# Communication and Broadcast Engineering

VOL. 3 NO. 4



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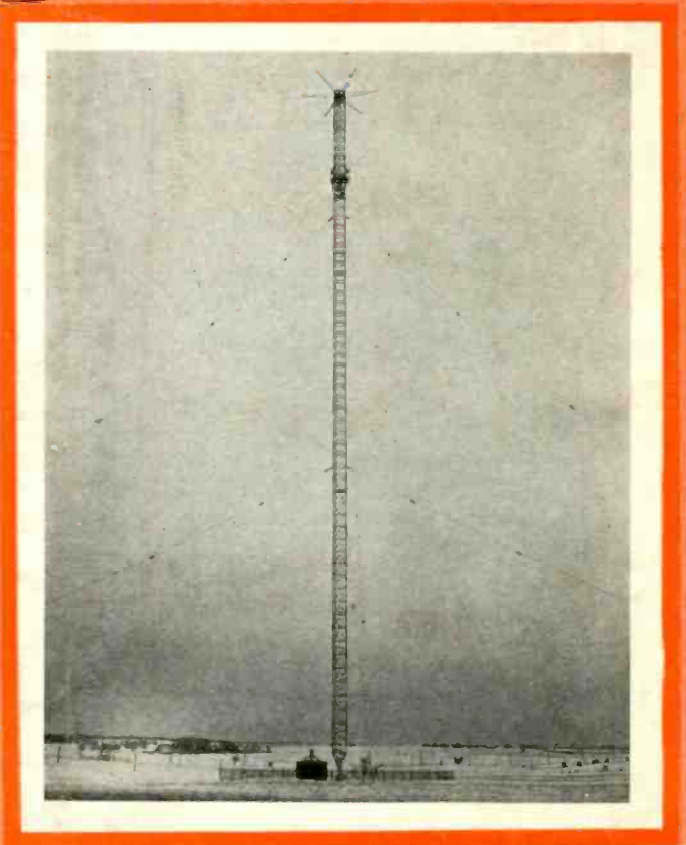

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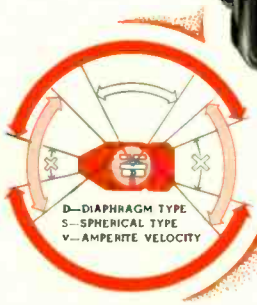


* Diagram shows angle of pickup without frequency discrimination of various types microphones.

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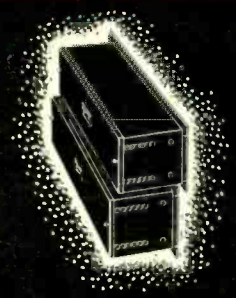

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RAY D. RETTENMEYER
Editor

F. WALEN
Associate Editor

VOLUME 3 APRIL, 1936 NUMBER 4

## COVER ILLUSTRATION

TUNED FLAT-TOP ANTENNA AT NBC STATION WMAQ, CHICAGO, ILLINOIS. EIGHTY FEET BELOW THE TOP IS A TUNING COIL. THE SIXTY-FOOT FLAT TOP IS 490 FEET ABOVE THE EARTH

# CONTENTS

## FEATURES



## DEPARTMENTS



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# EDITORIAL

## FCC ALLOCATION HEARING

AT A RECENT MEETING, the Federal Communications Commission approved a recommendation of their Chief Engineer for an informal hearing before the Commission on June 15. The purpose of this hearing is to obtain information relative to the problems involved in the allocation of frequencies to the various classes of service.

In a memorandum, the FCC's Engineering Department reported that the foremost problems requiring the attention of the Commission are:

"1. Providing new radio-frequency channels for public services in classes of communication other than broadcasting, as well as providing for all classes of radio service in the interest of safety of life and property.

"2. Frequency allocation improvements to existing broadcast structure (550-1,600 kc).

"3. Visual broadcasting (television and facsimile).

"4. Aural broadcasting on frequencies above 1,600 kc."

At this meeting, the Chief Engineer of the FCC stated that of all the problems confronting the Commission visual broadcasting most complicated the situation because of:

"1. The technical requirements for an extremely large portion of the limited ether spectrum, thus restricting the amount which would be available for services other than broadcasting.

"2. The economics of visual broadcasting, including the possible economic effect it may have upon existing aural broadcasting and the existing receiver manufacturing industries, as well as the newspaper and motion-picture industries."

The more important specific recommendations of the Engineering Department were, in part, as follows:

"1. In new allocations or in reallocations of radio frequencies to services or to stations within services, proceed on the basis of 'evolution, experimentation and voluntary action.' . . .

"2. Encourage communication development along specific lines as may be indicated . . . from accumulated data. . . .

"3. . . . to hold an informal engineering hearing before the Commission for the purpose of:

"(a) Determining in a preliminary manner the most probable future needs of the various services . . . above 30,000 kc.

"(b) Securing keener insight of conflicting problems which confront the industry and the regulatory body in the application of the new frequencies. . . .

"(c) Guiding experimentation along more definite lines. . . .

"(d) Reviewing frequency allocations to services in radio spectrum below 30,000 kc.

"(e) Assisting the Government in its preparation for the International Telecommunication Conference at Cairo in 1938.

"4. Delay permanent allocation of frequencies above 30,000 kc . . . until after the hearing . . . and until after an executive order on the allocation of these frequencies to Government services. . . .

"5. . . . prepare minor modifications of existing regulations for experimental operation above 30,000 kc. . . .

"6. Encourage standardization of visual broadcast transmission performance by authorizing the Engineering Department to cooperate with the RMA and licensees of experimental television stations in forming a committee of the industry to endeavor to arrive at a recommendation with respect to ultimate standardization.

"7. Encourage the development of coaxial cables for the purpose of transmitting visual broadcast programs between television broadcast stations. . . .

"8. Continue the policy of granting visual broadcast station licenses on an experimental basis only and making more stringent requirements. . . .

"9. At the proper time in the future, if there is sufficient accumulated data with respect to visual broadcasting, and after it has been decided what the allocation of frequencies above 30,000 kc should be, promulgate visual broadcast transmission performance standards. . . .

"10. After standards have been adopted, continue the policy of keeping visual broadcasting on an experimental basis until sufficient data has been accumulated with respect to the economic factors of visual broadcasting, as well as the possible economic effect on other broadcast services and upon other industries. . . .

"11. Continue to encourage aural broadcasting on an experimental basis on frequencies above 30,000 kc until such time when sufficient data is accumulated with respect to this particular service, as well as television and other services. When data as to the technique of this type of broadcasting is understood, and when the needs of other services . . . are known to a sufficient extent, *the Commission should consider the desirability of commercial aural broadcasting on frequencies above* 30,000 *kc.*" (Italics ours—Ed.)

This general hearing of June 15 is certainly needed. It should serve to guide the Commission and the industry in the development of communications.



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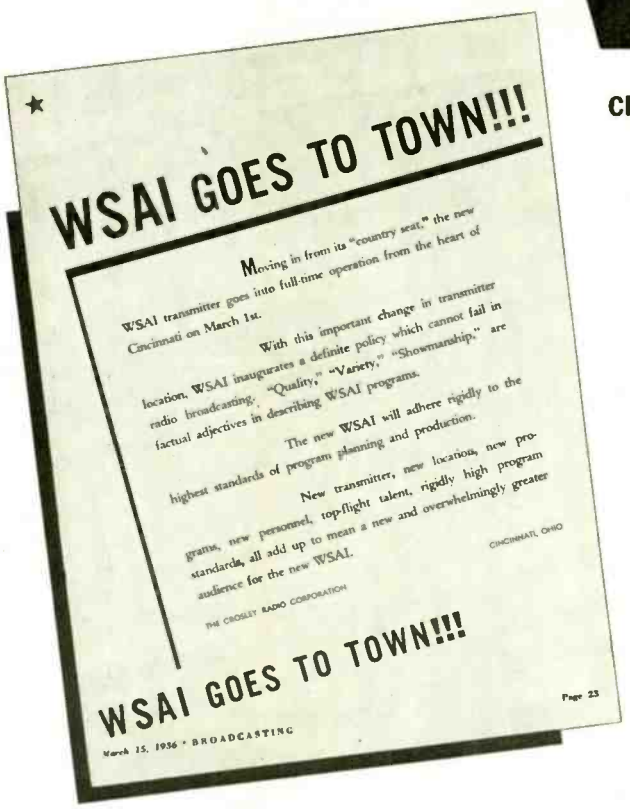
# WSAI

**CROSLEY RADIO CORPORATION, CINCINNATI**



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WSAI GOES TO TOWN!!!

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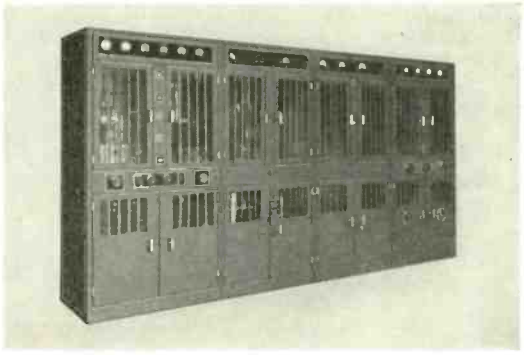
Page 23

## does it with this new Western Electric 5KW High Fidelity Transmitter



## These 8 features are some of the reasons!

1. COMPLETE AC OPERATION.

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RADIO TELEPHONE BROADCASTING EQUIPMENT



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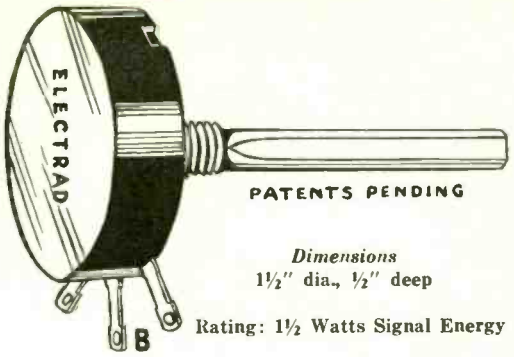
# A New Development in ATTENUATORS

## *Electrad Type BN*




*Dimensions*
1½" dia., ½" deep

Rating: 1½ Watts Signal Energy

The Electrad BN Attenuators replace the Electrad Attenuator types TN, LN and U. These new BN Attenuators have advantages of greater attenuation, true logarithmic attenuation and lower noise level.

This Attenuator involves a new principle in design which makes it possible to obtain a substantially constant impedance unit whose attenuation is linear in Db and continuously variable over the entire range.

The attenuation is accomplished by means of an infinitely variable ladder network consisting of a series element on which the contact rides, and which has a shunt element connected to it along its entire length.

This Attenuator may be used to control the output (source) of microphone, phonograph pickup, radio line, antenna matching impedance line, amplifier tube plate thru a choke-condenser coupler, secondary of line transformer, audio or radio frequency oscillator. Can be used in the usual series-parallel arrangement for input mixing. They are obviously suitable for many other applications. The correct impedance value should be chosen to match the line or circuit in which attenuator is used.

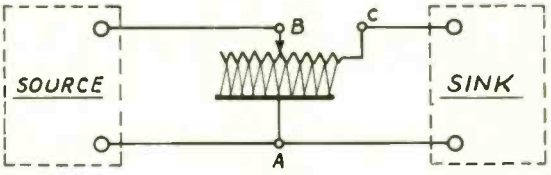



Fig. 1

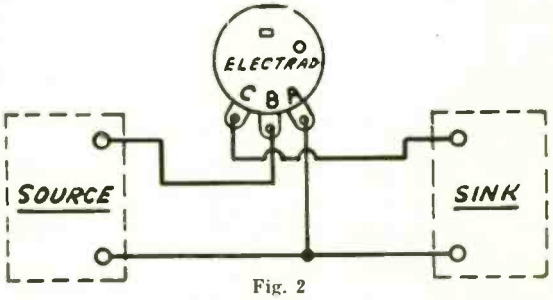



Fig. 2

Fig. 1 shows the basic circuit.

Fig. 2 shows the proper connections for values of impedance above 50 ohms.

Fig. 3 shows the proper connections for values of impedance of 50 ohms and lower.

Fig. 4 shows attenuation characteristic.

In figures 2 and 3 the control is viewed looking at metal cover.

