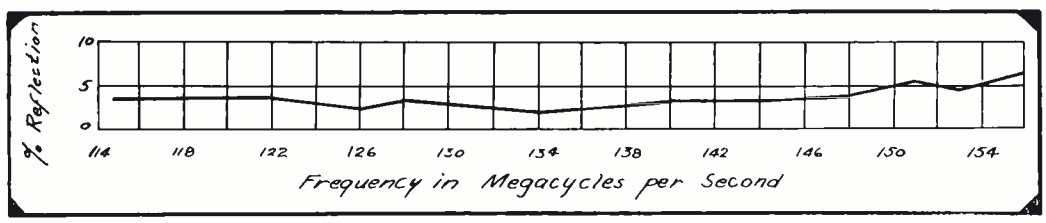
The antenna described in the above was of a general experimental nature and primarily designed to demonstrate the possibilities of building a broadcasting antenna having horizontal polarization and vertical directivity. The radiation obtained with this antenna was uniform in the horizontal plane and the vertical power gain was 2.3. The approximate band width of the antenna was 3 percent.

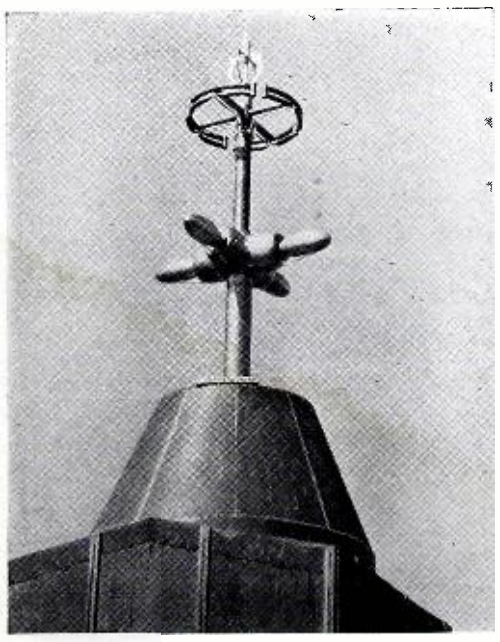
At the time of introduction of the 343-line pictures it became evident that the use of vestigial side band operation must be attempted in order to counteract the general reduction in amplification and the requirement of greater channel width resulting from the increased modulation frequency.

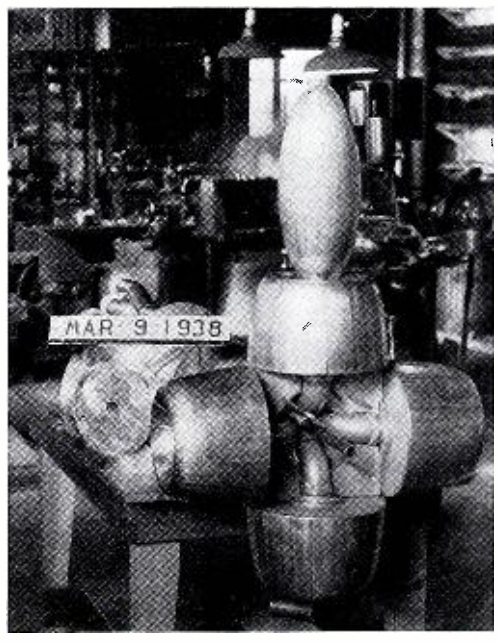
The experimental receivers for the 343-line field tests were therefore made selective enough to receive only one full side band and portion of the other side band. At the transmitter it was planned eventually to eliminate, by absorbtion, the portion of the side band not used in the receivers.

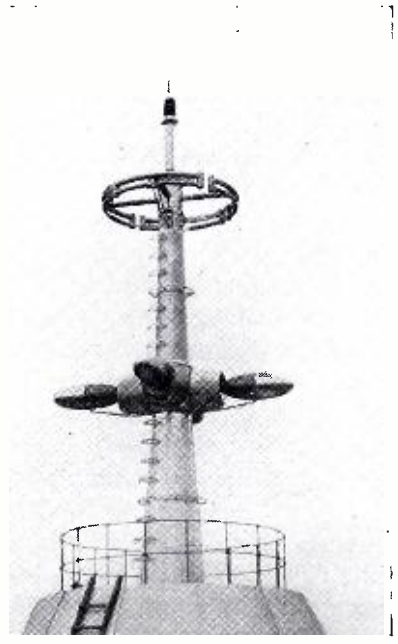
The antenna just described had suf-

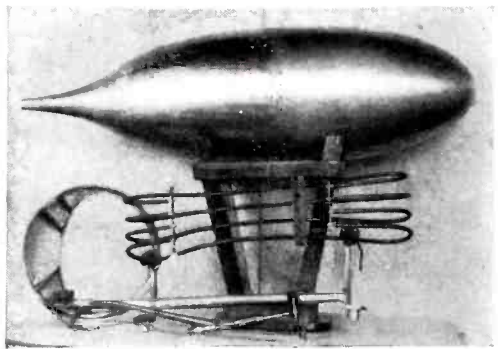
Right: Fig. 31. Response of 100-150 mc vision antenna (turnstile).
Below: Fig. 29 (left) Complete 100-150 mc model of vision and sound antenna. Fig. 30 (center) Shop view of 100-150 mc antenna. Fig. 33 (right) Antenna erected at Rocky Point.











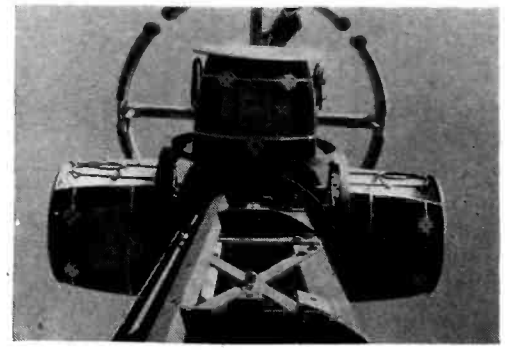
Above: Fig. 34. Ellipsoid and associated parts.

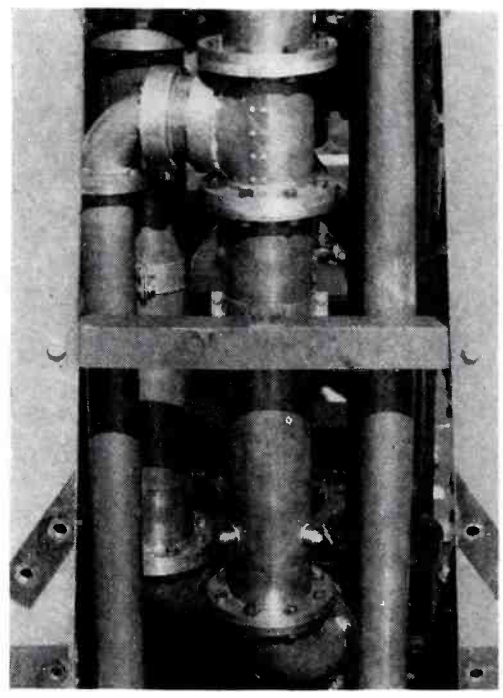
ficient band width to meet the above conditions. In view of the immediate need of an antenna to replace the original vertical dipoles, this antenna design was adopted. It was also considered desirable, at this time, to attempt simultaneous sound and picture transmission from the same antenna.

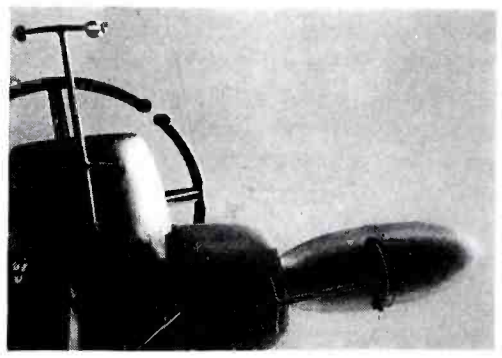
A 50-mc antenna, Fig. 23, Fig. 25, and a separation filter, Fig. 24 and Fig. 26, between the sound and picture transmitters was therefore manufactured and installed. One of the 72-ohm transmission lines of the original vertical dipole installation was used for energizing the new antenna.

The antenna structure was mechanically sturdy. By virtue of its design, surges from lightning strokes were very effectively prevented from entering the transmission line system.

While the field tests with 343-line pictures were necessary technical steps, it was quickly realized that the picture detail must be further increased before television was offered to the public. While, therefore, the triangular loop antenna served the dual purpose of providing a transmitting antenna for 343-line pictures and providing a better knowledge of the relationship between requirements and tolerances, it did not have sufficient band width by which full resolution of 441-line pictures could be maintained. It should here be remembered that the band width requirement increases approximately as the square of the definition. The new frequency allocation plan also called for change in carrier frequencies. This frequency change, alone, called for major alterations in the antenna. Further analysis and also experiments with the model of the triangular loop antenna had shown that only a slight increase in band width characteristics could be expected by alteration of this type. A new antenna therefore became a necessity. In order to avoid early obsolescence from possible future changes in frequency allocation or other alterations in channel experiments it was considered very desirable that the operable band of the new antenna possess a liberal margin. It should, however, be noted that the few successful antenna designed for the transmission of high definition tele-







Above: Fig. 35 (top) Internal structure for collars—note heating units. Fig. 36 (center) Main line, junction, branch feeders inside supporting structure of antenna. Fig. 39 (bottom) Showing supporting bracket with respect to ellipsoid and collar. Right: Fig. 40. Control unit for ice removal circuits.

vision provided no margin at all and required intricate compensation networks. The new American standard of 30-frame, 441-line pictures also represented the highest modulation frequency ever used outside the laboratory. Further progress in high-definition television had therefore come to largely rely upon advances in antenna design. Research in quest of such progress had, as yet, not matured into anything definitely practical.

As has already been demonstrated, the reflection effects from an antenna become less troublesome if the transmission line between transmitter and antenna is made short. The temporary expedient of erecting a simple antenna system in the closest possible vicinity to the transmitter was therefore considered. Such a system would, of course, not be suitable for transmission in all directions, but would provide an improvement in the characteristics of the load applied to the transmitter.

Two folded horizontal dipoles, one for vision and one for sound transmission, were therefore erected on the north wall, at the 85th floor of the Empire State Building. This eliminated the need of the separation filter. While the greatest portion of the gain in performance was due to the use of shorter lines, the simple folded dipole also possessed a somewhat better frequency response characteristic than that of the triangular antenna.

This arrangement provided a more workable system for the initial tests with the 441-line pictures.

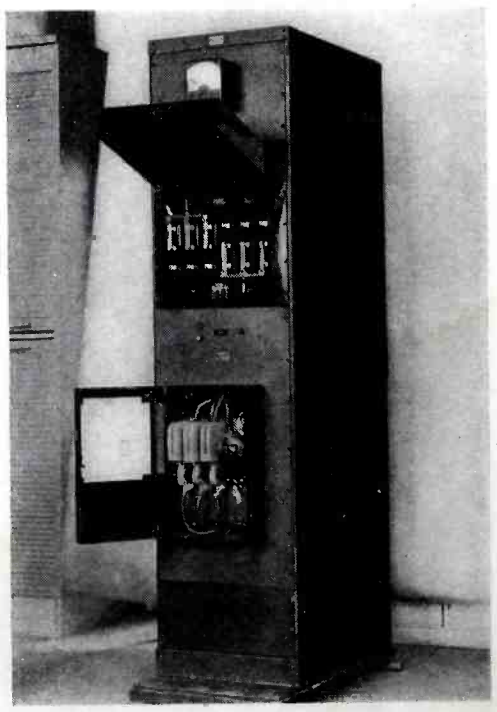
3. *Development and Design of New Television Broadcasting Antenna.*

Some time subsequent to the installation of the temporary dipole system just described, the development of the composite radiator had advanced to such a stage that this radiator appeared eminetly applicable to the solution of the antenna band width problem.

The development was therefore continued with the object in view of combining several composite radiators into a suitable aggregate for broadcasting of horizontally polarized waves.

Careful consideration of all factors invovled in the design of a complete antenna for high-definition television resulted in a decision favoring separate vision and sound antennas.

One of the principal reasons for the application of vestigial side band operation is conservation of channel width. This can not be accomplished unless the disregarded side band portion is thor-



oughly prevented from entering the radiating system. Such side tracking of high-frequency energy requires elaborate filtering equipment. The use of a single antenna for simultaneous transmission of vision and sound also requires considerable filtering for the prevention of cross-interference between transmitters. A complicated filter array would naturally introduce hazards to trouble-free operation and it therefore become desirable to reduce the number of filters to a minimum.