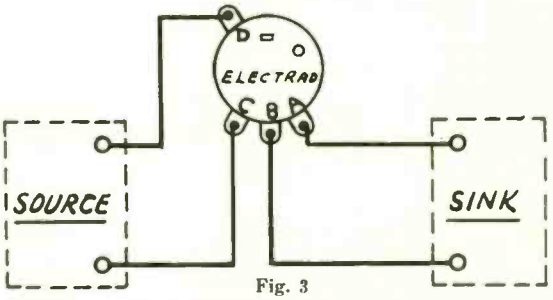



Fig. 3

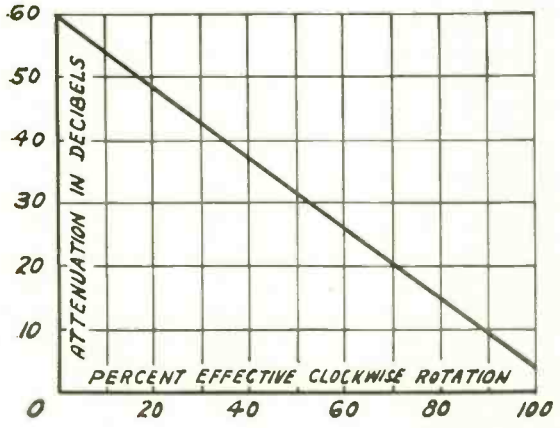



Fig. 4

| | *Line Impedance in Ohms* |
|---|---|
| *Type BN 15 | 15 |
| *Type BN 50 | 50 |
| Type BN 100 | 100 |
| Type BN 200 | 200 |
| Type BN 250 | 250 |
| Type BN 500 | 500 |
| Type BN 3000 | 3000 |
| Type BN 4000 | 4000 |
| Type BN 5000 | 5000 |
| Type BN 7000 | 7000 |
| Type BN 10000 | 10000 |

**LIST PRICE**
**All Sizes $3.00**

*Use circuit in fig. 3 for Attenuators of 50 ohms and lower values of impedance.

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FOR APRIL, 1936

# CALIBRATING MICROPHONES

## BY MEANS OF A RAYLEIGH DISK

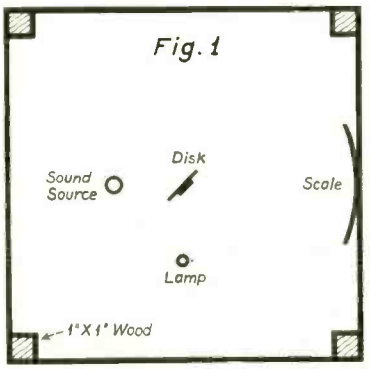
By MICHAEL RETTINGER

THE PURPOSE of this article is to outline the theory and practice associated with the determination of the frequency response of microphones by means of a Rayleigh disk, without attempting to indicate all possible methods for such a calibration employing the disk, and without taking into account the, as yet undetermined, effects of viscosity and turbulence that possibly may affect the disk motion.

It is customary to rate the sensitivity of a microphone in terms of the open-circuit voltages that the microphone alone, for different frequencies and without any associated amplifiers, is able to generate when actuated by a known sound pressure; and also to state the electrical impedance of the microphone as a function of frequency. It should be noted here that if a microphone is introduced into a uniform sound field, the calibration of the unit will include any diffraction effects caused by the size and shape of the instrument.

It is necessary, therefore, for the securement of a quantitative measure of the amount of distortion caused by the microphone to make a free-wave calibration; that is, to establish a plane progressive sound wave of known intensity and then introduce the microphone. This precaution should be taken for all frequencies above 500 cycles per second, as the sound is diffracted around the microphone with but little reflection when the wavelength is large compared with the diameter of the microphone; while if the wavelength is small the sound pressure at the face of the microphone tends to become double what it is in free space . . . and even more than twice when the diaphragm is recessed so far from the front of the instrument that an acoustical resonator is formed.

One way to secure a calibration of the microphone for the higher frequencies is to place the transducer and the Rayleigh disk (which is within a protecting silk enclosure) an equal distance, and not less than one foot, from a pivotable source of sound, which might be an "artificial voice," so as to render the acoustic characteristics of this source the same as those of the human head. The deflection of the disk noted, the "voice" is turned around and impressed on the microphone to be tested. Later, when a small voltage from the oscillator is substituted in series with the microphone and adjusted so as to give the same output reading that was secured when the sound was actuating the transducer, it becomes only necessary to divide the sound pressure, as measured by the Rayleigh disk, into the series voltage in order to obtain the absolute free-wave sensitivity of the microphone for the particular frequency, without having to know anything about the amplification characteristic of the amplifier connected to the transducer.




SETUP FOR CALIBRATING A MICROPHONE WITH A RAYLEIGH DISK.

To preclude the error from the floor reflections that prevail at the lower frequencies when performing the calibration inside, it becomes advisable to calibrate the microphone below 500 cycles per second within an open tube in which the sound, past the disk, is absorbed without reflection from the open end opposite the one where the source of sound is located. This is accomplished by introducing absorbent material such as hair-felt or rock-wool in a progressively increasing amount as the distance from the unit increases, thus simulating an infinite non-dissipative line in which abrupt changes in the impedance are reduced to a minimum. It must be noted at this point that in the calibration of pressure-actuated microphones attention must be paid to the disproportionality that exists at the lower frequencies between the sound pressure and the particle velocity recorded by the Rayleigh disk. While correction factors are available for this source of error, it becomes desirable to employ a comparison method or an "actual pressure" calibration, since at these low frequencies the "free-air" and "actual



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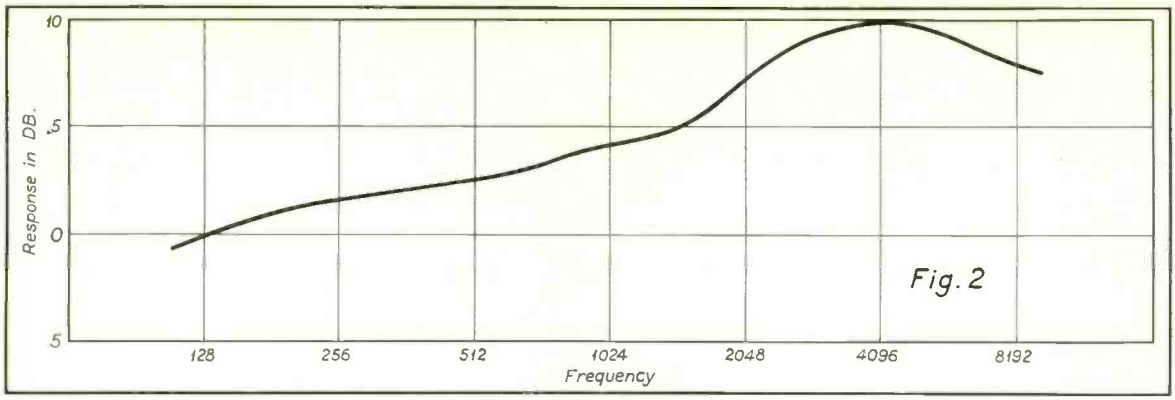


THE FREQUENCY-RESPONSE CURVE OF A CONDENSER MICROPHONE AND AMPLIFIER AS OBTAINED WITH A RAYLEIGH DISK.

pressure" calibration are identical for microphones of ordinary dimensions. For velocity ribbon microphones, of course, such a precaution becomes obviated.

## EQUATION OF MOTION OF RAYLEIGH DISK

For the derivation of the equation of the motion of the Rayleigh disk, consider the following constants:

r = Density of air = 0.001205 g/m³.
a = Radius of the disk.
d = Angle made by the normal to the disk and the direction of the air stream. (For maximum turning moment, d is 45 degrees.)
u = Root-mean-square velocity of the air particle.
M = The turning moment acting on the disk.
s = Angular deflection of disk in radians.
S = Moment of torsion.
T = Period of the suspended disk.
I = Moment of inertia of the disk (the disk being assumed circular).
m = Mass of the disk.
D = Damping factor of the disc, equal to the ratio of two successive swings.
c = Velocity of sound = 34,400 cm/sec.
p = Root-mean-square value of the excess pressure.

From Koening's equation[1]

$$M = \frac{4 r a^3 u^2 \sin 2d}{3}, \text{ or } d = 45 \text{ degrees.}$$

$$u^2 = \frac{3M}{4 r a^3} \quad \ldots\ldots (1)$$

But

$$M = sS \quad \ldots\ldots (2)$$

Substituting (2) in (1)

$$u^2 = \frac{3sS}{4 r a^3} \quad \ldots\ldots (3)$$

But

$$S = \frac{I[4\pi^2 + (\log_e D)^2]}{T^2} \quad \ldots\ldots (4)$$

Substituting (4) in (3)

$$u^2 = \frac{3sI[4\pi^2 + (\log_e D)^2]}{4 r a^3 T^2} \quad \ldots\ldots (5)$$

[1]Koening, Ann. d. Physik, Vol. 43, p. 43, 1891.

And

$$I = \frac{ma^2}{4} \quad \ldots\ldots (6)$$

Substituting (6) in (5)

$$u^2 = \frac{3 sma^2 [4\pi^2 + (\log_e D)^2]}{16 r a^3 T^2}$$

$$= \frac{3 sm [4\pi^2 + (\log_e D)^2]}{16 r a T^2} \quad \ldots\ldots (7)$$

But

$$u^2 = \frac{p^2}{r^2 c^2} \quad \ldots\ldots (8)$$

Equating (7) to (8)

$$p^2 = \frac{3 r c^2 sm [4\pi^2 + (\log_e D)^2]}{16 a T^2}$$

$$= \frac{267365.4\, sm [4\pi^2 + (\log_e D)^2]}{a T^2}$$

$$p = \frac{517 (sm [4\pi^2 + (\log_e D)^2])^{1/2}}{a^{1/2} T}$$

Hence, all that need be known about the Rayleigh disk is its mass, its radius, its period of vibration, and its damping factor. Once these constants have been determined, it remains only to note the angular deflection of the disk when sound strikes it to learn the excess sound pressure on the disk. It is assumed that the thickness of the disk is very small (less than 0.002 inch), for the theoretical formula applies only to disks of infinitesimal thickness. However, correction for the thickness can be made.[2]

## CONSTRUCTION OF DISK AND METHOD OF CALIBRATION

Rayleigh disks should be cut or punched out of a fine sheet of non-hygroscopic material such as mica or glass. The radius of the disk should be kept small, since errors are likely to occur when it is less than ten times the wavelength of the sound with which the experiment is carried on. Some investigators use a larger disk for the low frequencies, a smaller one for the intermediate ones, and one about 0.75 cm in diameter when working with frequencies as high as 10,000 cycles per second.

A disk that the author made consists of a thin layer of mica which was cut into a circle of 1 cm diameter with a fine pair of scissors. It was possible to scale from an old mirror a piece of the mercury layer, about 0.2 by 0.5 cm, and shellac it to the center of the disk; to prevent troublesome reflections the entire disk was painted black with India ink. The mass of the disk came to 0.02 g. It was suspended on a fine quartz fibre two feet long, the fibre running truly through the center of the disk.

With the disk set at 45 degrees to the passage of sound, a light is focussed on the mirror and the spot of the reflected beam is directed to a (preferably) circular scale about 1 m from the disk. When observing the deflection of the spot of light, it must be remembered that the angle through which the disk actually turns is one-half the angle of deflection. The angle through which the disk turns is

$$s = \frac{g}{2d}$$

where g is the distance on the circular scale through which the spot of light has moved, and where d is the distance between the disk and the scale.

It is understood that, at present, we are concerned only with the method of free field calibration; that is, with the determination of the voltage per unit of the pressure existing in a plane progressive wave before the microphone is placed in the sound field. (The so-called "pressure method," which does not employ the Rayleigh disk, gives the voltage generated per unit of pressure

(*Continued on page* 10)

[2]W. Zernov, Ann. d. Physik, 26, 79, 1908.



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# A TWO-CHANNEL PROGRAM AMPLIFIER

By A. C. McCLELLAN

*Chief Operator*

KFH

A DECISION by the management of station KFH to move the studios to a more convenient location brought up the question of speech equipment. It was decided that the equipment would be built by the engineering department of the station. Specifications called for a two-channel system that could be handled by one operator, each channel being complete from mixer to output, but flexible enough for a quick change from one to the other, if the necessity should arise. Each channel was to be high fidelity, and as near failure-proof as possible, adding to the general appearance of the studios.

Since an audition channel is a necessity at a station on the air seventeen hours a day, the second channel serves this purpose. In the event of failure of the program channel it is a simple matter to switch the audition channel over to replace the regular program channel. Two other amplifiers were required, one to feed the studio and office loudspeakers and the other to feed the audition speakers.

### AMPLIFIERS

The amplifying equipment occupies three standard relay racks. In normal operation the program amplifier consists of units A, B and D on rack No. 1 (see Figs. 1 and 2). The audition channel consists of units A, B on rack No. 3 and unit D on rack No. 2. Units designated A (Fig. 3) are identical and consist of two 6C6 tubes operating in push-pull. Units designated B (Fig. 4) are identical and are two-stage, the first stage being a pair of 76 tubes in push-pull, followed by a pair of 89's in push-pull, operated as triodes. Unit C is a power amplifier (Fig. 5) used to drive the studio speakers; it consists of a pair of 56's and a pair of 2A3's, both in push-pull, operating with fixed bias, and giving an undistorted output of fifteen watts. There are three power-supply units designated D, D and E. Units designated D (Fig. 6) furnish plate voltage for each channel. Unit E (Fig. 7) furnishes plate and filament power for unit C and also negative bias for the 2A3's. Unit B on rack No. 2 is used in series with the audition channel to give sufficient output to operate a speaker. Plate currents on the tubes are read on the milliammeter F. All six-volt filaments are supplied from two transformers, one for each channel. The filament and plate currents are applied simultaneously. To operate the whole system, it is only necessary to perform the simple operation of throwing three switches, one on each power supply.

High-quality transformers were used throughout, not only to assure proper frequency response, but also to prevent the introduction of hum from the power transformers or other stray fields.

### CHASSIS DESIGN

The chassis design is shown in Fig. 8. Each unit is built on a metal chassis two inches deep and sixteen and one-half inches long with the width varying to accommodate the necessary parts. As tubes and transformers are of the base-

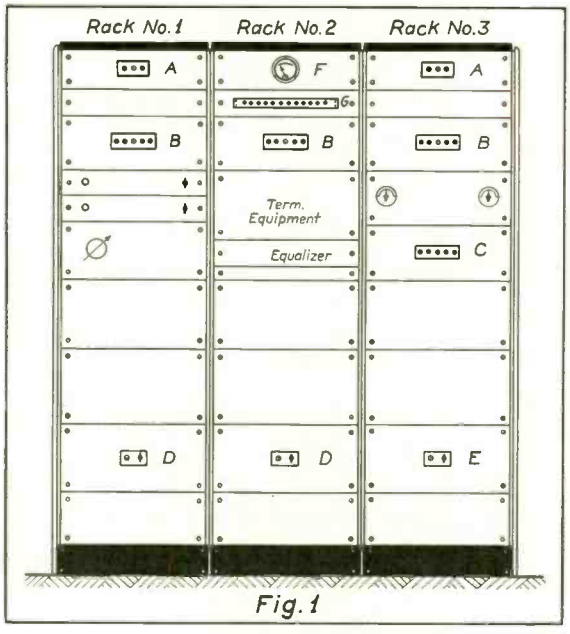

Fig. 1

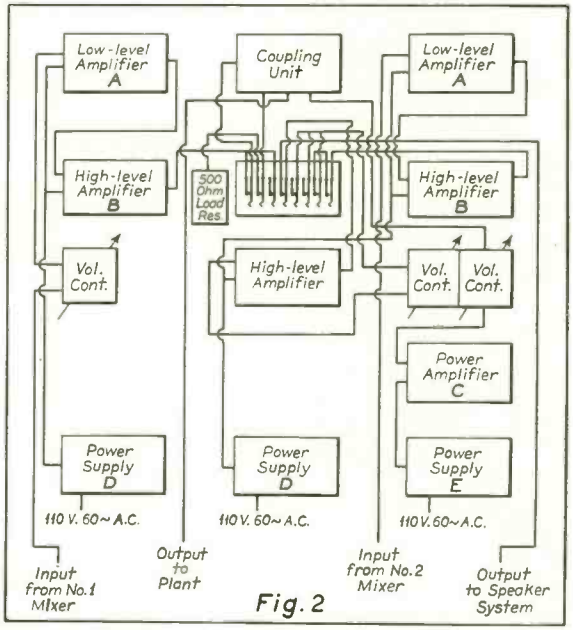

Fig. 2



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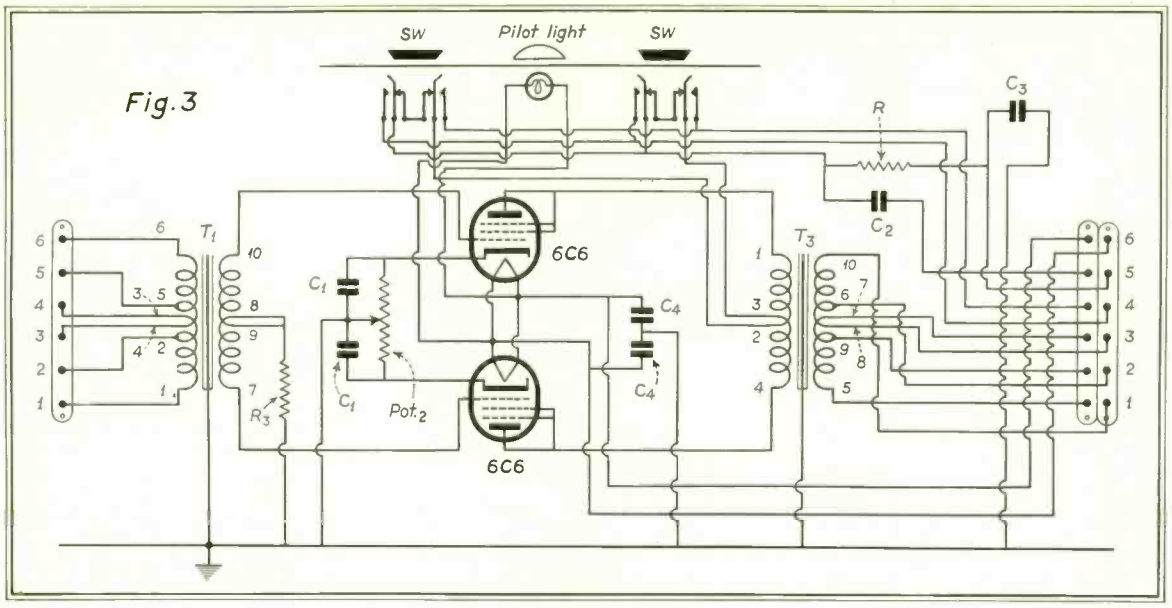


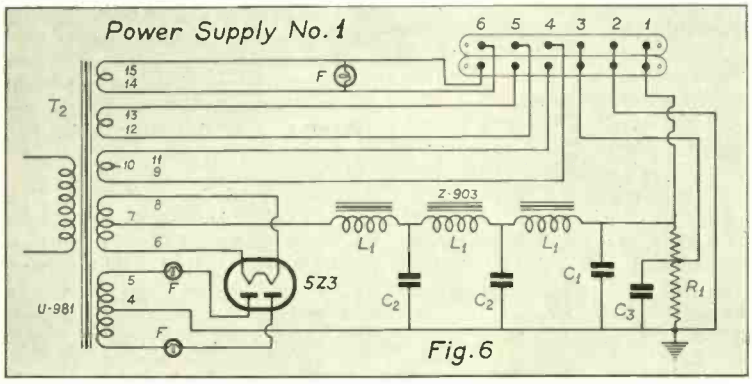
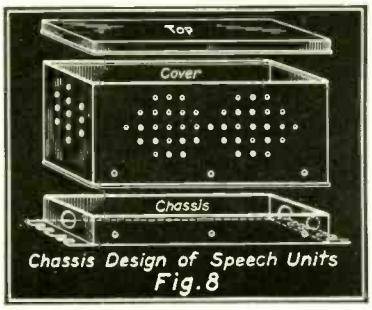
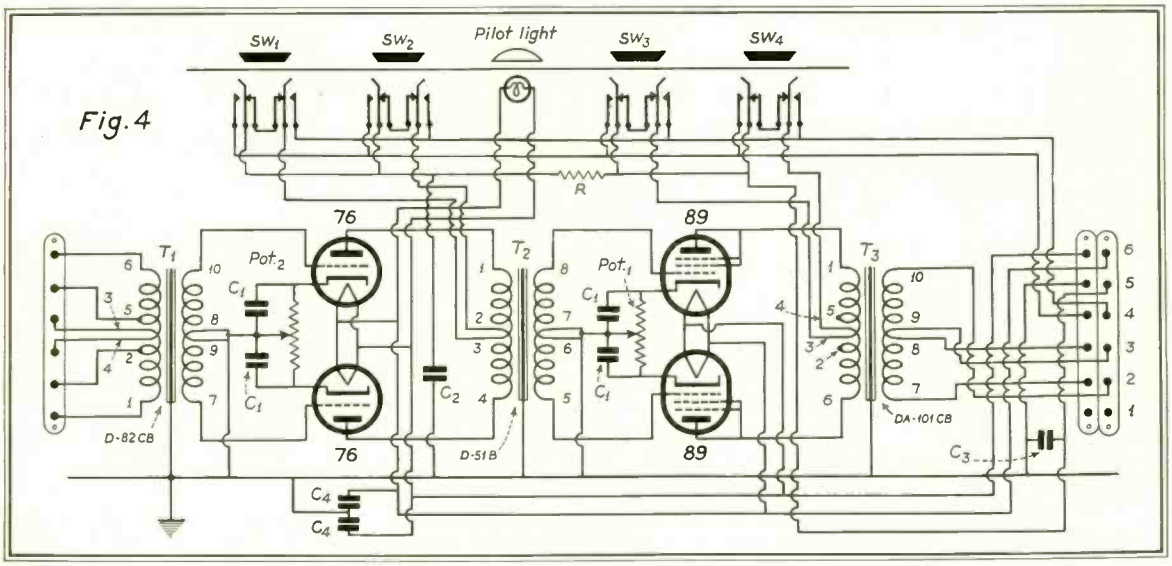



Fig.6



Chassis Design of Speech Units
Fig.8



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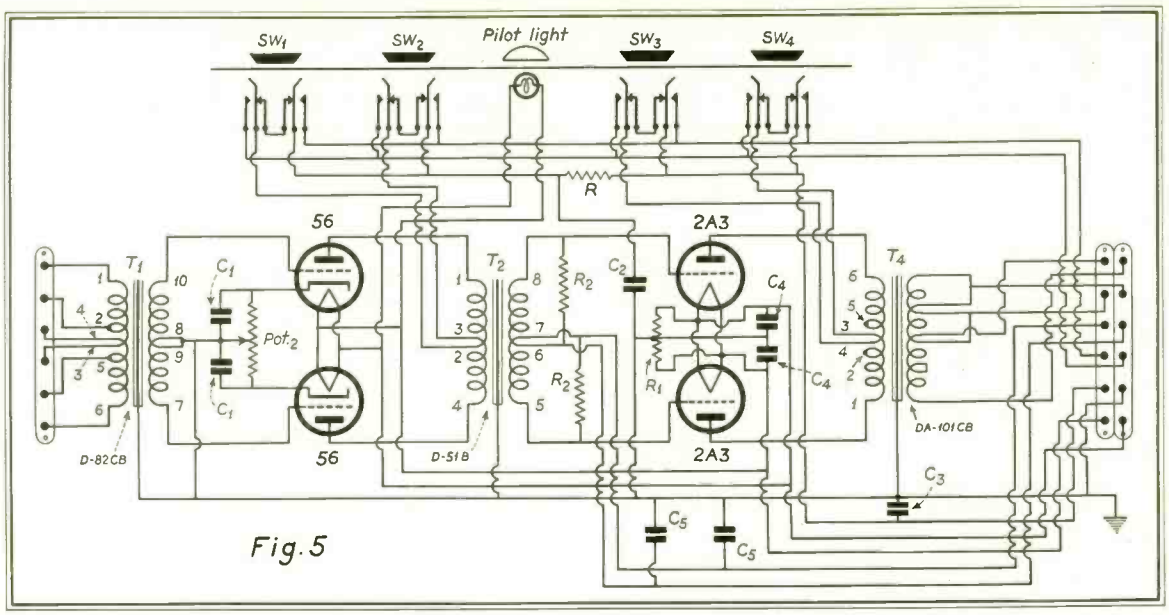
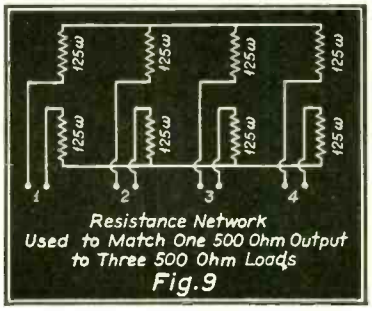