(a) Vision Antenna Model

The turnstile variety of radially combined radiators was chosen as the most suitable form of antenna aggregate for picture transmission. The reflection reducing properties of phase quadrature connections could then be taken advantage of with the object in view of obtaining a total input impedance even more resistive and less variable over a certain frequency band than that obtainable with a single composite radiator. In order to expedite the determination of the new collar dimensions resulting from combination into a hub, Fig. 29 and Fig. 30, a half section, Fig. 27, was first developed. The apparent optimum dimensions derived from the tests with the half section are indicated in the sketch Fig 28. It was also found during these tests that the throat taper and corresponding bracket dimensions had to be somewhat modified to restore optimum performance.

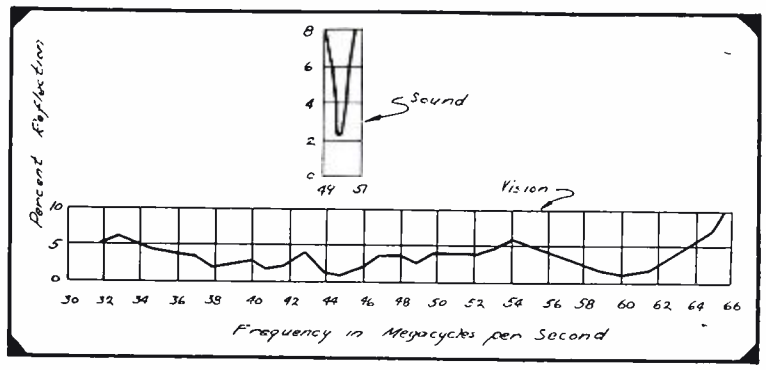
After these new dimensions had been established, the 100-150 mc model shown in Fig. 29 and Fig. 30 was built and tested. Fig. 29 also incorporates the sound antenna at the top which will be described later.

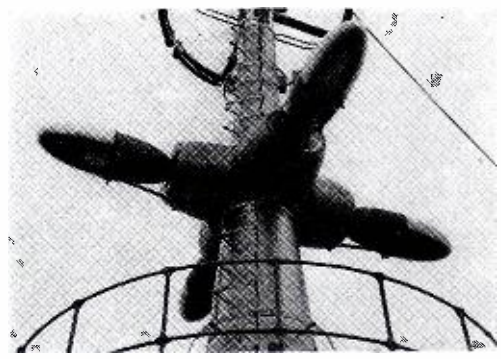
The very nearly resistive input impedance, at midfrequency, of each composite radiator is 110 ohms. The ratio of diameter, between outer and inner conductor, of the individual radiator feeders was therefore made such that the characteristic impedance of these feeders equals 110 ohms. In a phase quadrature system of radiators, the phase of the currents in successively adjacent radiators is progressively advancing or receding in quadrature steps. The currents in oppositely located radiators are then of opposing phase in reference to the center of the system. Instead of using four 110-ohm lines, progressively differing in length by a quarter wave, for connection to the transmitter, the lines feeding opposite radiators can have equal length if fed in phase opposition. The differential length of a quarter wave between feeders to adjacent radiators can then be provided near the antenna and the whole system can be fed through two main transmission lines, each having a characteristic impedance of 55 ohms and operating in phase opposition. Further reduction of the number of main lines was considered inadvisable since such procedure would result in the introduction of a transmission line balance converter in one form or another. While the quarter wave sleeve type of line balance converter shown previously renders excellent performance, within a frequency band corresponding to one television channel for 441-line picture definition at 40-50 mc carrier frequency, it would impose limitations on a system capable of handling greater band widths. These limitations may, of course, be lessened by further compensation as described earlier in this series. For the sake of providing a vision antenna of maximum attainable band width the method was not used.

Above: Fig. 41. Showing ice formation on antenna. Above, right: Fig. 42. Lightning striking Empire State Building.

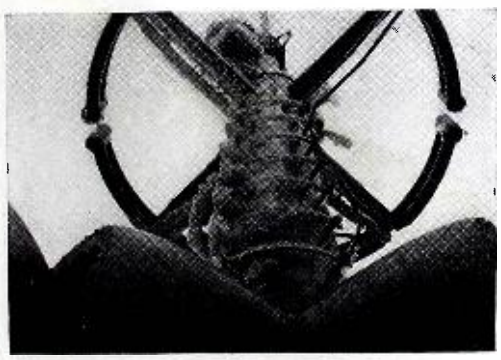
Right: Fig. 43. Freuency response.

Below: Fig. 44. Vision turnstile radiator system.





Showing ice formation on antenna. See also Fig. 41.



With the vision portion of the 100-150 mc antenna model, shown in Fig. 29, a frequency response characteristic having less than 5% reflection within a frequency band of 30% was obtained. Fig. 31. This represented an increase of more than 50% over band width obtained with single composite radiator.

The vertical directivity of a single turnstile antenna is less than that of a vertical dipole. By locating the turnstile at a distance of a half wave above a conductive surface, the vertical directivity can be made very nearly equal to that of a vertical dipole.

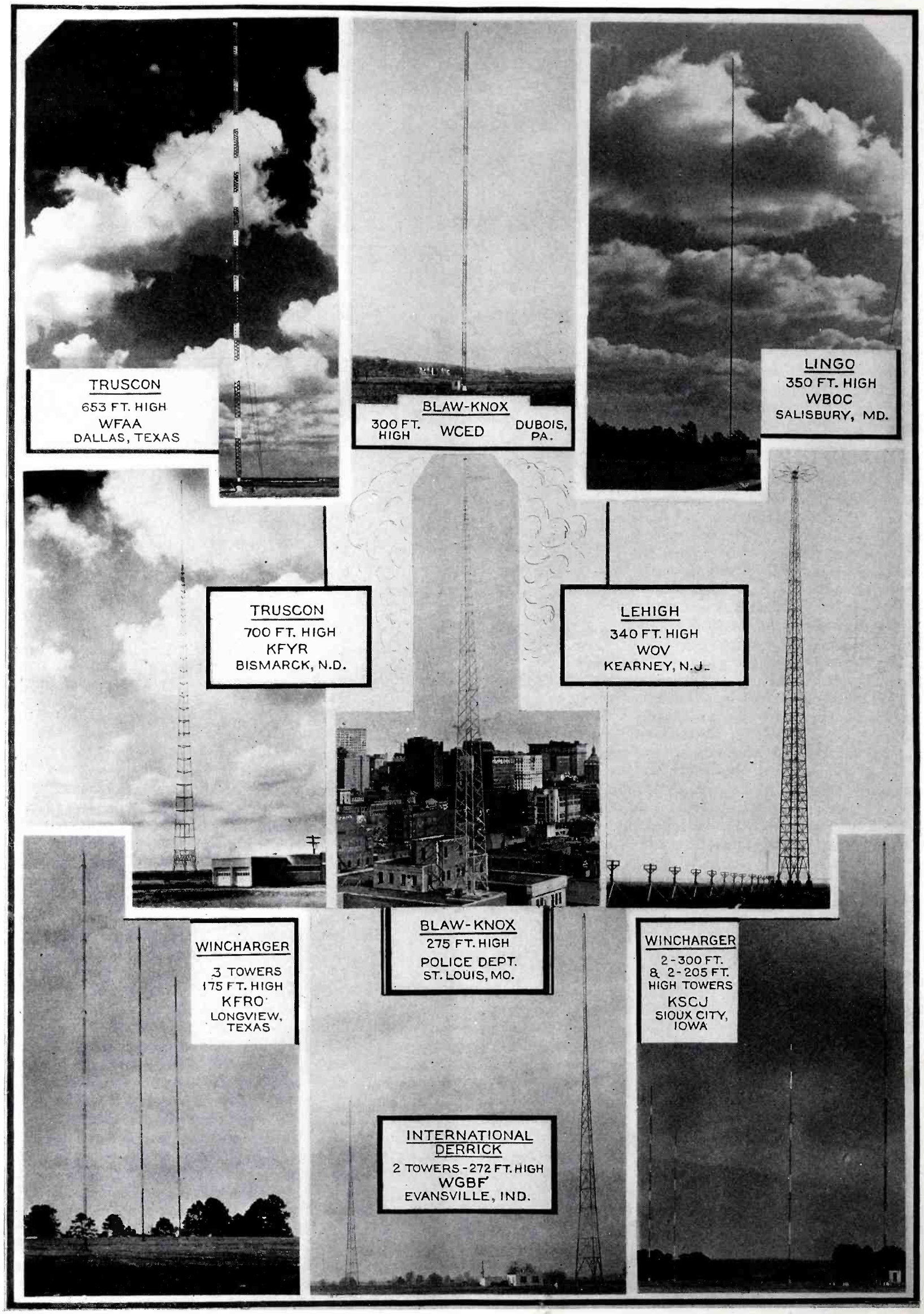
(b) Sound Antenna Model

In view of the limited space available on top of the Empire State Building and for the sake of compactness in general, it was decided to support the sound antenna from the same structure as that supporting the vision antenna, Fig. 29. Since, therefore, the sound and the vision antennas could not be located very far apart, special radiator combinations, providing uncoupling by means of electric balance had to be considered. Such balance can generally be achieved only when the two antennas are symmetrically located in respect to one another.

Since the vision antenna must be located a half wave above the roof for best vertical directivity and since the space between the vision antenna and the roof therefore must be as unobstructed as possible, the location of the sound antenna must be above the vision antenna. A location of half a wave above the vision antenna was chosen.

The two systems thus having a common, central, vertical axis, uncoupling could be attempted by making the sound antenna of the radial type and having

(ANTENNAS—continued on page 31)



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405 NORTH MAPLE DRIVE, BEVERLY HILLS, CALIFORNIA

Manufacturers of Continuous Verbatim Disc Recorders

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Mr. Sigurd A. Sollie, Sales Manager of Memovox, is in attendance at the National Association of Broadcasters Convention in St. Louis, May 12th to 15th, inclusive, and will be happy to confer with anyone who faces a reference recording problem. After the convention closes Mr. Sollie can be reached at the Gotham Hotel, 55th and 5th Avenue, New York City.

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MEMOVOX, INCORPORATED

By Walter W. Hagan
President

Annual Convention
National Association of Broadcasters

- *May 12-15, 1941*
- *New Jefferson Hotel, St. Louis, Mo.*

Neville Miller, president, National Association of Broadcasters.

PLANS for the Annual Convention of the National Association of Broadcasters, which have been in the making for a number of months, are fast coming to a head. Under the able direction of Merle Jones, KMOX, General Chairman, St. Louis broadcasters have completed arrangements to assure the careful handling of all details necessary for the comfort and proper entertainment of all who attend.

Housing

The Housing Committee, of which Ray Dady, KWK, is Chairman, has almost finished its task. According to NAB Reports more than 500 advance reservations have been made, although it is understood that there are still plenty of available rooms in St. Louis hotels and that even the headquarters hotel, the Jefferson, is capable of accommodating a few additional guests.

Ed Kirby, NAB's director of public relations.

Promotional Exhibits

The NAB indicates that the response to the Promotional Exhibits Committee's activities, has been most encouraging and the big Crystal Room of the Jefferson is certain to be crowded with a most interesting and enlightening display of all types of promotion material which has proven effective to stations large and small.

Equipment Manufacturers

Twelve equipment manufacturers and transcription companies, all associate members of NAB, will conduct exhibits during the convention. All of these headquarters have been definitely established and prior announcement of their locations in the hotel will be made.

Entertainment

Splendid entertainment in connection with the banquet is assured. The production heads of CBS, MBS and NBC are cooperating, and William Bacher, WGN, Chicago, has been named as manager of production of the show which will be put on in connection with the banquet. Every facility of writing and production in the three network departments have been placed at the disposal of Mr. Bacher.

Business Sessions

The programs for the business sessions promises to introduce subjects which are of considerable importance to broadcasters at this time; questions which deeply and vitally effect every person engaged in the radio broadcasting industry.

Attendance

It may well be predicted that this St. Louis meeting will go down as one of the most important the broadcasting industry has ever had. Present indications are that it will be one of the largest from standpoint of attendance.

Paul Peter, director of research, NAB.

Joseph L. Miller, NAB's director of labor relations.

Growing FM Acceptance

with G-E Simplified Circuit Design

The Voice from the Heart of New England

WTAG

RADIO STATION
OWNED AND OPERATED BY THE
WORCESTER TELEGRAM AND GAZETTE
WORCESTER, MASS.