Fig. 5




Resistance Network
Used to Match One 500 Ohm Output
to Three 500 Ohm Loads

Fig. 9

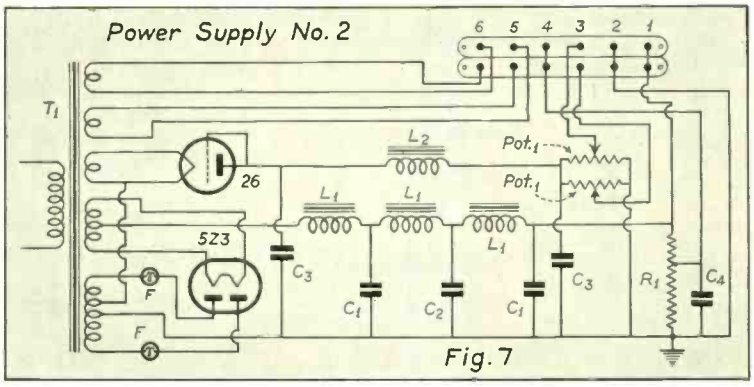



Fig. 7

## List Of Parts

### -Amplifiers-

$T_1$ - Input transformer (Line to two grids)
$T_2$ - Interstage transformer (Two plates to two grids)
$T_3$ - Output transformer (Two plates to line)
$T_4$ - Output transformer (Two plates to line or voice coil)
$R$ - 10,000 Ohm, 10 Watt resistor
$R_1$ - 20 Ohm center tapped resistor
$R_2$ - 500,000 Ohm carbon resistor
$R_3$ - 100,000 Ohm carbon resistor
$C_1$ - 25 Mfd., 35 V. electrolytic condenser
$C_2$ - 8 Mfd., 450 V. electrolytic condenser
$C_3$ - .1 Mfd., 400 V. tubular paper condenser
$C_4$ - Dual .1 Mfd. paper condenser
$C_5$ - 25 Mfd., 100 V. electrolytic condenser
$Pot_1$ - 5000 Ohm receiving type potentiometer
$Pot_2$ - 2000 Ohm receiving type potentiometer
S - Push-button type pole, double-throw switch

### -Power Supplies-

$T_1$ - High-voltage winding; 700 V. center tapped and tapped at 100 V. off center. Filament windings; 1-5.0 V., 1-1.5 V., 2-2.5 V.
$T_2$ - High-voltage winding; 700 V. center tapped Filament windings; 1-5.0 V., 3-2.5 V.
$L_1$ - 16 H. retard
$L_2$ - 500 H., 5 Milliampere retard
$R_1$ - 25,000 Ohms, 25 Watt
$Pot_1$ - 50,000 Ohm wire wound potentiometer
$C_1$ - 16 Mfd., 450 V. tubular electrolytic
$C_2$ - 8 Mfd., 450 V. tubular electrolytic
$C_3$ - 8 Mfd., 450 V. electrolytic
$C_4$ - 4 Mfd., 450 V. electrolytic
F - 0.5 Amp. pilot lamp used as high-voltage fuse



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mounting type, all wiring is done underneath the chassis. This makes for neat, direct wiring. Flanges extend from each end of the chassis allowing the unit to be mounted on the rack with wiring to the front, thus allowing easy servicing and facilitating wiring between units. They are mounted with flat-headed machine screws allowing mats or covers to be placed over the front. The mats are finished with several coats of black Duco, and polished. In the center of each amplifier mat is mounted a nickeled escutcheon plate drilled to match corresponding holes in the mat. For each tube in a unit there is a corresponding double-pole, double-throw, push-button switch, mounted to extend through the escutcheon plate when the mat is in place. Any switch, when depressed, gives the plate current on meter F for the associated tube. As switches are mounted on the chassis, the mat is easily removed. A pilot light indicates that the unit is in operation.

### BIAS VOLTAGES

A method of adjusting the bias voltage to compensate for differences in tubes is used in each push-pull stage. In the low-level stages exact balance of current through the plate winding of the transformers filters out any residual ripple from the power supply. Of course, in the output stages this is desirable to protect the permalloy cores from magnetization. Bias is obtained through a cathode dropping resistor for each tube. In each stage the resistor is a potentiometer with the end connections to opposite cathode terminals, the arm being grounded. Thus varying the position of the arm either side of center as required, exact balance may be obtained. A wire-wound "receiving" type potentiometer operates satisfactorily.

When first tested the low-level amplifiers oscillated badly. This was remedied by inserting a 100,000-ohm resistor between the center tap of the grid winding and ground. (This resistor is not bypassed.) A similar difficulty was experienced in the 2A3 stage of the power amplifier. However, in this case it was impossible to use the same remedy due to the fixed bias arrangement on the grids of the 2A3s. A 5,000,000-ohm resistor across each leg of the grid coil was used here. It might be well to add that shunt resistors across the grid coil would not stop oscillations in the low-level amplifier.

A method of coupling (Fig. 9) one 500-ohm amplifier output into several 500-ohm loads was used which, although applied extensively in telephone work, is not often found in the broadcasting station. The coupling unit consists of a resistance network with four pairs of terminals, any one of which may be used as input. As long as there is a 500-ohm load across each of the other three-terminal pairs the proper impedance match is obtained. The loss from input to any output is ten decibels.

Units are wired to terminal strips located near the bottom of the racks. Connections between racks and outside lines are made at this strip. Removal of the bottom panel gives access to the terminal strip. All wires are run in metal braid and cabled. Pairs of wire, such as inputs, outputs, 110-volt a-c lines, filament, leads, etc., are twisted and run in a single shield. Care was exercised in keeping low-level audio lines well separated from a-c lines and high-level audio outputs.

### TESTS

Tests on the finished amplifiers resulted in frequency-response curves flat within two decibels from 30 to 10,000 cycles per second, a noise level of approximately 70 decibels below program level and a harmonic content that was negligible at operating levels. The low-level amplifier has a gain of 30 decibels. The high-level amplifier has a gain of 50 decibels. The appearance of the finished product is such that it adds considerably to the control room.

This equipment was designed and built by the author with the assistance of G. E. Parcell, plant operator. Much credit is due Mr. A. C. Dadisman, technical director of KFH, for helpful suggestions and advice.

## CALIBRATING MICROPHONES

(*Continued from page* 6)

acting on the *instrument;* this method, as stated before, is advocable only when the wavelength is large compared with the diameter of the microphone.)

Since circulating air currents may easily produce noticeable deflections, the stream velocities in a sound wave being minute, it is necessary to suspend the Rayleigh disk in a small enclosure completely shielded by sheets of muslin or silk. Fig. 1 shows this arrangement diagrammatically. It should be noted here that for this part of the calibration—which has in mind the calibration of the microphone for the higher frequencies—the sensitivity of the disk must be made much higher than when the microphone is being calibrated for the lower frequencies by means of the aforementioned tube, since the magnitude of sound intensity producible in free space is considerably less than that which can be produced in a tube.

The length of the tube used for the low-frequency calibration should be commensurate with the wavelength of the sound, and the tube itself should be thick-walled enough to prevent troublesome vibrations. The tube may be round or square, but its cross-sectional area should be several times the diameter of the microphone to facilitate the operation of the calibration as much as to prevent the possibility of standing waves being set up across the walls of the tube at the higher frequencies. A tube 20 feet in length with walls of wood 2 inches thick provides a satisfactory acoustic transmission line; a glass window inserted in the side of the tube at the place where the disk is suspended allows for the reading of the deflection of the disk. The amount of absorbing material is increased progressively as the distance increases between the disk and the open end which does not contain the loudspeaker.

The value of the resistance inserted in the microphone circuit—the resistance across which a known emf is applied to simulate the emf generated by the microphone—should be small enough and sufficiently free of inductive reactance as not to introduce any appreciable or misleading impedance into this circuit. When calibrating a condenser microphone, this resistance may be several ohms, while in the case of low-impedance units such as the velocity ribbon microphone this resistance should be of the order of 5 percent of the ribbon resistance, and hence will be as small as 0.01 ohm.

In conclusion it may be said that the overall free-wave calibration is the most significant calibration when the unit is used for speech pickup. In addition it provides a very desirable standard microphone, the calibration for which is obtained at considerably less cost than when using a thermophone. Fig. 2 represents the frequency response of a high-grade condenser microphone and amplifier as obtained with a Rayleigh disk.

The author takes this opportunity to express his sincere appreciation to Messrs. Hansen and Townsend, of the Twentieth Century-Fox Film Corp., and to Mr. Carl Dreher, RKO Studios, Inc., for interest shown in the work.



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# OPTICAL PATHS OF LIMITING TRANSMISSIONS AT ULTRA-HIGH FREQUENCIES

EXPERIENCE indicates that centimeter waves and even those of a meter or so in length, travel in straight lines similar to light. Assuming this to be true, transmission can be expected between two antennas as long as there is a clear optical path between them. And, in general, this does represent the limit of transmission for such waves.

Let us consider a transmitting antenna of height $h_1$ (Fig. 1). Now a straight line $d_1$ to the point of tangency with the earth will be the limit of the optical path. However, if a receiver antenna of height $h_2$ is erected over the horizon so that a straight line can be drawn between the tops of the two antennas and the point of tangency, this line $(d_1 + d_2)$ will represent the new optical path of limiting transmission.

It is well known that for short distances, say one hundred miles or so, the following approximate relation holds:

$$d_1 = 6500\sqrt{h_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where $d_1$ and $h_1$ are both in feet. Or,

$$d_1 = \frac{6500}{5280}\sqrt{h_1} = 1.23\sqrt{h_1} \quad \ldots\ldots\ldots (2)$$

if $d_1$ is in miles and $h_1$ in feet. This latter equation is plotted in Fig. 2.

Now from equation (2) we have

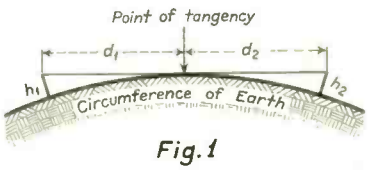
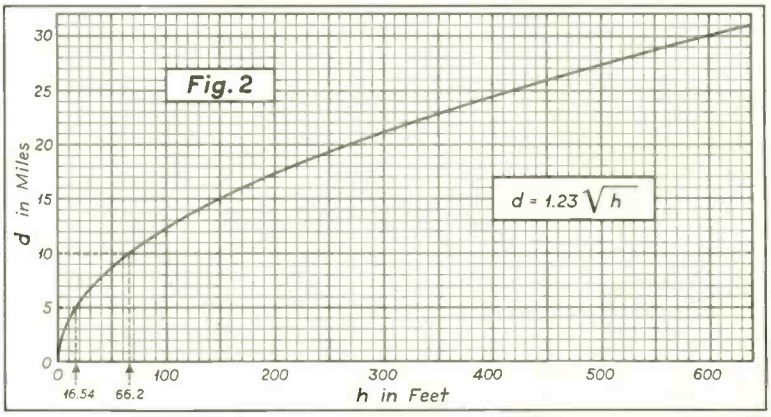


Fig. 1




$$h_2 = \frac{d_1^2}{(1.23)^2} = \frac{d_1^2}{1.51} \quad \ldots\ldots\ldots\ldots (3)$$

Fig. 3 is a plot of equation (3).

At a distance of five miles (Fig. 2) we find h to be 16.56 feet. Now the square root of 16.56 is 4.07, and a straight line, in Fig. 3, between 4.07 on the horizontal axis and 4.07 on the vertical axis represents the square root of the antenna height for an optical path of five miles over a spherical earth.

From the foregoing, the receiver antenna height for a given transmitting antenna can be determined for any optical path. As an example, let $h_2 = 100$. The square root of 100 is 10. Then for a 15-mile path (Fig. 3) $\sqrt{h_1} = 2.20$ and $h_1 = 4.84$ feet. Similarly, for a 20-mile path $\sqrt{h_1} = 6.4$, and $h_1 = 40.96$ feet. If desired, of course, the axes can be plotted directly in feet.

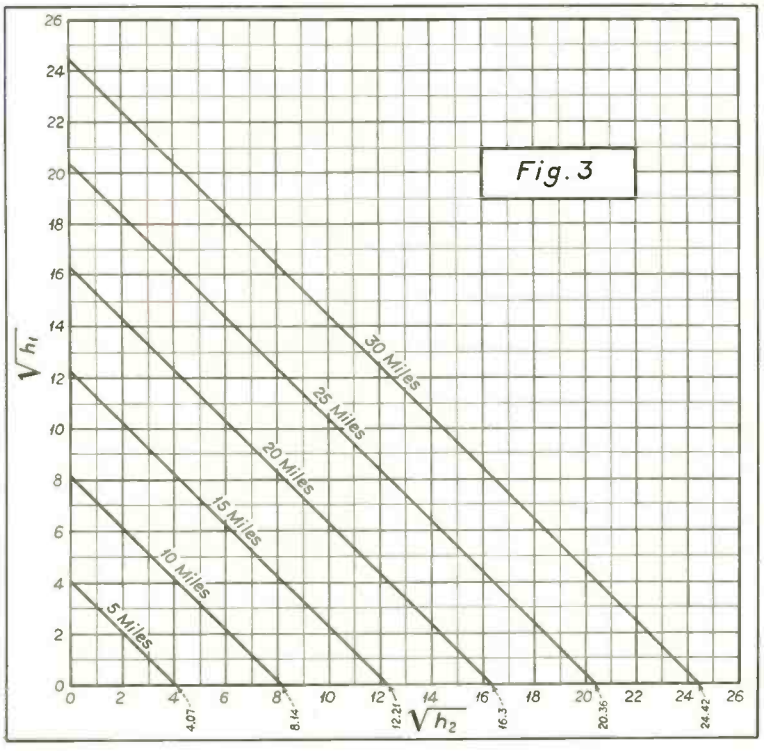



Fig. 2 is especially interesting for computing distances of limiting transmissions for aircraft in flight. Ultra-short waves have been proposed for blind-landing and even for radio-range courses. The former will undoubtedly soon be in use—as a matter of fact it has already been successfully demonstrated both in this country and in Germany. It is probably not looking too far into the future to visualize regular radio-telephone communication service between aircraft and ground. When high-altitude flying over long distances becomes a reality, large distances can probably be spanned at the ultra-high frequencies, if sufficient power is provided. It must be borne in mind that to date no substitute for adequate transmitted power has been discovered. Therefore, it is hardly to be expected that a low-power transmitter will be sufficient to establish reliable radio-telephone communication over the 175 miles which represents the limiting range of a plane at an altitude of 20,000 feet. Power rather than optical path may become the limiting quantity in such instances.

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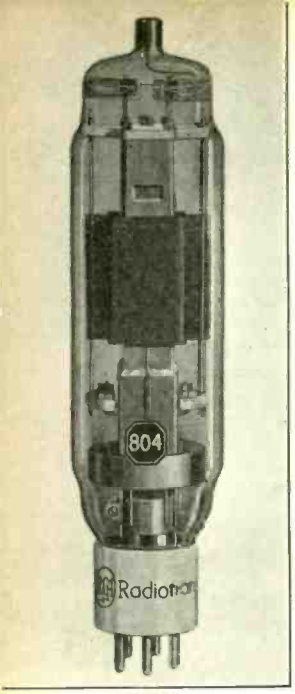
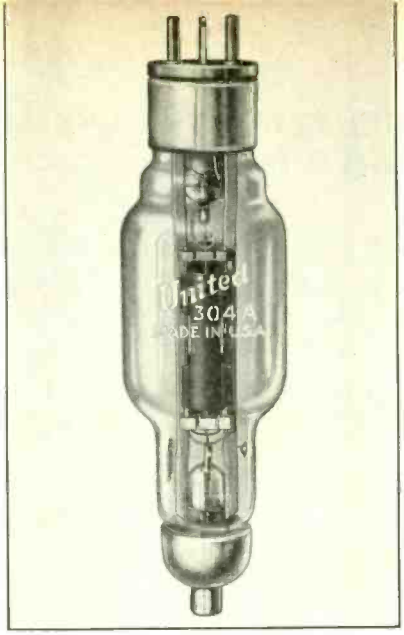
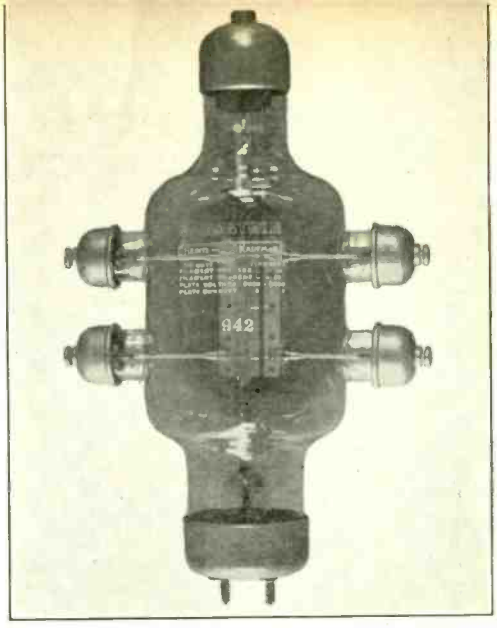


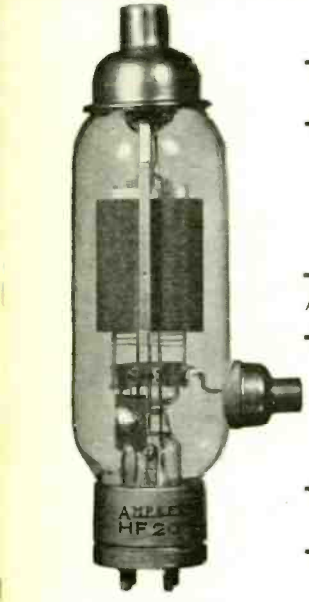




UNITED 949




GAMMATRON TYPE 255

# NEW TYPES OF



RCA 804

AMPEREX HF 200

RCA 830-B

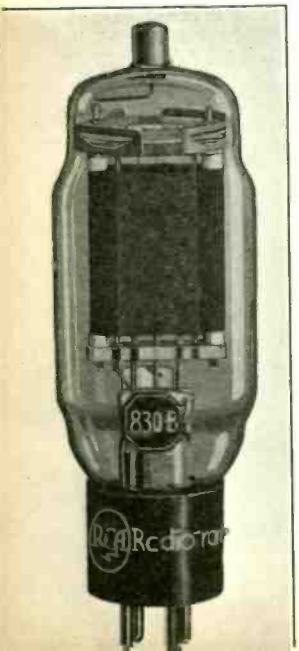
ON THIS and the following page are shown some of the newer type of tubes which are available for commercial distribution. A brief description of each type is contained in the following paragraphs:

The RCA 804 is a pentode tube having a maximum plate dissipation of 40 watts (Class C telegraph service). This tube is for use as an r-f power amplifier, frequency multiplier, oscillator and suppressor, grid- or plate-modulated amplifier. It can be operated at maximum ratings as high as 15 mc.

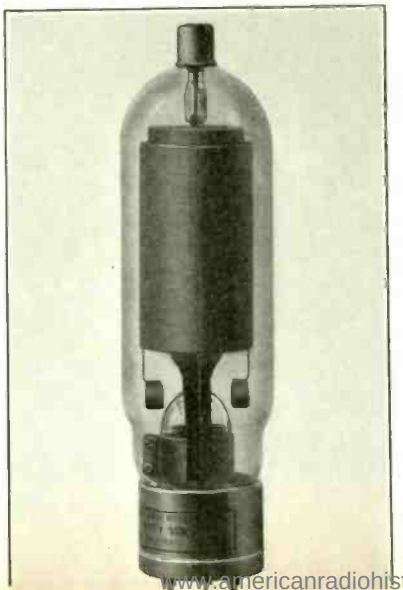
The Gammatron Type 255 (gridless construction) is a tube especially constructed for use at ultra-high frequencies, and is suited for use as oscillator, a-f or r-f amplifier. The normal plate dissipation is 500 watts.

The United Type 949 is a 3-element tube. It has been designed for use as Class A amplifier and modulator (Max. plate dissipation 350 watts), Class B audio (250 watts) or r-f amplifier (500 watts), and Class C oscillator or r-f amplifier (350 watts).

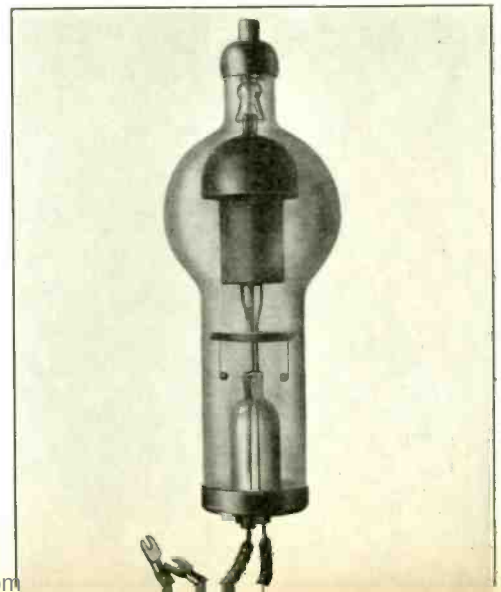
The United Type 304-A is also a 3-




FEDERAL TYPE F-353 A



FEDERAL TYPE F-357 A



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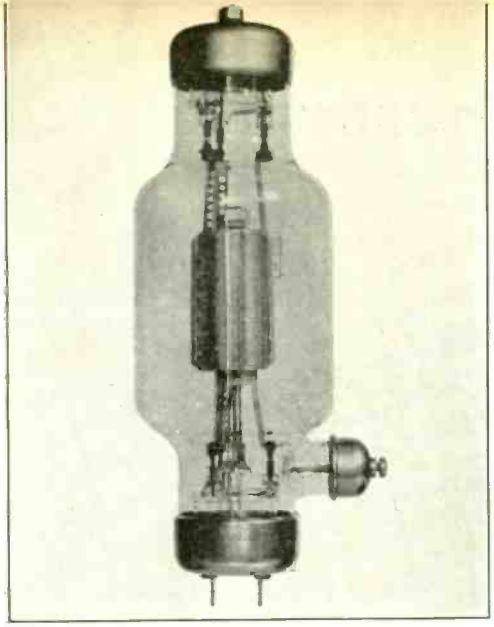
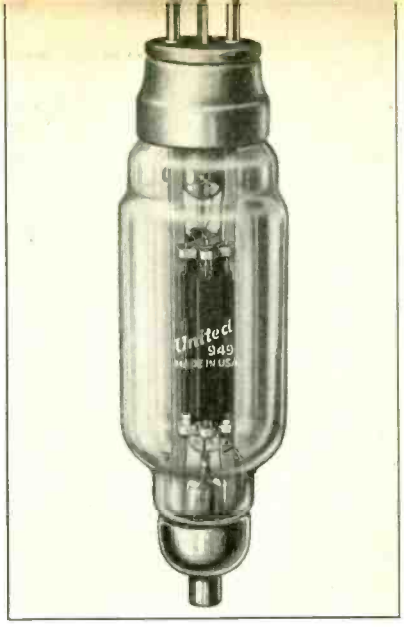
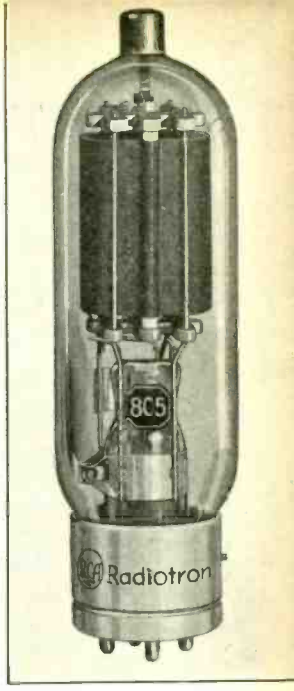


GAMMATRON TYPE 1554




UNITED 304-A




# TRANSMITTING TUBES

element tube, and is for use in Class B r-f power amplifier, and Class C oscillator and r-f amplifier service. The maximum plate dissipation of the 304-A is 250 watts.

The Gammatron Type 1554 is a general-purpose triode which has a maximum plate dissipation of 750 watts. This tube has low-capacity construction and is suited to operation at wavelengths as low as 5 meters.

The RCA 805 is a high-mu triode intended for use as an r-f power amplifier, oscillator, and Class B a-f amplifier. It may be used at maximum ratings for frequencies as high as 30 mc. The maximum plate dissipation in Class C telegraph service is 125 watts.

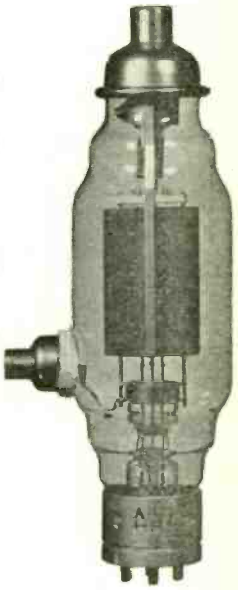
The Amperex HF 200 and HF 300 are high-mu tubes. The allowable plate dissipation as Class C oscillator or power amplifier for the HF 200 is 150 watts, and for the HF 300, 200 watts. These tubes may be used at maximum operating ratings for frequencies as high as 60 mc.