March 12, 1941

Mr. W. R. David
Radio and Television Department
General Electric Company
Schenectady, N. Y.

Dear Mr. David:

The one kilowatt General Electric frequency modulated transmitter at W1XTG has now completed its first nine months of service, and we wish to congratulate you on the success attained in its use.

The circumstances have provided an ideal opportunity to judge the performance of your equipment. In this region where F M had its initial introduction as a regular full time service to the public, the interest is keen, the audience critical, and there is ample opportunity for comparison with other F M as well as A M services. A 16 hour a day program schedule has been maintained during the above period by W1XTG.

The results have exceeded expectations. Listener comment on the quality of reproduction has been most favorable Maintenance of the initially fine operating characteristics, and the general operating record of the transmitter have been very good indeed.

We feel that the excellent performance of your transmitter has done much to aid the growing public acceptance of F M in New England.

Very truly yours,

H. H. Newell

H. H. Newell
Chief Engineer
WTAG - W1XTG

HHN:A

FM's toughest job is audience building. And the trend in W1XTG's area shows that G-E simplified FM is doing more than its share in winning listener approval.

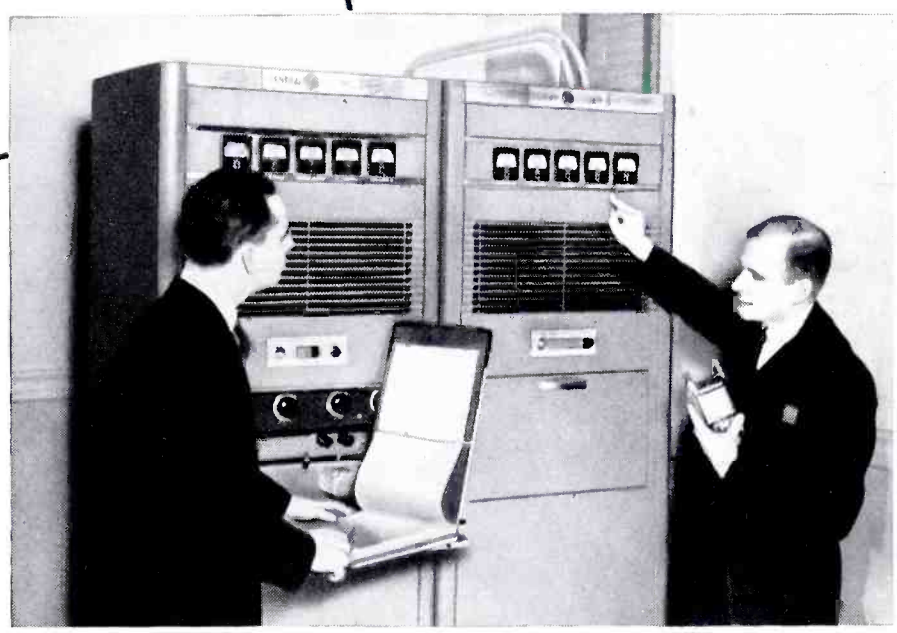
General Electric FM broadcast transmitters give full fidelity, real dependability, extra economy. Ask to see the figures on G-E performance.

G.E. for Complete Service

General Electric offers the only complete line in FM today—broadcast and relay transmitters, tubes, receivers, antennas, crystals, and the new station monitor. Speech equipment will be announced soon.

FM audience building is a specialty with G.E., through co-ordination of the work of our receiver and transmitter sales divisions.

Get an early start in FM. Your copy of "How to Plan an FM Station," and full information on the G-E complete service, are available through any of our 80 offices, or from Radio and Television Dept., General Electric, Schenectady, N. Y.



Chief Engineer H. H. Newell *(right) compliments G.E.'s S. H. Magruder on the excellent life of the G-E tubes at W1XTG, A complete set of tubes for W1XTG's 1-kw G-E transmitter* ***costs less than $290!***

FOR TOP PERFORMANCE
Use G-E Transmitting Tubes

GENERAL ELECTRIC

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Monument

MEMORIAL Services were held by our Association at the Wireless Operators Monument in Battery Park, New York City, at 6:15 p.m., April 15th, 1941—the 29th Anniversary of the sinking of the *Titanic*.

The New York *Times* reported the services as follows:

"A heroic Greek radio operator who gave his life two years ago to save his shipmates caught in a pounding Atlantic storm off the Azores received posthumous honors in a ceremony in Battery Park last night.

"The date was chosen by the Veteran Wireless Operators Association and the Wireless Operators Monument Association to honor Papas Theodorou, radio operator aboard the Greek freighter *Kyllene*, because it was the anniversary of the sinking of the *Titanic* in 1912.

"After the *Titanic* disaster a Monument was erected at the southeast fringe of the Park outside the Barge Office and a plaque with the name of Jack Phillips, radio operator on that ship, was placed upon it.

"Other names were added to his as time passed. Yesterday's plaque was the twenty-seventh on the Monument, each representing a wireless operator who gave his life, on the sea or in the air, to save others.

"William J. McGonigle, President of the Veteran Wireless Operators Association, presented the Marconi Memorial Medal of Valor to Nicolas Lely, Greek Consul General in New York, who will present it to the family of Mr. Papas.

"Mr. Lely declared that Mr. Papas, in standing by his post after the ship had broken up at the height of the storm, had demonstrated 'sacrifice of life for the benefit of the people at large' in the same way that 'the Greek people are sacrificing their lives for the lofty principles of liberty'.

"The Reverend Dr. Walter P. Doty, a former radio officer in the American merchant marine, now Rector of St. Johns Protestant Episcopal Church at 11th Street and Waverly Place, and Chaplain of the VWOA, read prayers at the ceremonies."

Through the cooperation of Commander J. S. Baylis, Captain of the Port, United States Coast Guard, the services were attended by a color guard and a bugler from the local Coast Guard station. Lieut. R. E. Morrell, Communications Officer of the New York Division of the Coast Guard, participated in the services. The services were also attended by members of the communications department of one of His Majesty's warships in the harbor. A large delegation of VWOA members was present. We express our grateful appreciation to Mr. M. S. Novik, Director of Municipal Broadcasting station WNYC, for the use of the sound truck of that station at the services.

San Francisco

This is a complete report on all activities out this way in connection with the 1941 annual cruise on February 11, 1941.

As you know, our Chapter met in Vallejo this year. Every year the old timers from Mare Island and Vallejo district (40 miles north of here) have driven down to attend our San Francisco gatherings. This year Ray Myers suggested we reverse the idea and come up to Vallejo. This was agreeable to San Francisco members, and so we gave Ray the green light. He worked hard and did a splendid job of getting together 40 old timers on the windiest, stormiest and most inclement night of the year.

The dinner took place at the Vallejo Country Club. The food was splendid and the service satisfactory.

On the telephone hook-up Mr. McGonigle spoke with Ray Myers, toastmaster of our affair, with Arthur Isbell and with Gilson Willets. Mr. Myers told of our gathering and extended greetings to you-all in N. Y. Mr. Willets introduced Mr. Isbell and Mr. Isbell acknowledged receipt of the Pioneers Medal . . . we hope it all came through OK.

Ray Myers had place cards for every person and had meticulously arranged the seating. One long table, 20 men on each side . . . and not a place was vacant. Mr. Myers, as host and toastmaster, sat in the middle, flanked on one side by Mr. Isbell, the other by Mr. Willets.

The dinner was tasty, plentiful and nicely cooked. During the salad course, Toastmaster Myers told jokes, during the next course Toastmaster Myers told more jokes and recited a poem he had written especially for this occasion. It honored those intrepid operators who had given their lives in the line of duty. During the meat course Toastmaster Myers told more jokes, and for the thousandth time told the now famous story of operator "Pegleg Johnson." The morale was high, everybody was happy and Host Myers' running humor kept the thing from lagging.

Over our coffee Toastmaster Myers told of the objectives of the VWOA and read parts of the constitution and by-laws. He then touched briefly on how the organization had been formed in 1925 and introduced one of the founders, Gilson Willets, chairman of the San Francisco chapter.

Mr. Willets arose and gave a brief biography of Mr. Arthur Isbell, stressing the many pioneering achievements of the now retired RCA executive. It was a concise life story and a fascinating one. At the conclusion the Pioneer's Medal was presented.

Mr. Isbell arose, thanked the members for the honor which had been bestowed upon him and then everybody arose and applauded . . . he blushed with radiating pride as the applause continued for many minutes.

The members present, VWOA members only, proposed electing Mr. Arthur Isbell as secretary-treasurer. He steadfastly declined . . . and let us know today that he definitely will not accept the job. Thus we are at this time still without our new set of officers, but will have a report on this for you in the near future. Mr. Willets remains chairman of the San Francisco district chapter, assisted by Stanley Fenton, Capt. Dodd and Mr. Myers, etc.

It was moved and seconded by the entire group present that the VWOA take steps to have the new National Broadcasting Building now being constructed in San Francisco officially dedicated to our honorary President, Dr. Lee DeForest. The motion was made by Tim Furlong. Mr. Arthur Isbell was appointed to communicate this desire to you and the proper authorities. The air mail package sent to me with Mr. Isbell's biographical sketches had arrived and every man present received one of these.

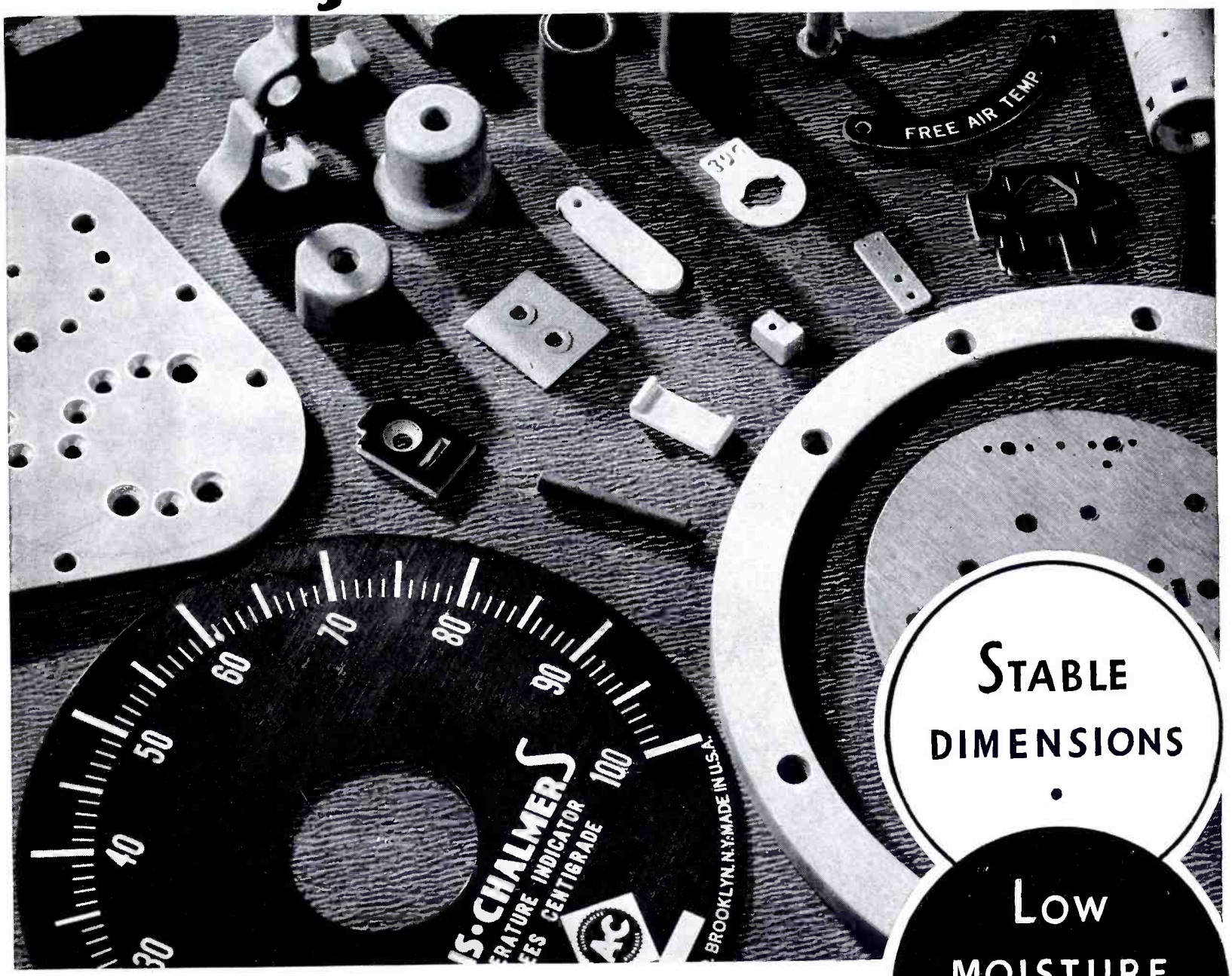
Code Proficiency

In line with our policy of doing our part in "National Defense," our Association offered a Marconi Memorial Award to be presented to the winner of the Army Amateur Radio System Code Proficiency contest. Major General J. O. Mauborgne, Chief Signal Officer of the Army, advises us that the winner of the contest is W. B. Hollis, W5FDR of Houston, Texas. The Award will be presented over a nationwide radio network with General Mauborgne participating. A biographical sketch of Mr. Hollis follows.

W. B. Hollis, W5FDR/WLJR, 8010 Grafton Street, Houston, Texas, winner of the annual AARS code speed contest at 65 w-p-m, was born in San Antonio, Texas, in 1903. He has been a licensed radio amateur since 1935 and members of the AARS since 1936. Mr. Hollis has had an active radio and military career. From 1919 to 1921, he was in the Navy at the Naval Radio School at Great Lakes, Ill. Following a year as a commercial operator, he served in the Marine Corps during the period 1922-25 as radio operator and chief radio operator at Naval radio station NPP at Peking, China, remaining in the Marine Corps Reserve until 1929. Since 1925 he has been associated with the Southwestern Bell Telephone Co. at Houston, but the years 1931-35 saw him also serving as radio operator in the observation squadron of the Texas National Guard. In the ARRL, he has been West Gulf alternate director, Route Manager, ORS, OBS, A-1 Operator, RCC, and manager of Trunk Line D. It is interesting to note that he won the AARS speed contest in 1939, also at the 65 w-p-m speed. He is married and has six children. While amateur traffic handling is his first interest, other hobbies include woodworking and model airplanes.

(VWOA—continued on page 25)

»» We Punch, Machine and Print, Insulating Parts for Electrical Devices



STABLE DIMENSIONS

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LOW MOISTURE ABSORPTION

LOW POWER FACTOR AND HYSTERESIS LOSSES

IN addition to one of the largest volumes of production in the industry for laminated, sheets, tubes and rods, Formica maintains a very complete and well equipped fabricating department for all types of machining on laminated parts. It also prints, stamps and engraves sheet and tubing by a number of processes.

For 28 years the Formica organization has been specialized on just one product — laminated phenolic material. It has maintained a large and well equipped laboratory whose business it has been to learn as much as possible about that one product.

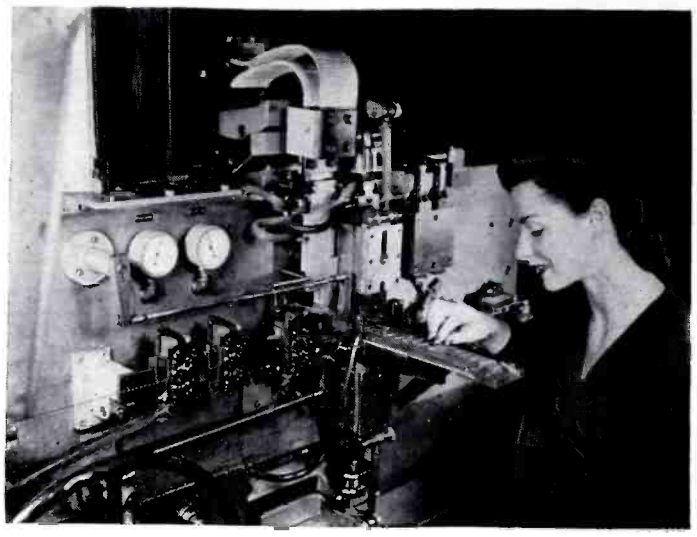
The result has been high and uniform quality, and the development of special grades emphasizing special qualities to meet particular requirements. You can get what you want in laminated insulation from Formica. Send your blue prints for quotations.

FORMICA

The Formica Insulation Co.
4616 Spring Grove Ave.
Cincinnati, Ohio

INSULATING PARTS

Improved efficiency in manufacturing grids used in radio tubes results from the new automatic grid machine perfected by the RCA Manufacturing Company at its radio tube plant at Harrison, N. J. This machine has been under development for a number of years and is said to have been made economically possible by the fact that RCA concentrates much of its receiving tube business in 31 types.



The new machine makes grids by welding formed wires to the side rods at a single operation. The welding operation is controlled by radio tube circuits to assure the exact amount of electric current for the exact time required to make perfect welds of all grid wires to the side rods. Water - cooled electrodes perform the welding operation. A variable speed motor is used to drive the machine.

BOOK REVIEWS

THE STEREOGRAPHIC PROJECTION, by F. W. Sohon, published by Chemical Publishing Co., 148 Lafayette St., Brooklyn, N. Y., 210 pages, price $4.00.

The use of stereographic projection is not new to the communications engineer. Indeed, its applications to crystallography and navigation are matters of the utmost importance in these branches of the art. This book can be read without difficulty by those familiar with spherical trigonometry, although the methods of vector analysis are used in many proofs. In general several sets of proofs are used so that the reader may choose the method he wishes. In the preface the author points to the antiquity of the origin of projection, attributed to Hipparchus (150 B. C.).

This book has seven chapters, an appendix, and a number of trigonometric tables including the Weston-Woodstock table. Chapter one deals with the projection of points and starts with the fundamental definitions necessary for the discussion. The following chapters on "The Projection of Circles," "The Projection of Angles," "The Projection of Meridians and Parallels, "The Projection of the Spheroid," etc., are treated in considerable detail and in a readable and understandable style.

This book is no doubt intended as a text, but in this reviewer's opinion it merits a place on the engineer's book shelf as a reference work. This book is highly recommended to those engineers and physicists interested in this subject.

TELEVISION, TODAY AND TOMORROW, by Sydney A. Moseley and H. J. Barton-Chapple, published by Pitman Publishing Co., 2 West 45 *St., New York City,* 179 *pages, price* $3.00.

This book presents a history and brief description of television. It deals essentially with the Baird system and presents the picture from the British standpoint.

The first chapter deals with the history of television and submits documentary proof of dates of various television accomplishments. Succeeding chapters deal with fundamental concepts of television, dissecting a television picture, generating the picture signal, ultra-short waves and aerials, cathode-ray tubes, television receivers, big screen television, infra-red images, fog penetration, color television, stereoscopic effects, etc.

The book is written in an elementary style and is profusely illustrated. Of particular interest to this reviewer is a large field strength contour map of the Alexandra Palace television transmitter in London.

FESSENDEN—BUILDER OF TOMORROW, by Helen M. Fessenden, published by Coward-McCann, Inc., 2 West 45 *St., New York City,* 362 *pages, price* $3.00.

This book presents in interesting fashion the life and work of Reginald A. Fessenden. Written by his wife, this volume is a straightforward account of this man's great work and some of his legal encounters over patents and inventions. As everyone interested in the radio art knows, Fessenden is responsible for a prodigious amount of early work in originating communication and navigation devices.

The book contains many interesting and amusing episodes as related by his contemporaries. Many of the great and well-known names in the radio art are mentioned and often quoted. An interesting addendum contains Fessenden's own account of his discovery of the electrostatic doublet theory and of the nature of cohesion and elasticity. One chapter contains a description of Fessenden's fathometer and the important events connected with its perfection and application.

This book is recommended to all interested in the radio art and in particular those interested in a personal insight into the life of one of radio's greatest contributors.

TELEVISION—THE ELECTRONICS OF IMAGE TRANSMISSION, by V. K. Zworykin and G. O. Morton, published by John Wiley and Sons, 440 *Fourth Ave., New York City,* 646 *pages, price* $6.00.

This book is intended for the advanced student or engineer. It deals specifically with electronic television, employing the storage principle rather than other systems.

The first part of the book is devoted to fundamental physical phenomena involved in the television art. This section of the book is concerned particularly with emission of electrons, fluorescence, electron optics, etc. Part two deals broadly with the field of television as a whole—such subjects as the relationship between the physical system and picture quality, the principles of ultra-high-frequency transmission and reception of television signals, and methods of pickup and reproduction of images. In part three the authors present an analysis of the components of the electronic television system based on the storage principle. This section deals in detail with the iconoscope, kinescope, electron gun and associated circuits, the television transmitter, and the television receiver. There follows a description of the equipment involved in the RCA-NBC television project.

This book is one of the most complete technical works on the subject of television that has come to the attention of this reviewer. As might be expected, mathematics is used when required and in some instances the analyses become somewhat involved. The subject matter is well presented and carefully written. Hence this book is highly recommended to the television engineer or the communication engineer interested in television.

PRINCIPLES OF TELEVISION ENGINEERING, by Donald G. Fink, published by McGraw-Hill Book Co., 330 *W. 42nd Street, New York City,* 541 *pages, price* $5.00.

This book is intended to help the radio engineer make the transition from radio engineering to television engineering. The author makes this transition simple and easy by first clearly defining the basic differences on the part of the observer between visual and aural transmissions of intelligence, and then by following an orderly sequence in discussing the factors and apparatus involved from scanning to reproducing.

The first chapter deals with basic factors in producing an image on the eye of the observer, as well as with the fundamental methods and equipment involved. Chapter two covers image analysis, involving factors determining the number of picture elements, visual acuity, scanning technique and image defects. Following this such subjects as fundamentals of television camera action, deflection, synchro-

(BOOKS—continued on page 25)

Producing Communications Receivers

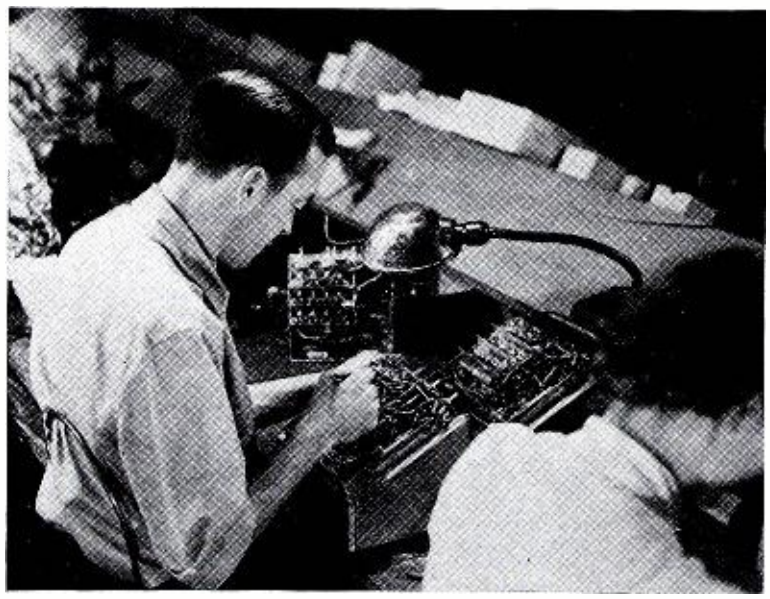
By S. GORDON TAYLOR

LONG after the broadcast listener found that he need no longer build his own receiving equipment—that he could buy better than he could build, and cheaper—engineers in experimental, broadcast and communications services, and hams, were still "rolling their own." And they had good reason for so doing. Mass production methods which had brought prices of broadcast receivers down to an economically practical level could not satisfy the far more critical requirements of communications receiver design.

A few receivers of the communications type were placed on the market but these were mostly designed and constructed much as individual laboratory projects, and were accordingly high priced. In effect this system simply transferred the job of building a receiver from the laboratory or home of the consumer to the laboratory of the manufacturer where specialists could do a better and quicker job—although still too high priced to satisfy more than a small fraction of the potential market.

Fig. 8. The final step is test laboratory where each receiver is instrument and on-the-air tested.

Fig. 6. At short distances along the production line an inspector checks work of operators immediately preceding.



But gradually design and production methods were improved until today's communications receivers satisfy not only all ordinary communications requirements, but the requirements of specialized services such as f-m, the ultra-high frequencies, etc. And they do it at a price that has made even the confirmed "diddler" think twice before tackling the job of building his own receiving equipment.