The RCA 836 is a half-wave, high-

(*Continued on page* 16)

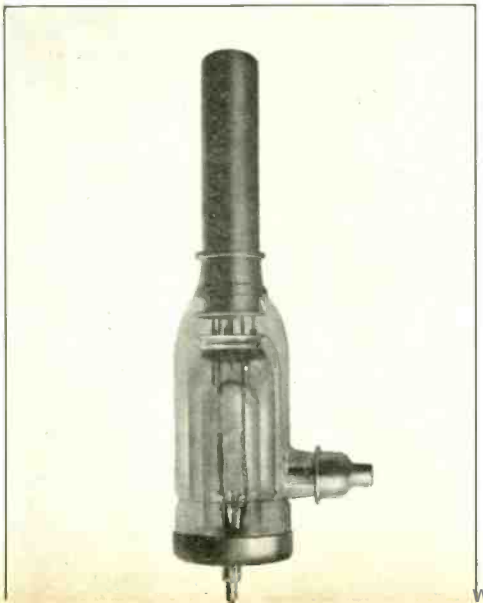
RCA 805

AMPEREX HF 300

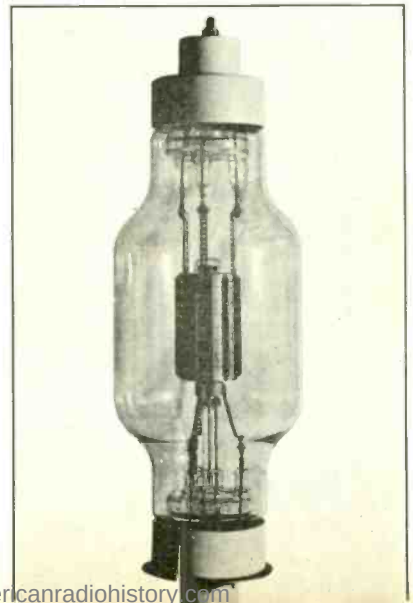


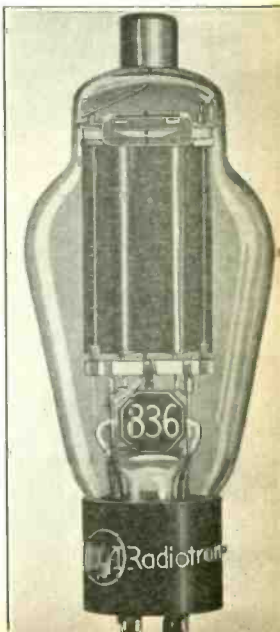
RCA 836

FEDERAL TYPE F-328 A



GAMMATRON TYPE 3054



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# TRANSMISSION-LINE CALCULATIONS

By J. G. SPERLING

and

E. W. GORDON, WHN

AN ALTERNATING-CURRENT transmission line may be expressed in terms of its four parameters: The series resistance $R$; the capacitance between the conductors $C$; the series inductance $L$; and the shunt leakage resistance or conductance $G$. See Fig. 1. This may be further expressed in terms of the series impedance $Z$, and the shunt admittance $Y$. See Fig. 2.

The total impedance, or characteristic impedance, of any length line is

$$Z_o = \frac{e}{i} \tag{1}$$

The voltage $e$ at the load may be derived, and is as follows:

$$e = \frac{E\sqrt{\frac{Y}{Z}}\,Z_L \cosh\sqrt{YZ}\,x + \sinh\sqrt{\frac{Z}{Y}}\,x}{Z_L\sqrt{\frac{Y}{Z}}\cosh\sqrt{YZ}\,x + \sinh\sqrt{YZ}\,x} \tag{2}$$

The current $i$ through the line is:

$$i = \frac{E\frac{Y}{Z}Z_L \sinh\sqrt{YZ} + \cosh\sqrt{YZ}\,x}{Z_L\sqrt{\frac{Y}{Z}}\cosh\sqrt{YZ}\,x + \sinh\sqrt{YZ}\,x} \tag{3}$$

Therefore the characteristic impedance is:

$$Z_o = \frac{e}{i} = \frac{Z_L\sqrt{\frac{Y}{Z}}\cosh\sqrt{YZ}\,x + \sinh\sqrt{YZ}\,x}{Z_L\frac{Y}{Z}\sinh\sqrt{YZ}\,x + \cosh\sqrt{YZ}\,x} \tag{4}$$

Since all r-f transmission lines are terminated in a unity power load equal to the characteristic impedance of the line, we may substitute in (4) for $Z_L$ the value $\sqrt{\frac{Z}{Y}}$. See Fig. 3.

Therefore $$Z_o = \frac{x\cosh\sqrt{\frac{Y}{Z}}\sqrt{\frac{Z}{Y}}\sqrt{YZ} + x\sinh YZ}{\sinh x\frac{Y}{Z}\sqrt{\frac{Z}{Y}}\sqrt{YZ} + \cosh YZ\,x} \tag{5}$$

$$Z_o = \sqrt{\frac{Z}{Y}} \tag{6}$$

When the input voltage $E$ is sinusoidal:

$$E = E_o \sin\omega t \qquad \omega = 6.28\,f \tag{7}$$

Therefore $$Z = R + j\omega L \tag{8}$$

and $$Y = G + j\omega C \tag{9}$$

$$Z_o = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{R + j\omega L}{G + j\omega C}} \tag{10}$$

Differentiating the value of $Z_0$ with respect to $\omega$, and setting the derivative equal to zero, in order to find a value of $Z_o$, which is a constant regardless of frequency:

$$\frac{d}{d\omega}\sqrt{\frac{R + j\omega L}{G + j\omega C}} = 0 \tag{11}$$

$$\frac{-j\,C}{2}(R + j\omega L)^{\frac{1}{2}}\,(G + j\omega C)^{-\frac{3}{2}} + \frac{jL}{2}(R + j\omega L)^{-\frac{1}{2}}\,(G + j\omega C)^{-\frac{1}{2}} = 0 \tag{12}$$

Simplifying, $$\frac{L}{C} = \frac{j\omega + \frac{R}{L}}{j\omega + \frac{G}{C}} \tag{13}$$

and $$\frac{L}{C} = \frac{R}{G} \tag{14}$$

Substituting the values of $L$ and $C$ in (10)

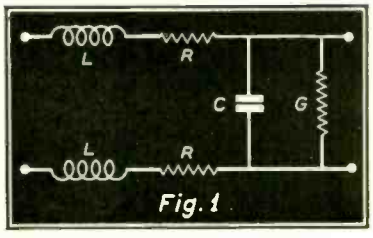

Fig. 1

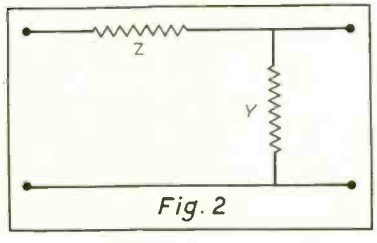

Fig. 2

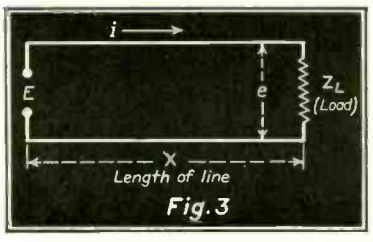

Fig. 3



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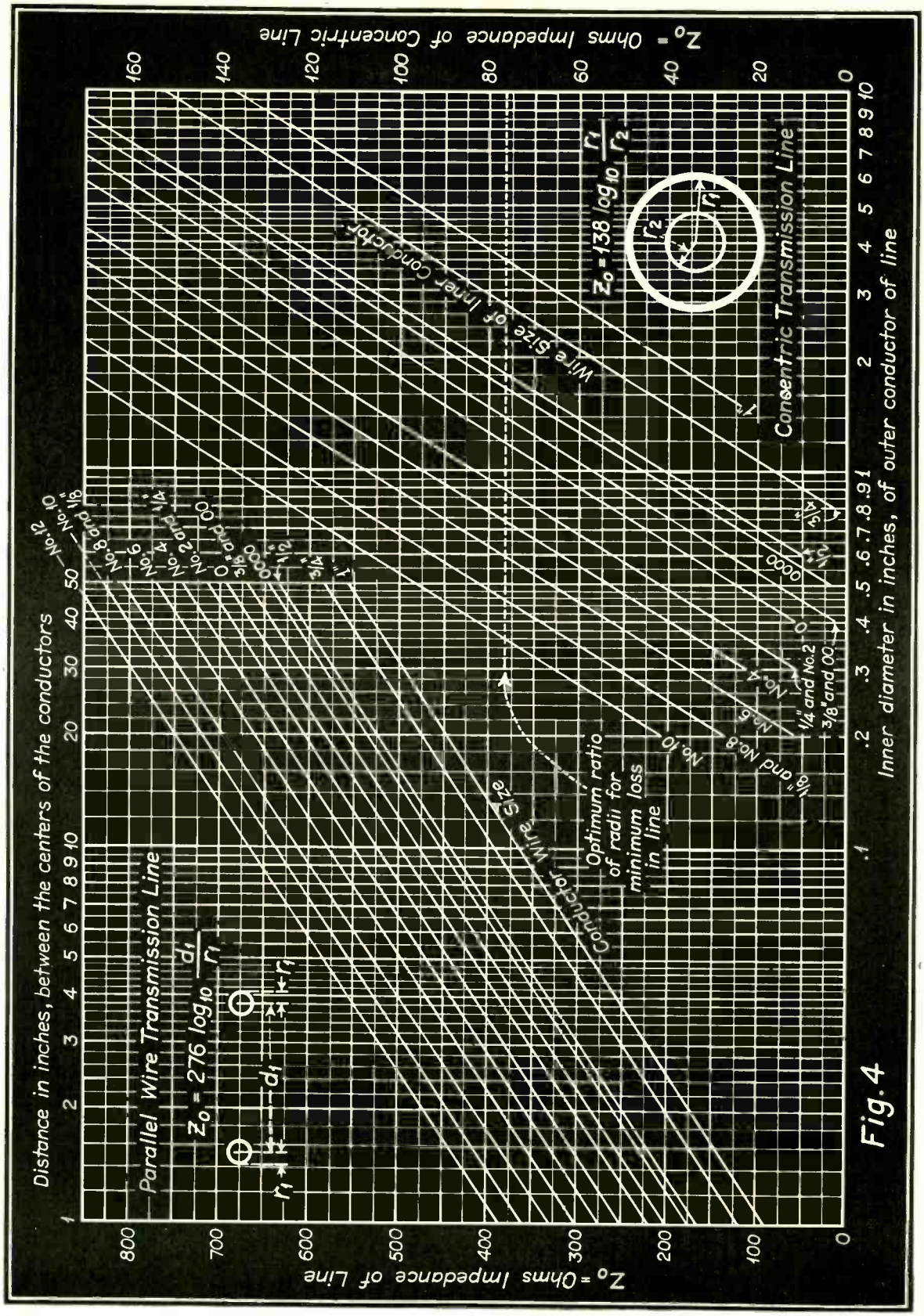


Fig. 4



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$$Z_o = \sqrt{\frac{R + \frac{j\omega CR}{G}}{G + \frac{j\omega LG}{R}}} = \sqrt{\frac{L}{C}} \qquad (15)$$

## PARALLEL-WIRE TRANSMISSION LINE

The characteristic impedance of a transmission line, as already shown, is

$$Z_o = \sqrt{\frac{L}{C}}$$

The inductance, in henrys, per inch of length, is:

$$L = \frac{10.16 \log_e \frac{d_1}{r_1} \mu}{10^9} \qquad (16)$$

$\mu$ = Permeability of media between conductors.
$d_1$ = Distance between centers of conductors.
$r_1$ = Radius of conductor.

The capacitance, in farads, per inch of separation, is:

$$C = \frac{K\ 10^{-10}}{142 \log_e \frac{d_1}{r_1}} \qquad (17)$$

K = Dielectric constant of media between conductors.

$$\text{Therefore } Z_o = \sqrt{\frac{10.16 \log_e \frac{d_1}{r_1} \mu}{\frac{10^9}{10^{-10} K}}} \qquad (18)$$
$$142 \log_e \frac{d_1}{r_1}$$

Since the media is air, the value of $\mu$ and $K$ is unity or 1.

Hence

$$Z_o = 120 \log_e \frac{d_1}{r_1} = 276 \log_{10} \frac{d_1}{r_1} \qquad (19)$$

On the left-hand portion of the curve sheet, Fig. 4, will be found a series of curves for readily determining the values of impedance of the parallel-wire transmission line versus the spacing distance between the conductors for various values of wire sizes.

## CONCENTRIC TRANSMISSION LINE

The characteristic impedance of a transmission line is

$$Z_o = \sqrt{\frac{L}{C}}$$

The inductance, in henrys, per inch of length, is:

$$L = \frac{5.08 \log_e \frac{r_1}{r_2} \mu}{10^9} \qquad (20)$$

The capacitance, in farads, per inch of separation is:

$$C = \frac{K}{7.08 \log_e \frac{r_1}{r_2} 10^{11}} \qquad (21)$$

$$\text{Therefore } Z_o = \sqrt{\frac{5.08 \log_e \frac{r_1}{r_2} \mu}{\frac{10^9}{K}}} \qquad (22)$$
$$7.08 \log_e \frac{r_1}{r_2} 10^{11}$$

$$\text{Or } Z_o = 60 \sqrt{\frac{\mu}{K}} \log_e \frac{r_1}{r_2} \qquad (23)$$

If the media between the two conductors is air the values of $\mu$ and $K$ is unity, or 1.

$$\text{And } Z_o = 138 \log_{10} \frac{r_1}{r_2} \qquad (24)$$

On the right-hand portion of the curve sheet will be found a series of curves for determining the impedance of the concentric transmission line, under transmission, versus the inner diameter of the outer conductor for various values of wire sizes of the inner conductor.

In the case of the concentric transmission line there exists an optimum ratio between the radius of the inner surface of the outer conductor and the radius of the inner conductor for a minimum loss. This value is found to be 3.6. The mathematics for this determination depend upon the value of the skin-effect loss.