It has always been recognized by manufacturers that "mass production" methods were not for communications receivers. In recent years it has also been recognized, on the other hand, that the "laboratory-built" procedure is impractical from the standpoint of cost. Yet somewhere between these two was the solution of the problem of manufacturing economy without sacrifice of rigid technical standards. It is the purpose of this article to describe how one manufacturer has successfully hurdled the obstacles.

There seems to be no definite terminology to describe the system developed by Hallicrafters. It is not "mass" production in the usual sense, although many thousands of communications receivers are turned out annually. Certainly it is not "laboratory" production in the sense that this term is usually understood. Perhaps as good a label as any is "coordinated sequence production."

In the Hallicrafters plant the punched chassis are fed into one end of a production line of workers, each making his or her specialized contribution, and comes out at the other end a finished receiver with anywhere from fifty to three hundred parts assembled on the chassis and wired. If this sounds like "mass" production methods it is because a number of contributing factors have been neglected in this one-sentence description of the basic production system. These factors will be clarified as the description progresses.

The first safeguarding measure is thorough pretesting of all parts before going into stock. For this purpose there is a separate department, its operators trained and equipped for precision working tests. A section of this department is shown in Fig. 1.

Here each r-f and i-f coil is given not only the usual tests but is directly compared with a standard master coil by means of the G.R. No. 721AR Comparator, to insure absolute duplication of the original values. All tuning condensers are similarly tested. Trimmer condensers are checked for capacity range and subjected to high voltage (usually 600 volts). All variable resistors are individually checked for resistance value and contact. In fact the only parts not individually tested are the fixed by-pass condensers and fixed resistors. But even in this case, from 5% to 10% of each incoming batch are picked at random and individually tested. If these are all within the specified tolerance the batch is passed, otherwise another "sampling" is tested in the same manner and if this shows rejects then every individual unit in the batch is tested.

Even cables and plugs, usually purchased completely

assembled, are sample checked for insulation of the individual wires, given thorough visual inspection and continuity tested for shorts and poor soldered connections.

Every individual tube is aged four hours in special racks as shown in Fig. 2. This results in improved stability and weeds out those which are incluned to be substandard. Experience indicates that potential weaknesses in a tube will almost invariably show up as a result of this aging.

Extreme importance is attached to this pretesting of parts. While it involves a considerable amount of expense, this is small as compared with the cost of locating and correcting trouble in completed receivers due to defective parts going into their assembly.

Chassis and cabinets are made up in a sheet-metal shop devoted exclusively to this purpose. When a particular model is scheduled to go into production, advance orders go to the stock room and sheet metal shop with the result that all needed parts are placed on trucks in readiness to go to the production department.

In this department the first operation is to mount the tube sockets, terminal strips and other riveted parts on the chassis. This is mostly machine work and is handled entirely by men. A section of the preassembly department is shown in Fig. 3.

In the meantime the make-up of the production line which is to handle this particular order has been planned so that the receivers will pass smoothly along the line with no wasted time and no bottle-necks. The number of workers in the line will depend on the receiver model and the number of operations involved. In the case of the more complex receivers the number may total fifty or more.

Fig. 4 shows a portion of one of the three production floors. Before production gets under way the parts which each worker is to mount on the chassis are placed on a shelf just above the work table and immediately in front of each worker is a jig for holding the chassis while working on it. Workers are placed in the order of their operations, rather than by types of work. Some may do nothing except mount one or more parts (the girl in Fig. 5, for instance). Others do nothing but solder certain connections. Still others may do both assembly and wiring. Whatever the assigned work, the portion contributed by each one takes exactly the same length of time.

Careful study and experience have shown that women are more capable of certain operations while men excel on others and the work is assigned accordingly. While the women exceed the men on the production line there is one type of job held by men exclusively—inspection.

This inspection is one of the important factors in the success of this type of production as applied to communications receivers. Distributed along the production line and averaging about one to every four workers, these inspectors (a close-up of one of them is shown in Fig. 6)

Fig. 4. A partial view of one of three production floors in the Hallicrafters plant.

Fig. 5. This girl mounts 3 r-f coil assemblies. Operators following will wire these

Fig. 1. Component parts being individually pre-tested before going into receivers.

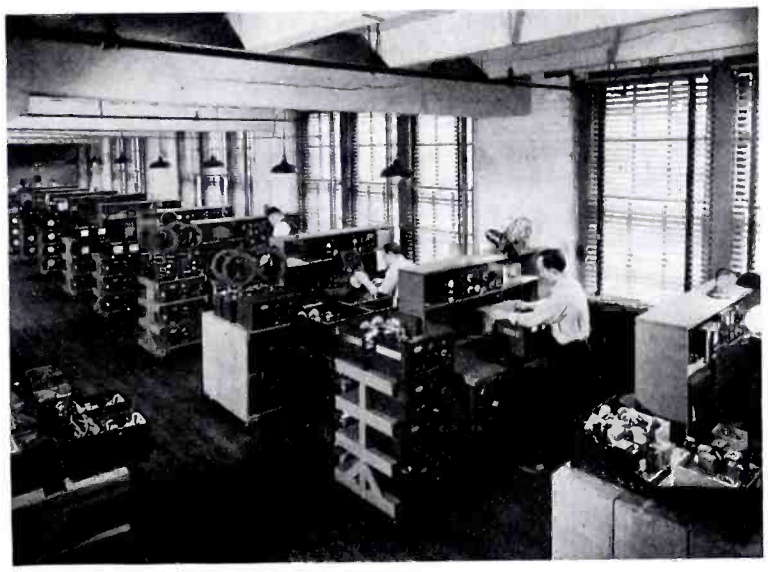


Fig. 7. From the production lines the finished receivers go to these benches for alignment and adjustment.

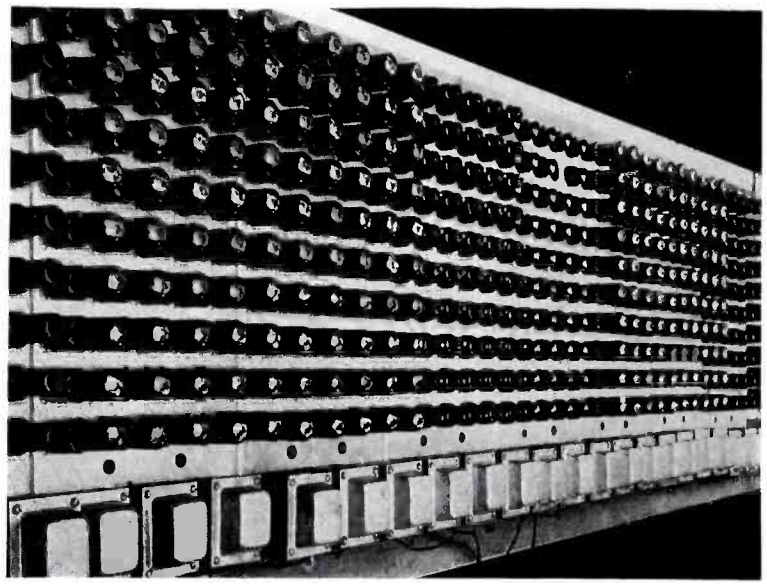


Fig. 2. "Green" tubes are potential trouble-makers. Tubes are aged several hours in this rack.

have as their sole duty the careful checking of the operations performed by the workers immediately ahead of them on the line. Each one tests soldered connections, placement and correctness of components and wiring, and completeness of the set-up to his stage of inspection. Thus it is practically an impossibility for a human error to get by. Were this inspection limited to receivers as they come off the line it would be much less effective because in the completed receiver wires, connections and parts may be concealed beneath other components added in subsequent operations. Moreover, it is substantially impossible for one man to accurately check all parts and connections of an entire receiver. But even if he could, errors detected after a receiver is completed would in many cases be expensive to correct.

When the finished receivers reach the end of the production line they are placed in special trucks and rolled immediately to the "Phasing Position" (Fig. 7), the locally adopted term for alignment experts. Here it is the job of specialists to align and otherwise adjust each receiver. Each of these men is equipped with a bench. Arranged on a shelf at eye level is his equipment consisting usually of a volt-ohmmeter, output meter, i-f signal generator and r-f signal generator.

This does not in any sense represent a final inspection, nevertheless if there is anything materially wrong with a receiver it will likely be detected here. In such a case the defective receiver is sent immediately to a special "Production Service" department where the cause of the trouble is located and corrected. By having all trouble-shooting handled in one department and immediately, recurring troubles can be tracked down to their source in the production line or elsewhere and there corrected so that the balance of the receivers on the line will not suffer this same ailment.

The adjusted and aligned receivers are replaced on their trucks and roll along to the final test department for a final and complete going over in every detail. Three of these final test positions are shown in Fig. 8. The test men here are engineers, thoroughly familiar with laboratory technique. Their equipment includes Ferris signal generators, crystal controlled 100-kc and 1000-kc calibration standards, audio oscillators and the necessary output and other meter equipment.

The tubes which will be shipped in the receiver are already in position (they were inserted when the receiver left the production line and before alignment) so these final tests are made with the receiver in the exact condition in which it will reach the ultimate owner.

The tests performed include both electrical and mechanical. Under the head of "mechanical" come the physical inspection and tests for operating smoothness of all controls. The electrical tests include checking the proper functioning of all controls, and a check of sensitivity, dial calibration and noise in each tuning range. These are laboratory-type tests and to meet requirements it is necessary that each receiver duplicate standards as set by the design laboratory for that model.

After these bench tests, each receiver is finally put through its paces on the air, band by band, to provide an operating check on tone quality, automatic noise limiter, a-v-c and crystal filter action, beat-frequency oscillator, headphone circuit, etc. It is only after all these tests have been successfully completed that a receiver is ready for an OK and shipment.

It is an interesting fact that over 95% of the receivers come off the production line in perfect condition to pass the critical alignment and final test operations. (Of the remaining small percentage the majority are held up for some minor defect which involves the work of but a few moments to correct.) This is not because of any laxness in these final test measures. Indeed the tests are far more searching than any to which the receiver is likely to be put by the ultimate purchaser. Rather it is due to the precautions taken all along the line to avoid any possibility of variation from the established standards, a practical application of the "ounce of prevention" theory.

The cost of pretesting component parts, intermediate line inspections, etc., is appreciable. This is, however, negligible as compared with the cost of tracking down and correcting defects in a completed receiver—defects caused by improper assembly or wiring, sub-standard parts, etc.

It is by such carefully planned and fool-proofed production methods that the market is today able to offer communications receivers of the most advanced design and features at prices undreamed of a very few years ago. And as prices have gone down the market has increased making further production economies possible.

But all the advantages of this carefully organized pro-

(RECEIVERS—continued on page 26)

Fig. 3. Riveting machines make quick work of mounting sockets, terminal strips and the like.

BOOKS

(Continued from page 20)

nization, scanning beams, video signal analysis, video amplification, image reproduction, television broadcasting practice and television receiver practice are treated in detail. An appendix dealing with definitions, recommended practice, RMA standards, etc., is included.

The book is written in an elementary style and follows a logical sequence. Only such mathematics are given as is required for a clear understanding of the subject matter under discussion. As a result this book is highly recommended to engineers as a readable text which sets forth the necessary fundamentals for a clear understanding of television. R. D. R.

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VWOA

(Continued from page 18)

Scholarship

The "National Defense" Scholarship in Practical Radio Engineering at the Capitol Radio Engineering Institute sponsored by our Association will be awarded to the winner of a contest to be conducted some time during the Summer. The contest will be in the form of an entrance examination and will cover the pertinent subjects which will indicate the man best suited to be honored by the award. The contest will be open to professional radio operators—commercial, broadcast, airlines, Army, Navy and Marine Corps. The plans for the contest are still tentative. We invite inquiries and will advise all those interested as soon as all the details have been worked out. Address us at Radio City.

• • •

COMMENT

(Continued from page 2)

• • • • Wire and cable manufacturers are faced with an acute shortage of shipping reels, spools and cases due to the failure of busy industries to return empty containers. While these manufacturers are buying and making containers as fast as possible, new containers are not available in adequate volume. Since this shortage is threatening deliveries on vital defense orders, all empty reels, spools and cases should be returned to the manufacturers at once.

• • • • A similar situation exists in respect to instantaneous recording discs. Due to the shortage of aluminum, all broadcast stations would do well to return used transcriptions to the manufacturer immediately in order that the aluminum may be reused in the production of new discs.

• • • • Beginning July 1, television broadcasting will be placed on a commercial basis as a result of regulations adopted May 2 by the FCC. It is understood that the standards are essentially the same as those recommended by the NTSC at the March 20 hearing. (See "NTSC Television Standadrs", p. 12, Feb., 1941, COMMUNICATIONS.) Stations must provide a minimum program service of 15 hours per week.

RECEIVERS—continued from page 24

duction program would be of little avail without equal thought to basic merchandising policies and careful planning. Under the flexible production set-up of Hallicrafters, for instance, receivers of the different models are produced only in the extent justified by existing orders from dealers. One result is that there is never a "manufacturers surplus" of these receivers, representing a loss that would have to be absorbed and reflected in higher prices for new models. Then, too, a reasonably large variety of models for the varied services in the communications field creates a staggered demand which keeps the plant busy the year round without the layoffs that so seriously affect the morale and production ability of workers.

Added to all the other economies mentioned, there is by no means the least important that many component parts are duplicated in different models and can therefore be produced or purchased in proportionately larger quantities at decreased cost. The danger of overstocking parts on the one hand, or being held up for lack of parts on the other, is therefore materially minimized.

OVER THE TAPE

G-E BULLETIN

The General Electric Co., Schenectady, N. Y., have issued a new bulletin on radio transmitting tubes. In addition to ratings, this bulletin contains the prices made effective March 15. Copies available on request.

AEROVOX DATA

The January and February issues of the Aerovox Research Worker contain Parts I and II of an interesting article on "Aplications of the A-F Oscillator." Copies of this publication may be secured by writing to Aerovox Corp., New Bedford, Mass.

IDEAL COMMUTATOR CATALOG

The Ideal Commutator Dresser Co., 1270 Park Ave., Sycamore, Ill., have issued their Twenty-fifth Anniversary Catalog. This catalog covers flashlight storage batteries, electric etchers, soldering irons, welders, wire strippers, cutters, cleaners, etc. Copies available from the above organization.

WESTINGHOUSE LEAFLET

Intricate porcelain shapes for high-voltage applications are described in a new leaflet announced by Westinghouse. Dielectric and mechanical strength, heat shock resistance, and dimensional fidelity of Prestite are discussed and compared to wet and dry process porcelain. Applications are listed. Photographs show texture of Prestite, wet and dry process porcelain. A copy of descriptive data 39-600 may be secured from department 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

HALLIGAN TO CHICAGO NDC

The appointment of William J. Halligan, president of the Hallicrafter, Inc., to the Chicago Commission of the National Defense, has been announced by Chicago's Mayor, Edward J. Kelly. Mr. Halligan served in the communications division of the Navy during the last World War and during the conflict was assigned to a mine layer operating in the North Sea. At the close of the war he attended West Point and is an active member of the West Point Club of Chicago.

DUOTONE DISTRIBUTOR

Duotone Co., Inc., New York, has appointed the National Recording Supply Co., Hollywood, as southern California distributors for its line of phonograph and home recording playback and cutting needles.

ATLAS CATALOG

The new 1941 Atlas Sound Catalog F-41, just released by the Atlas Sound Corp., 1449 39th St., Brooklyn, N. Y., describes p-a speakers, baffles, microphone stands, accessories. Copies may be secured by writing to the above organization.

RADIO RECEPTOR BULLETINS

Radio Receptor Co., Inc., 251 W. 19th St., New York City, have available bulletins No. 5001, 5002 and 5003. These publications cover their ultra-high-frequency airport traffic control receivers, transmitters and antennas, respectively. Copies may be secured from the above organization.

"WIRED FOR SOUND"

Western Electric Co., 195 Broadway, New York City, have recently issued an interesting bulletin entitled "Wired for Sound." It describes in an interesting and simple manner the art of piping programs to the stations throughout the nation.

MECK APPOINTMENT

The appointment of Mr. Wm. W. Montgomery as sales manager of the Audiograph Sound Systems Division has been announced by John Meck Industries, 1313 W. Randolph St., Chicago. Mr. Montgomery has been associated with the sound field for a number of years.

CLAROSTAT DATA SHEETS

New and revised engineering data sheets have been issued by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. They are available to those engaged in actual engineering, designing and production of radio, electronic and electrical assemblies. They provide information on the different types of Clarostat resistors, controls and resistance devices. They are gathered together in a loose-leaf binder, new sheets being sent to those who already have the binder so that the data are kept up to date.

AUDIO DEVELOPMENT APPOINTS NEELY

The Audio Development Co., of Minneapolis, recently appointed Norman B. Neely Enterprises' exclusive agents for several western states. The Neely organization maintains offices at 5334 Hollywood Blvd., Hollywood, Calif., and 420 Market St., San Francisco, Audio Development manufactures audio transformers and other allied items.

CROWE BULLETIN

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, have issued Bulletin 237 covering remote controls and kits for automobile radios. The various kits and controls illustrated may be used in connection with most auto radio sets. The No. 700 controls are interchangeable on all cars and with the proper panel kits as described in the bulletin when the set is to be moved from one car to another. Special consideration is given to proper installation with Arvin, Delco, and Philco auto radios.

GENERAL RADIO EXPERIMENTER

The April, 1941, issue of the General Radio Experimenter contains some very interesting data on "New Terminals for Use With Coaxial Transmission Lines." A new audio-frequency microvolter is described in the same issue. Copies of this publication may be obtained from the General Radio Co., 30 State St., Cambridge, Mass.

NEELY APPOINTMENTS

Frank B. Koessler is the newest member of the sales staff of Norman B. Neely Enterprises. Mr. Koessler formerly operated his own radio sales and service business, and shortly before joining the Neely organization he was employed by Listenwalter and Gough, Southern California Philco distributor.

HOWARD LITERATURE

Howard announces two new folders. No. 105 lists replacement chassis, including frequency-modulation and home recorders, while No. 106 gives data on paper base recording discs and needles. These bulletins are available without charge. Write to Howard Radio Co., 1735 Belmont Ave., Chicago.

WESTINGHOUSE BULLETIN

Improved a-c and d-c ammeters and voltmeters for general use are described in a new 12-page bulletin announced by Westinghouse. The ammeters are available in ranges from 5 to 125 amperes, and the voltmeters are made in ranges from 90-140 to 450-700 volts. Switchboard, portable, wall, and socket types are described, special attention being given to application. Operation and construction details are explained. List prices are quoted for all meter ratings and styles. Physical dimensions are given on outline sketches which show mounting details. Typical 1 and 6-day charts are illustrated. A copy of Catalog Section 43-414 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

DUMONT INCREASES PRICES

The Allen B. DuMont Labs., Inc., of Passaic,, N. J., have announced that the prices of their instruments and teletrons will be changed May 15. According to the announcement the increase in prices is due to increased material and labor costs. The new price lists are now available.

TURNER APPOINTMENTS

With the opening of the export market to Turner push-pull vibrators, two new departments have been created by The Turner Co., Cedar Rapids, Iowa. Mr. W. D. Lyon becomes head of the advertising department and Miss Garnet L. Ramsey is named manager of the Vibrator Export department. Mr. Lyon will have charge of the advertising of microphones and vibrators, while Miss Ramsey takes charge of exporting vibrators only. The exporting of microphones remains under the direction of Ad Auriema, New York.

CROWE BULLETIN

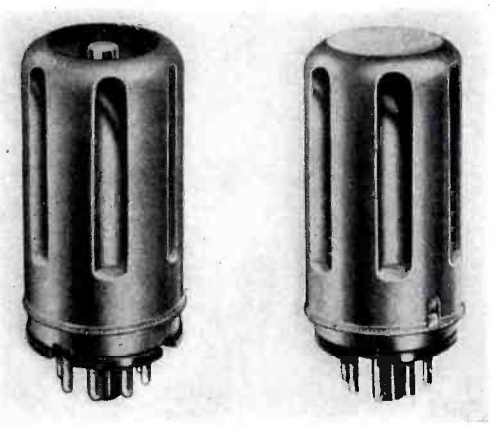
The Crowe Name Plate Mfg. Co., 3701 Ravenswood Ave., Chicago, have issued a bulletin No. 242 covering items for jobbers and manufacturers in radio components, including precision tuning devices, plates of all sorts for transmitters, radio receivers, phonographs, etc., in different metals and finishes. Knobs in bakelite and tenite for instruments, transmitter panels and other special uses in various styles and colors are also included.

HOWARD SALES

Joseph M. Muniz, general sales manager of the Howard Radio Company, announces that Howard C. Briggs, one of the firm's vice-presidents, will take over the sale of communication receivers, replacement chassis, household receivers and recording discs in the central states: namely, Illinois, Indiana, Kentucky, Michigan, Ohio, Wisconsin and the City of St. Louis, Mo. Mr. Briggs will be assisted in the sale of recording discs and replacement chassis by Russ Diethert, one of the well known sales representatives, in Indiana, Michigan, part of Wisconsin and the City of Chicago.

THIOKOL PLANT

To take care of an increasing need for oil-proof Thiokol synthetic rubber, Thiokol Corp. and The Dow Chemical Co. have opened for production a new plant in Midland. Michigan. The new plant is understood to have a capacity of more than 150,000 pounds per month, which together with other Thiokol plants now operating and planned will turn out 6,000,000 pounds of synthetic rubber annually.



TUBE SHIELDS

Goat Metal Stampings, Inc., announce their new 1330 series tube shields for GT/G, GT and loktal tubes. Made of one piece, the new Goat form-fit tube shield is solid drawn with ribbed design. The shields are quickly and easily attached and are automatically grounded to the metal base of the tube. The four available types are described in a bulletin available from Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.

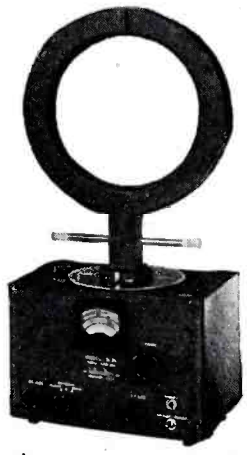
INDUSTRIAL PAGING SYSTEM

Allied Radio has recently placed on the market a new industrial paging system designed especially for use in factories, hotels, offices, warehouses, transportation

terminals, etc., for making announcements of general interest, paging individuals, calling parked cars and many similar services. Operation is from 110 volts, 60 cycles a-c, and the amplifier, which delivers 30 watts of usable power, will handle four or more 8" pm dynamic speakers with sufficient volume for simultaneous coverage of large areas or divergent locations. Allied Radio Corp., 833 West Jackson Blvd., Chicago.

RADIO COMPASS AND RECEIVER

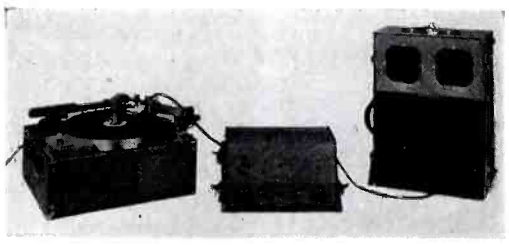
The Hallicrafters Model S-30 radio compass provides for the small boat not only means of taking bearings but also facilities for the reception of broadcast entertainment and marine information. For direction finding it utilizes any steady radio signal within its 3-band tuning range (220-540 kc, 535-1340 kc, 1200-3000 kc).



Null indications are provided visually by a tuning eye and aurally by headphones. Complete information may be secured from Hallicrafters, Inc., 2611 Indiana Ave., Chicago.

PORTABLE RECORDER

A portable disc recording equipment for cutting high-quality instantaneous recordings both in the radio studio and on remote locations, has been announced by the Engineering Products Section of the RCA Manufacturing Company, Camden, N. J. Although said to be a quality instrument in all respects, the device is compact enough to be enclosed in two handy carrying cases when ready for moving. It is designated as Type OR-1. This portable unit is a complete recording channel, with the exception of a microphone. It consists of a turntable, a record cutting attachment, and an amplifier and loudspeaker unit. The turntable and the amplifier-speaker unit may be used

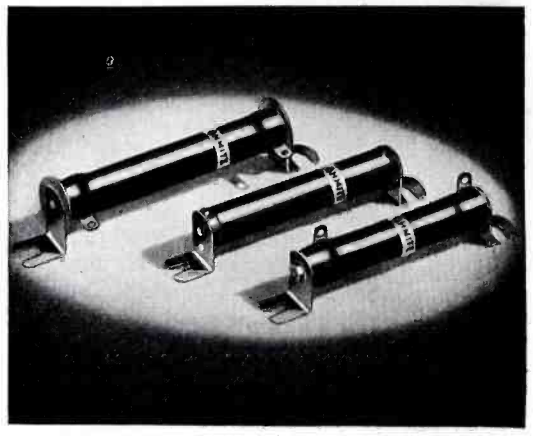


together as a high-quality record player.