The optimum-ratio impedance may be found as follows:

$$Z_o = 138 \log_{10} \frac{r_1}{r_2} = 138 \log_{10} (3.6)$$

$$Z_o = 76.7 \text{ ohms.}$$

Through the system of curves of the concentric transmission line is drawn a dotted line so as to provide a means of finding the correct value of the outer conductor, for a minimum loss, if the inner-conductor size is known, or vice versa.

Formulas (11) to (15) were reproduced through permission of G. R. Fugal, General Electric Company, from "Principles of Radio Engineering" page 100, by R. B. Dome.

*(Further data on transmission-line calculations will appear in a following issue.—*ED.)

# NEW TYPES OF TRANSMITTING TUBES

*(Continued from page 13)*

vacuum rectifier for use in high-voltage rectifying devices.

The Gammatron Type 3054 is a general purpose triode having a normal plate dissipation of 1500 watts.

The Federal Type F-328A vacuum tube has been designed for use as an oscillator and r-f power amplifier. The maximum plate dissipation of this tube is 5000 watts.

The Federal Type F-353A and F-357A are half-wave mercury-vapor rectifier tubes. For the former type the maximum peak current is 2.5 amperes and the maximum peak inverse voltage is 10,000 volts; while for the latter type the maximum peak current is 20 amperes, peak voltage being 22,000 volts.

The RCA 830-B is a 3-electrode tube for use as a Class B modulator, r-f amplifier and oscillator.



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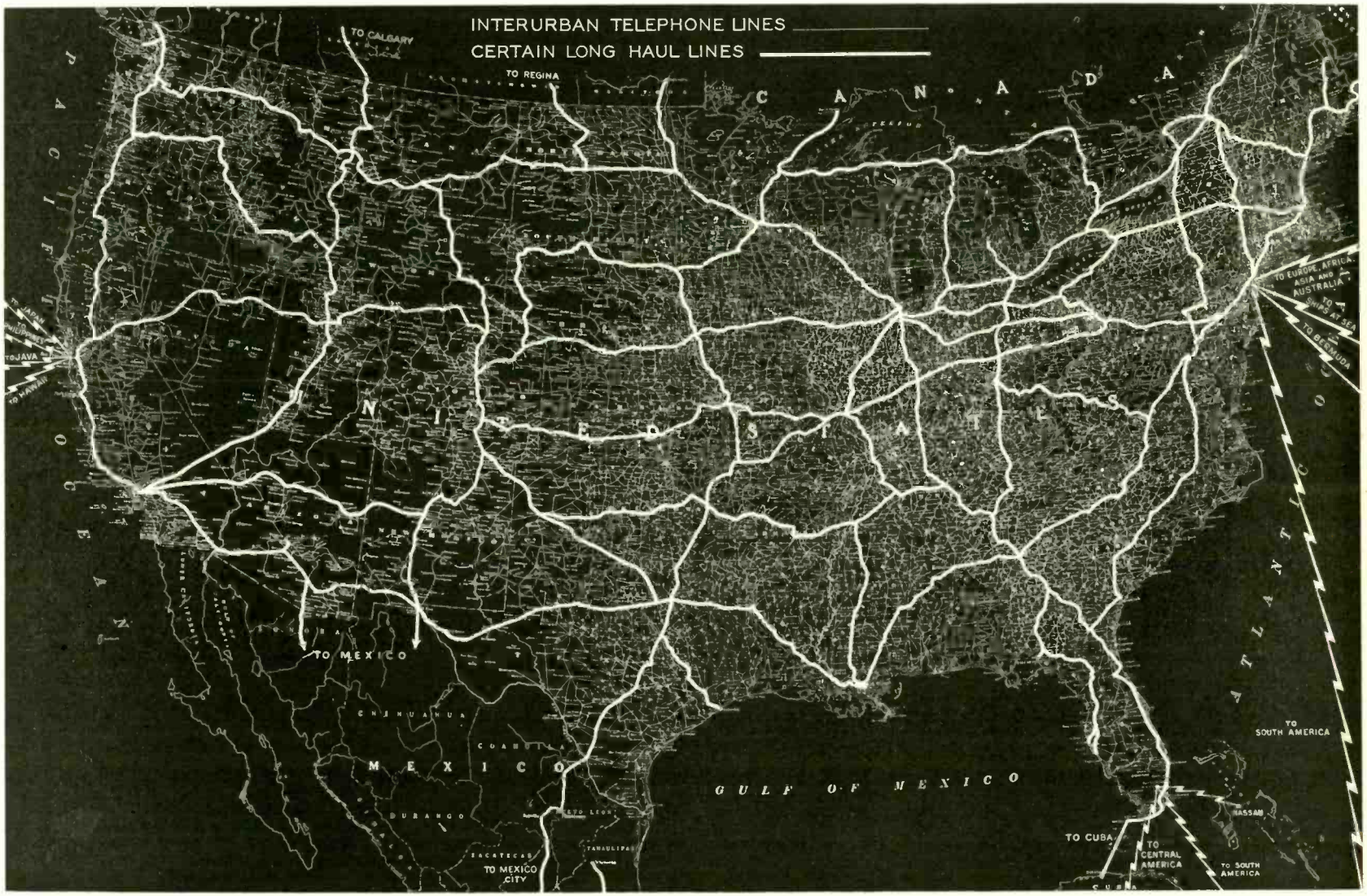


**MAP No. 17--TOLL LINES OF THE BELL TELEPHONE SYSTEM.**



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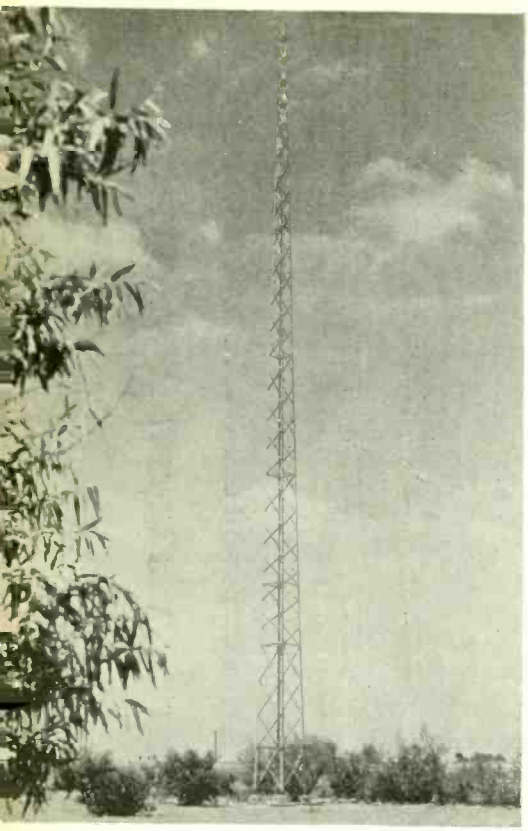
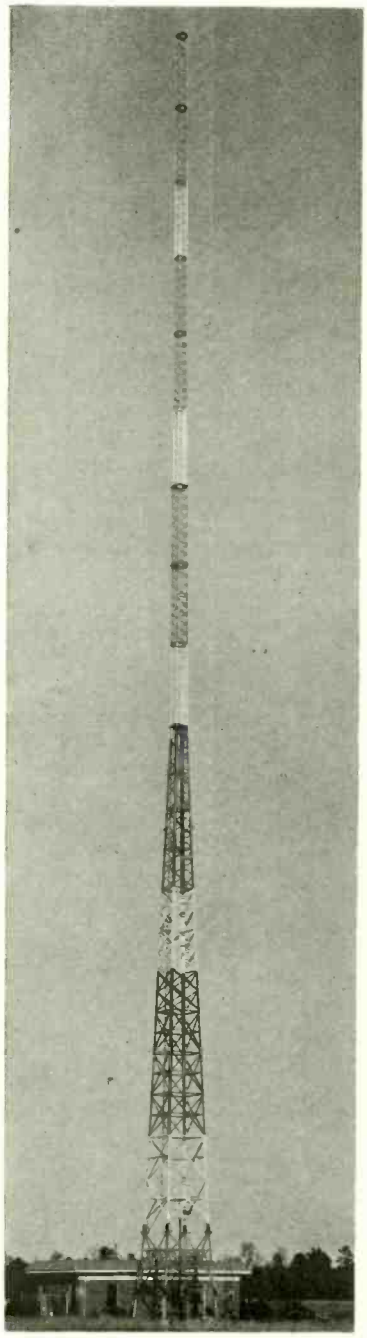
# TYPICAL BROADCAST

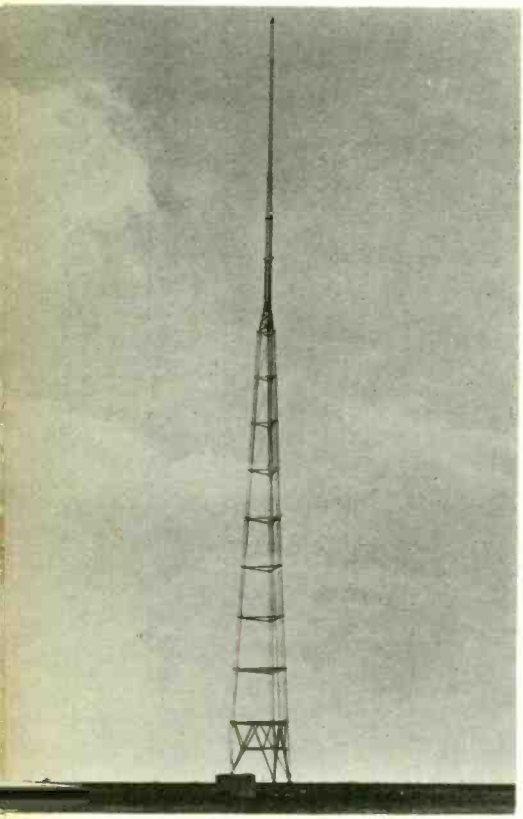


THE 179-FOOT SELF-SUPPORTING BLAW-KNOX VERTICAL RADIATOR OF RADIO STATION KGER, LONG BEACH, CALIFORNIA.

THE LEHIGH VERTICAL RADIATOR OF KVSO, ARDMORE, OKLAHOMA.



BROADCAST STATION WDOD, CHATTANOOGA, TENNESSEE. THIS TRUSCON SELF-SUPPORTING ANTENNA IS 320 FEET HIGH.



THE VERTICAL RADIATOR OF KPRC-KTRH, HOUSTON, TEXAS. THIS TRUSCON RADIATOR IS 375 FEET HIGH.



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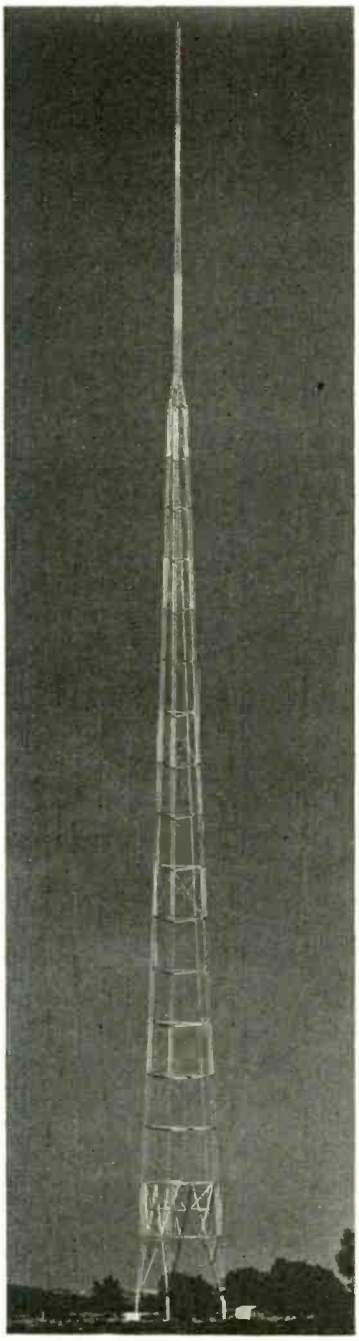
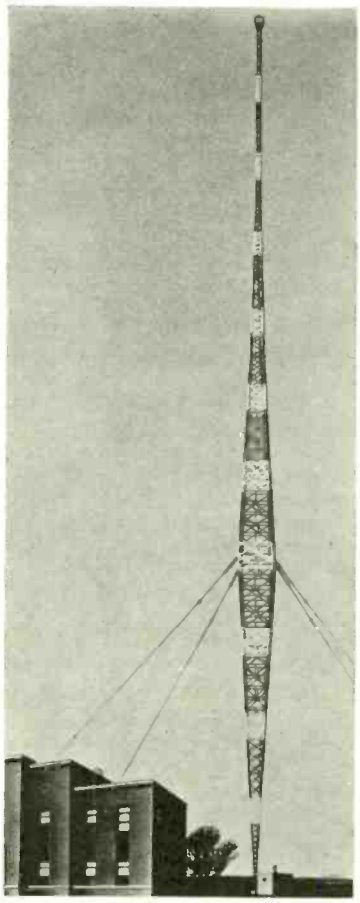
# ANTENNA INSTALLATIONS