The turntable unit cosists of a 16-inch aluminum turntable, rim-driven by a high quality synchronous motor. A unique feature is the use of two rubber-tired driver wheels (instead of the usual one) between the motor shaft and the turntable rim to prevent slippage. The off-on switch disconnects the power and, at the same time, releases both driver wheels to prevent "flats" from developing in the rubber. The turntable operates at 78 and 33⅓ r-p-m, the speed change being made by turning a single knob. The unit is equipped with an RCA high-fidelity combination pickup and tone arm with permanent diamond point stylus. The frequency response is uniform between 30 and 10,000 cycles.

RESISTORS

Ohmite wire-wound vitreous-enameled resistors are available in "live" bracket and "dead" bracket types for special applications. The "live" bracket type resistors have flexible leads connected to tin-plated brass brackets. They are designed for mounting and making electrical connection



by bolting the slotted brackets to panel terminals. Ohmite "dead" bracket type resistors are mounted by bolting to the brackets. Electrical connections are made separately to the lugs. The brackets for one, two or three resistors are mounted to the resistors by means of through-bolts.

Both types of resistors are used for signal circuits, storage battery charging, switchboards, and other applications. They are available in a wide range of core sizes with diameters from 9/16" to 2½". Ohmite Mfg. Co., Dept. 10, 4835 Flournoy St., Chicago.

REFLEX PROJECTOR

The new Atlas "Inter-mediate" 4½-foot "morning Glory" reflexed projector, Model DR-54, has a bell opening of 25 inches. Effective air column is said to be 54 inches; dynamic reflex design reduces the overall length of the double re-entrant trumpet to 23½ inches. This new projector is for general p-a applications and

sound truck use. Atlas Sound Corp., 1449 39th St., Brooklyn, N. Y.

WHEN YOU CHANGE YOUR ADDRESS

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RESISTOR DECADE BOX

Introduced several months ago, the Clarostat power resistor decade box provides a power resistor of anywhere from 1 ohm to 999,000 ohms, for actual use in a given circuit. It provides a resistor handling up to 225 watts per decade. Adjustment of the rotary decade switches provides any resistance value within the above range. Complete information may be secured from Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y.

PLUGS AND CORDS

In the accompanying illustrations are shown the new plugs and cords made available by Audio Development Co., 123 Bryant Ave. No., Minneapolis, Minn. The

plugs are made for patch cord use and are interchangeable with cords now in common use by broadcast stations. They are said to be designed for ease in cord replacement.

The conductors in the cords are composed of very fine gauge strands of tinned copper wire well insulated and shielded. Literature available on request.

MOBILE AMPLIFIER

Weighing only 20 lbs., a new Thordarson 12-watt amplifier, which operates from a 6-volt storage battery, is suitable for many p-a applications. It measures only 13½" by 7½" by 7¼". Several output

impedances are available by adjusting a rotary selector switch. Complete technical information on this unit may be secured by writing to Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago.

You and your associates can obtain a year's subscription to COMMUNICATIONS (12 issues) for only $1.00 each by using the Group Subscription Plan.

A regular yearly subscription to COMMUNICATIONS costs $2.00 — but when four or more men sign up at one time, each one is entitled to the half-price rate. (Foreign subscribers on the "G-S-P" only pay $2.00 each).

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City-State .....
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IMPEDANCE MATCHING BRIDGE

The Radex Corp., 1733 Milwaukee Ave., Chicago, have placed on the market a testing unit known as an impedence matching bridge. It is intended for use by coil and receiver manufacturers. It can also be used for testing condensers and resistors. The bridge setup as supplied consists of an oscillator, an amplifier, a cathode-ray indicator and the bridge proper. Further information may be secured from the manufacturer.

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ANTENNAS

(Continued from page 13)

a phase rotation opposite to that of the vision antenna. Since, however, the two radiator systems must operate at different carrier frequencies and since each radiator system will provide exact phase quadrature only at the respective frequencies for which their phasing circuits have been dimensioned, it is evident that uncoupling having a high degree of perfection becomes unattainable by the use of this method.

The variations in signal strength in different horizontal directions which obtain at any frequency at which the phasing circuits do not operate in exact phase quadrature are very small even for bands much wider than required for 441-line pictures and of no consequences except in respect to uncoupling. The tolerable amount of coupling between the vision and the sound transmitters seems, however, somewhat elusive to estimate. Experience has shown that the sensitivity to coupling varies with conditions. The only reliable insurance against trouble is therefore to provide uncoupling of highest possible order.

The combination of a sound antenna of the loop type and a vision antenna of the radial type, provides a natural uncoupling balance which is independent of frequency. The current paths in one type are circular while radial in the other type. Since the loop and the radial systems are both horizontally located in respect to a common, central, vertical axis, the induction set up in the loop from any direction of the diametric field produced by the vision antenna will be symmetric and balance peripherally. Since circulating energy in the loop produces no diametric field component, the theorectical uncoupling is perfect.

The approximate equivalent of a continuous loop can be simply provided by locating a number of dipoles on a circle. In order to simulate the loop condition, diametrically opposite dipoles will then have to be so connected to a common feed line that they carry equal currents in opposite directions, Fig. 32. The induction from the vision antenna will produce currents of the same direction

in opposite dipoles. The equivalent to the peripheral cancellation in a continuous loop is then obtained intrinsically in connecting the loop components to a common feeder.

The sound antenna was made up of four folded dipoles bent into circular segments, Fig. 29 and Fig. 32. The smaller type folded dipole, previously discussed, was used. This type has a spread only of approximately a quarter wave between the folding points. A loop made up of such dipoles needs therefore to be only half the diameter of a loop made up of ordinary dipoles. The smaller diameter further reduces the possibility of undesirable mutual effects between the sound and the vision antennas and also reduces the mechanical problems. Due to the particular voltage distribution, the capacity between the parallel, adjacent branches in this radiator provides a path for circulating currents which tend to make the radiator have a low power factor. This is generally not a desirable characteristic. The resulting increase in frequency selectivity does, however, in this particular case became a virtue, since it still further decreases the possibility of energy transfer from the vision antenna into the sound transmitter. Since the percentage band width required for a sound antenna at 50 mc is insignificant, no band width problem will exist except in case it should be necessary to move the sound carrier. In such a case only antennas of the widest possible band width would be of any practical importance. A loop combination of composite radiators would, however, become very costly.

The input impedance of a single small type folded dipole would normally be very high. However, when comcombining a number of such dipoles into a loop, mutual effects between adjecent folding points of adjacent dipoles tend to lower the individual input impedance of the dipoles. By connecting four of these dipoles in parallel across a common feed line, as shown in Fig. 32, it was possible to obtain a combined impedance of 55 ohms. It was therefore possible, without any impedance transformation, to use a main feeder of the same size and proportions as the main feeders for the vision antenna. This, of course, had practical and economical advantages. The four dipoles were connected by balanced opened feeder pairs of 220 ohms characteristic impedance, through a balance converter to the 55-ohm line, as shown in Fig. 32.

Less than one part in a million of the energy in one antenna was transferred to the other. The vertical directivity of the sound loop is very nearly equal to that of a vertical dipole. This is fortunate since the sound ring can not be located so as to derive much of any benefit from the conductive roof surface. The sound loop and the vision turnstile thus both provide about equal vertical directivity. Their radiation characteristics in the horizonal plane are practically uniform in all directions.

(c) Full Scale Antenna

Except for variations in unimportant details, the relative proportions established during the development work with 100-150 mc models of vision and sound antennas, were then reproduced for the 40-50 mc region, Fig. 33.

The radiator components of the vision antenna models, having curved surfaces, were made of wood covered with thin copper strips which were soldered together to form the equivalent of a continuous metallic envelope. The central supporting column in the model shown in Fig. 29 consisted of a copper pipe.

No wood was used in the full-scale antenna. The vision antenna radiator envelopes consist of sheet copper formed into the desired shapes by process of spinning. They are internally braced by suitable metallic structures, Fig. 34 and Fig. 35.

The sound antenna is made of steel tubing, Fig. 36. The central supporting arm of each dipole has a diameter of 5 inches and can be slid into the supporting head at the top of the supporting tower. The diameters of the main and the feed members of each dipole are 4 and 3 respectively. The short cylindrical sections at the folding points have a diameter of 5 inches and have removable end covers. All pipe sections are welded together.

The common, central supporting column for the vision and the sound antenna consists of a square lattice tower, Fig. 37, covered by cylindrical segments of copper sheeting. This facilitates inspection of the phase quadrature branches for the vision antenna, Fig. 38, the line balance converter for the sound antenna, Fig. 34, auxiliary wiring, etc., which are all located within the supporting tower.

The exposed surfaces of all antenna members are chromium plated. For some of the parts the chromium plating was not a complete success. In such cases the surfaces are protected by aluminum paint. The surfacing seems to have no effect upon the electrical characteristics. This is, of course, natural since the radiation resistance is overwhelmingly the greater part of the total antenna resistance.

All radiator members of both vision and sound antennas are internally equipped with Calrod heaters for the purpose of ice removal, Fig. 34, Fig. 35 and Fig. 36. The connection for the ice removal heaters in the ellipsoids pass through the supporting bracket, Fig. 39, which is made of thick walled Shelby steel tubing. The average power required for the removal of ice from each ellipsoid, collar and sound antenna dipole is 1.5 kw. The Calrod groups of each radiator component are connected, by individual wiring, to a distributing panel in the dome under the antenna.

The sound antenna, the ellipsoids and the collars thus form three groups, each requiring a normal heating power of 6 kw. They are therefore connected in three phase and supplied with power from the control unit shown in Fig. 40. The transformers of this power control unit are equipped with voltage taps so that the power may be regulated to suit conditions. Ice conditions encountered are shown in Fig. 41. Thermostats have been installed on top of the dome so that the ice removal power may be applied automatically when the air temperature approaches sleeting temperature.

All antenna members are effectively grounded against lightning, Fig. 33 and Fig. 39. The picture of the lightning conditions at the Empire State Building shown in Fig. 42 illustrates the necessity of this design feature. The fact that the system forms a metallic unit is also a valuable mechanical feature. Only the feeders of the system require insulation.

With few exceptions, clear, fused quartz is used as insulation throughout the transmission line system. The transmission line lead-ins, of the sound antenna, at the top of the supporting tower, Fig. 33, consist of high grade porcelain. The same type of lead-in insulators are used to seal off the long 55-ohm main feeders at their end terminations. These 55-ohm lines are made to withstand a power transfer, under matched line conditions, of 300-kw at atmospheric pressure. Provisions are made so that the pressure in these lines can be raised. In this way greater insulation may be obtained if found necessary.

The lead-ins in the throats of the vision antenna consist of ⅜-inch thick double windows of clear, fused quartz. These windows are protected against water by staggered mica guard rings located further out in the throat and on the center conductor.

Great care was exercised in proportioning all parts to conform with the best shapes determined in the experimental work with the models. Great care was also exercised in making all similar parts as identical as possible. Symmetry was strictly adhered to.

The results of these efforts were most gratifying. It was found that the vision antenna in reality had very considerably better band characteristics than re-

vealed by the models. The frequency response characteristic taken with this antenna, Fig. 43, indicates a band width of 60 perecent. The useful band is therefore fully an octave wide. At a mean frequency of 45 mc this antenna can accommodate six channels for 441-line picture transmission.

A protecting rail, Fig. 33, is absolutely vital at the location of this antenna. This rail is the cause of the slight bump in the frequency response curve shown in Fig. 43. This rise in reflection, while tolerable in itself, is of no consequence at all under the particular operating conditions at the Empire State Building since it falls considerably outside the channel assigned to this station.

The power transfer from one antenna to the other remained less than one part in a million as already determined during the model tests.

The vertical conductor at the top of the supporting tower, Fig. 33, is a pick-up rod for the recording of lightning strokes in connection with research on the characteristics of lightning carried out in this locality by the General Electric Company. Wind recording instruments are also mounted at the top of the tower.

CONCLUDING REMARKS

One of the most serious obstacles to the progress of high-definition television has therefore been amply removed. It is, however, only just to acknowledge that no one but a large corporation with the finest traditions of scientific adventure, would or could contribute to progress and knowledge by backing such long and costly developments as those outlined in these articles.

• • •

F-M

(Continued from page 8)

tenna elements is obtained by a suitable phasing section of transmission line located on the mast below the radiating bays. An impedance-matching section is used to provide the correct termination for the 150-ohm balanced transmission line from the transmitter.

It has been customary in antennas of this type to space the turnstile bays 180 degrees, vertically, but we have found that by using a vertical spacing of 270 degrees, three bays can be made to give a field in the horizontal plane slightly greater than would be obtained from four bays vertically spaced 180 degrees. The theoretical gain of our antenna is approximately 0.4 db greater than that of a four-bay, 180-degree turnstile. The theoretical field gain for FCC calculations is about 1.6 or 4.2 db power gain. It is believed that this antenna provides the highest field gain obtainable consistent with simplicity and good mechanical design. Our ultimate antenna height will be the maximum allowed by the Civil Aeronautics Authority at our particular location.

R-F Transmission Line

The line from the transmitter to the antenna may be either open wire or concentric. Most users prefer concentric lines because of neater appearance and better protection from adverse weather conditions.

Transmission line power losses are due to the conductors and the dielectrics. It is usually necessary to install larger concentric lines than a calculation of the losses indicate as necessary. This is due to mechanical factors as well as poor radiation of heat from the inner conductors. Due to confined air space around the inner conductor and the presence of insulators, there is little conduction of heat; consequently, the temperature rises quite high with a small amount of inner-conductor loss. The following transmission line sizes are suggested. These sizes are based on tests made at the General Electric proving ground:

Transmitter Output	Minimum Size of Concentric R. F. Line	
250 watts to 1 kw	1—⅞" single-conductor.	75 ohms.
	2—⅞" single-conductor.	150 ohms.
	1—⅞" twin-conductor.	150 ohms.
1 kw to 3 kw	2—⅞" single-conductor.	150 ohms.
	1—⅞" twin-conductor.	150 ohms.
3 kw to 10 kw	2—⅞" single-conductor.	150 ohms.
10 kw to 50 kw	2—2⅝" single-conductor.	150 ohms.

When installing lengths of these lines greater than 100 feet, thermal expansion joints should be provided to take care of movement of the line due to expansion and contraction.

In calculating the power delivered to the antenna, consideration must be given to the transmission line losses. For example, we have found that a ⅞" single-conductor concentric line has approximately 2.8-db loss per 1000 feet while a ⅞" dual conductor concentric line has approximately 3.0-db loss per 1000 feet at 45 mc, when correctly terminated. If the line is incorrectly terminated, local "hot spots" occur due to standing waves, and the loss will be greater.

Once the antenna height and gain were determined for our f-m broadcast station, we next determined the antenna input power required to cover the New York State Capital District trade area. This was done by calculating the field strength in accordance with the methods prescribed by the FCC.

F-M Transmitter Circuit Design Problems

The major circuit design problems for an f-m transmitter relate to modulation, carrier-frequency stability, and reliability. All of these problems with the exception of frequency stability can be solved much more easily for f-m than for amplitude-modulated transmit-

ters. Now let us consider these design problems and how we have solved them in our line of f-m transmitters, such as the one at our "proving ground."

Modulation

The transmitter is directly frequency modulated by means of two tubes (Fig. 4). One tube operates in a conventional oscillator circuit, across which are connected the plate and cathode of a reactance-tube frequency modulator. The modulator functions as a capacitance connected across the frequency-determining circuits of the oscillator and this capacitance varies in accordance with the voltage impressed on the grid of the modulator.

The frequency modulator is operated by a single audio stage through a pre-emphasis filter. The resulting over-all audio response (Fig. 5) departs less than ± 1 db from the standard 100-microsecond pre-emphasized response from 30 to 16,000 cycles. It should be noted that the response decreases quite rapidly below 20 cycles and above 25,000 cycles, conditions which we consider very desirable. At low audio frequencies, the decrease in response is necessary to permit very rapid correction of the mean carrier frequency. At very high audio frequencies, or at super-audible frequencies such as occur during high-amplitude transients, adjacent-channel interference might result if the response characteristic were permitted to increase indefinitely with frequency.

The carrier swing is linear with modulation within 0.25 db up to ± 150-kc swing, or twice the normal maximum swing.

Audio-frequency distortion measurements taken at various kilocycle swings are shown in Fig. 6.

Cross modulation products were measured and found to be very small. With combinations of 400 and 700 cycles or 4000 and 7000 cycles, the r-m-s distortion due to cross modulation is less than 1% at 100% modulation.

Correct audio-frequency response, modulation linearity and low distortion are obtained by careful design of all circuits contributing to these characteristics.

The f-m noise level of the G-E transmitter is low enough to permit full dynamic program range. Low f-m noise is obtained by separating the a-c or d-c wiring in the transmitter cabinet, employing a regulated plate supply for the modulator, oscillator and audio stages, and by careful attention to proper r-f shielding and bonding. With these precautions, an f-m noise level in the order of 62 db below ± 75-kc swing is consistently possible. In our transmitter this value is made better than minus 70 db by using a small amount of stabilized feedback.

Low amplitude-modulation noise is obtained by using the same precautions employed in a-m transmitters. An a-m noise level of 60 db below 100 per cent amplitude modulation is consistently possible.

Carrier Frequency Stability

The frequency-stabilizing circuit is extremely simple; only four tubes are used. Aside from the crystal oscillator and its tripler stage, only two tubes are used for the entire frequency stabilizing circuit (Fig. 4). The output frequency of the transmitter (F_1) minus the directly crystal-controlled frequency (F_2) gives the 3-mc intermediate frequency (F_3). The frequency-stabilizing circuit develops a corrective voltage for the frequency-modulator tube when there is any change in the mean carrier frequency. If an exact 3-mc "beat" is fed into the discriminator, no corrective voltage is furnished to the modulator. Furthermore, since control is all electronic, the correction is quick acting, there is no overshooting of frequency, and there are no moving parts.

No temperature-controlled compartments are used except that provided within the crystal thermocell itself. Only one crystal is used for stabilization, but provision is made for switching to a spare crystal during operation. The thermocell will reach a stable temperature in approximately 15 minutes.

The voltage-regulated plate supply to the transmitter maintains a constant voltage which affords high fidelity and frequency stability despite line voltage fluctuation. Fig. 7 indicates the carrier frequency shift versus line voltage variations of 85% to 115% of normal for a typical G-E f-m transmitter. Only about 600 cycles total change occurred due to this line voltage variation. However, if the filament voltage is kept constant, a much smaller change is made in the carrier center frequency.

Fig. 8 shows the carrier-frequency stability of a typical transmitter operated over a temperature cycle of freezing (32° F.) to tropical heat (122° F.). The total frequency change was found to be about 300 cycles. The trans-

mitters provide an over-all stability of better than ± 1000 cycles over a normal room temperature range and normal line-voltage variations. The FCC requires ± 2000-cycle stability.

Reliability

Simplified circuit design in the G-E 250-watt basic transmitter means continuity of service because there are:

(1) Only 25 tubes in the entire transmitter (9 r-f tubes; 2 for the modulation indicator; one audio stage; 9 power supply tubes; and 4 tubes in the frequency stabilizing circuit).

(2) No moving parts.

(3) No trick, hard-to-adjust circuits.

(4) No complicated multi-tube networks.

(5) No temperature-controlled compartments other than crystal thermocell.

(6) Only one crystal, with provision for switching to a spare during operation.

(7) Every tube in the transmitter can be reached by opening the front and rear main doors. Thus tube failures can be located very quickly. All circuit elements can be reached without disassembly of transmitter parts or removal of wiring.

(8) All parts are conservatively designed and applied. Every part and tube is operated well within its rating for long life and dependability.

All units of higher-power transmitters are provided with automatic-reclosing overload protection. Momentary overloads mean an almost imperceptible interruption of service to the listener, because of the automatic recloser circuit which restores power to the transmitter almost instantly. "Cutback" switches are provided so that the operator may instantly transfer the antenna-feed circuit from the output of the 50-kw or the 10-kw amplifiers to their driver stages in case servicing in the high-power units is necessary during station operation. This feature permits maximum continuity of operation.

General-Electric FM Transmitters

Fig. 9 shows the 250-watt transmitter which provides all of the desirable characteristics just mentioned. This unit may be used as an exciter to drive a 1-kw amplifier or a 3-kw amplifier as shown in Fig. 10. If higher power is desired, General Electric has a 10-kw transmitter and a 50-kw transmitter (see Fig. 11).

The vacuum tubes (Fig. 12) used in these new high-power units were specially designed for f-m and television service. The 3-kw amplifier uses the GL-8002-R, the 10-kw amplifier uses the GL-889-R, the 50-kw amplifier employs the GL-880 tubes. All tubes used in the G-E transmitters are air cooled except type GL-880.

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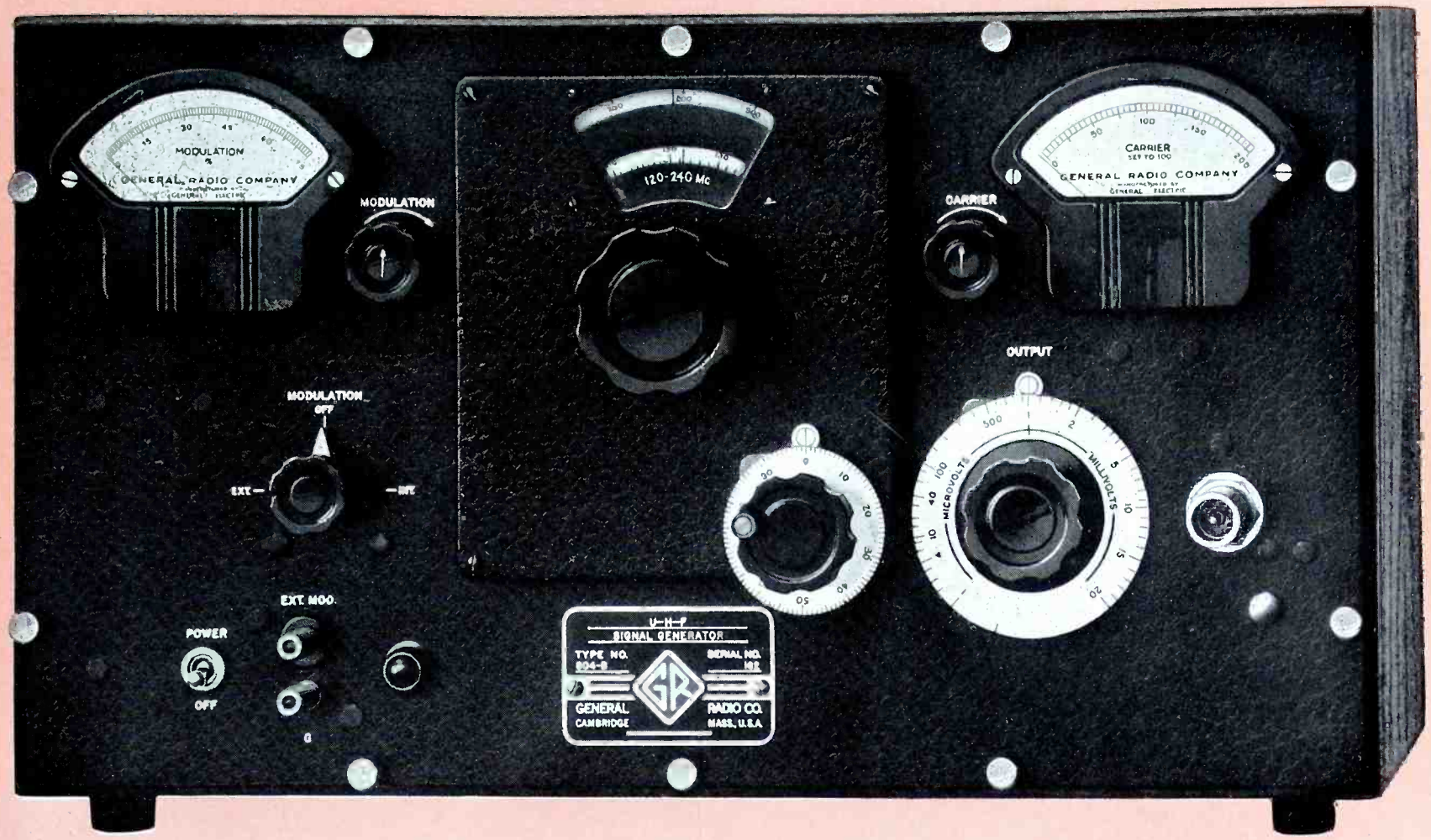

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