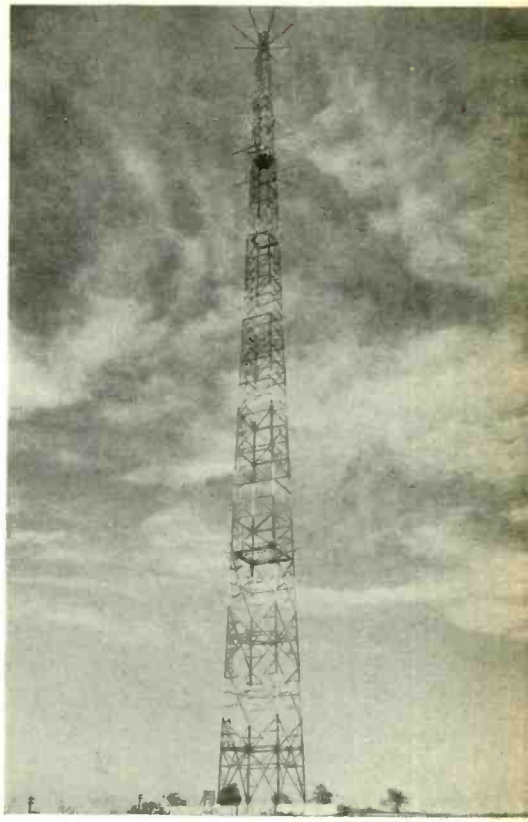


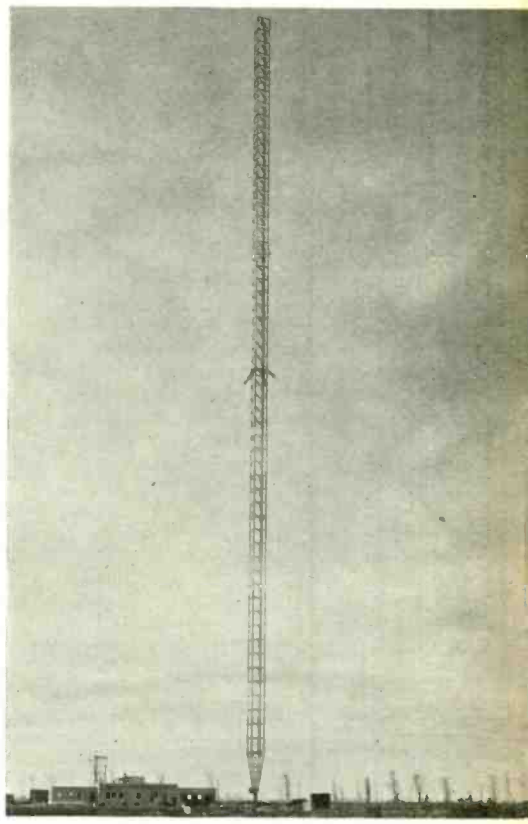
RADIO STATION KGHL, BILLINGS, MONTANA. THIS TRUSCON RADIO TOWER IS 556 FEET HIGH.



THE 520-FOOT VERTICAL RADIATOR OF WHO, DES MOINES, IOWA. THIS IS A BLAW-KNOX ANTENNA.

THE SELF-SUPPORTING BLAW-KNOX RADIATOR AT WCFL, CHICAGO, ILLINOIS. NOTE THE VERTICAL WIRES SIMULATING UNIFORM CROSS SECTION. THE TOWER IS INSULATED 40 FEET BELOW THE TOP.





WWJ, DETROIT, MICHIGAN. NOTE THAT THIS 400-FOOT BLAW-KNOX RADIATOR IS OF UNIFORM CROSS SECTION.



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# TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

## FIELD-INTENSITY MEASUREMENTS

CONCERNING FIELD-INTENSITY MEASUREMENTS, Rule 131 provides, according to an announcement made by the FCC on March 30, that certain minimum field intensities are acceptable in lieu of the required vertical heights of the antenna proper. The following are the requirements governing the taking and submission of data on the field intensity produced:

Beginning as near the antenna as possible without including the induction field, measurements should be made on eight or more radials, at intervals of one-quarter mile or less up to two miles, at intervals of one-half mile or less from two miles to six miles, and a few additional measurements at greater distances from the antenna. Where the antenna is rurally located and unobstructed measurements can be made, there should be as many as eighteen or twenty measurements on each radial. However, where the antenna is located in a city or where unobstructed measurements are difficult to make, measurements should be made on each radial at much closer intervals, particularly within two miles of the antenna.

A curve for each radial is plotted from these data on semi-logarithmic coordinate paper with the field intensity times distance as ordinate, and distance as abscissa. From the curve so plotted, the unattenuated field intensity at one mile on each radial is determined.

When all radials have been analyzed in this manner, a curve is plotted on polar coordinate paper from the unattenuated values obtained, which gives the unattenuated field pattern at one mile. The radius of a circle, the area of which is equal to the area bounded by this pattern, is the effective unattenuated field intensity at one mile.

While making the field intensity survey, the output power of the station must be maintained at the licensed power as determined by the direct method. To do this it is necessary to determine accurately the total antenna resistance (the resistance variation method or the substitution method is acceptable) and to measure the antenna current by means of an ammeter of acceptable accuracy.

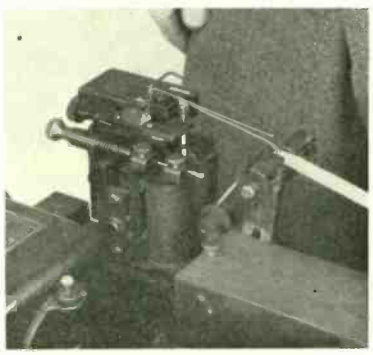
An accurate value of the antenna resistance can be determined only by making a series of measurements, each for a different frequency. From ten to twelve resistance measurements covering a band 50 to 60 kilocycles wide with the operating frequency near the middle of the band, must be made to give data from which accurate results may be obtained. The values measured should be plotted with frequency as abscissa and resistance in ohms as ordinate and a smooth curve drawn. The point on the ordinate where this curve intersects the operating frequency, gives the value of the antenna resistance.

The following data should be submitted to the Commission in affidavit form:

1. Complete data taken for field-intensity measurement, including a map showing each point of measurement numbered to agree with the tabulated data and for the antenna resistance measurement.
2. The graphs drawn for each radial, the unattenuated field pattern and the antenna-resistance curve.
3. Description of methods used to take readings for field intensity and antenna-resistance measurements.
4. Manufacturer's name of each calibrated instrument used, and manufacturer's rated accuracy.
5. Accuracy, date and by whom each instrument was last calibrated.
6. Name and qualifications of engineer making measurements.

## THE UNDULATOR BECOMES A LIE-DETECTOR

THE SO-CALLED brain testing, or lie-detecting, recording instruments which intrigued the public imagination this past year are former Western Union telegraph instruments, known as undulators. They record the variations of electric current in the brain of a person or animal, just as in past years they recorded the pulsations of electric current through telegraph wires.



In justice to the scientists of Harvard University Medical School who conducted the tests, it must be said that the correct facts have been stated repeatedly by them, but imaginative stories of the uncanny abilities of these tests to read the mind bear little resemblance to the facts.

Let's look in on one of these tests and see what happens. A group of scientists watch intently while one of their number inserts a wire in the scalp and another in the ear of a man sitting quietly in a chair. The two wires connect the man's head with a battery of electrical apparatus on a table.

A tiny glass tube, on a Western Union telegraph recording machine known as an undulator (see accompanying illustration), begins to vibrate, and marks a chain of mountains and valleys on a narrow paper tape. The man in the chair is asked to work out a mathematical problem, and the inky mountains and valleys become larger. The man does not speak, but the scientist in charge soon announces that the man has solved the problem. Then he announces that the man in doing the problem over again to check his answer, and finally states that the answer is ready. The man then verifies the scientist's statements.

The instruments used in these tests were originally designed and used to record in rapid succession the electrical peaks and valleys of telegraph signals. A number of telegraph undulators were obtained from Western Union for use in the experiments since there is little use for these instruments now in telgraph work. For about three decades undulators were used as an aid in balancing duplex circuits and observing the performance of multiplex telegraph circuits, over which as many as eight messages are transmitted simultaneously. More efficient methods of accomplishing these results now have been found by telegraph engineers.



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## PORTABLE RADIO DIRECTION FINDER

THE SEMI-PORTABLE radio direction-finding equipment, shown in an accompanying illustration, is a recent development of the United States Coast Guard. It is primarily designed for the purpose of obtaining first-hand information in distress cases by means of radio bearings.

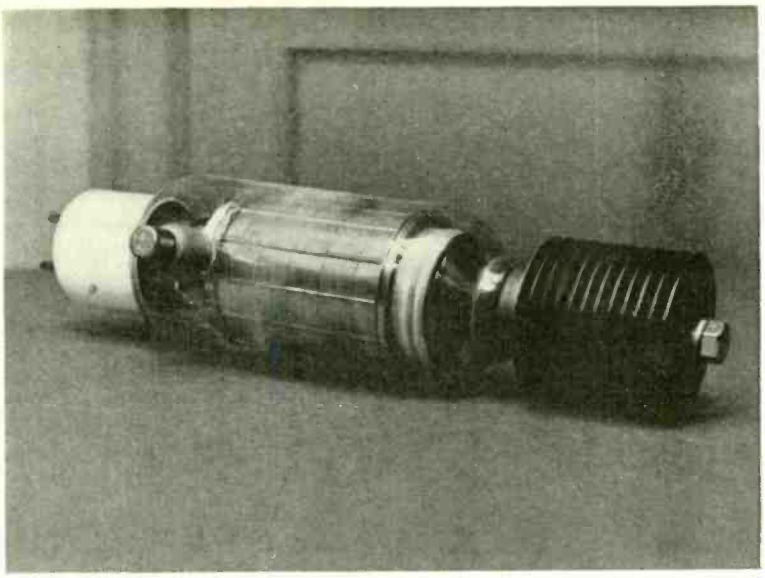
This equipment, while it was designed primarily for use at shore radio stations and at air stations of the Coast Guard, is so constructed that it may be readily transported for use as portable equipment in motor boats and other surface craft, or in motor vehicles, such as trucks, etc. The specifications of the equipment are summarized as follows:

A—The frequency ranges are 200 to 750 kilocycles and 2,000 to 5,000 kilocycles, which are covered by a switching arrangement whereby the use of plug-in coils or interchangeable tuning units of any sort are avoided. Two interchangeable loop antennas are used in order to cover the two frequency bands.

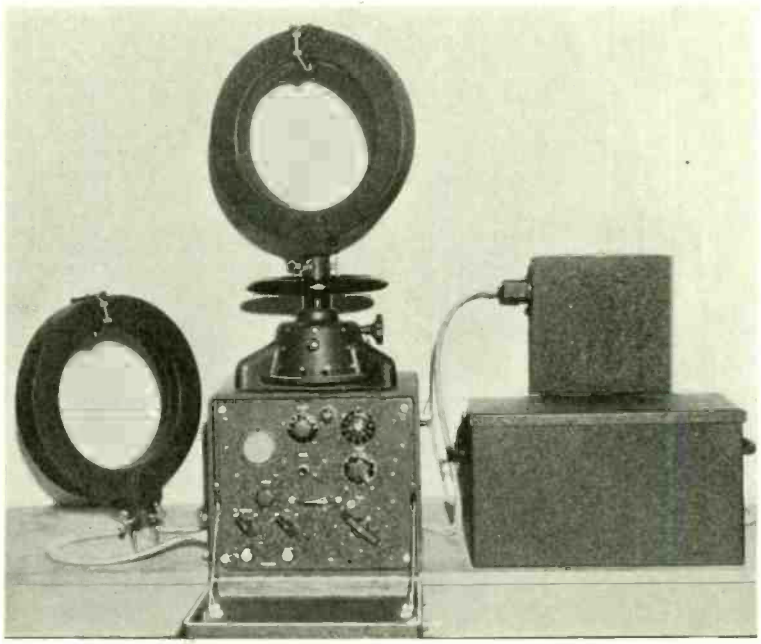
B—The loop-antenna circuit consists of a symmetrical-wound center-tapped shielded loop inductor feeding into a push-pull loop coupling stage utilizing a pair of 78 tubes. Balance and directional sense operation are obtained by the proper phasing of energy obtained from a small vertical antenna. A 77-tube is utilized as the first detector, while a 37 serves as the r-f oscillator. The 66-kc intermediate-frequency amplifier utilizes a single 78 tube feeding into a 77 detector. CW operation is obtained by means of a 37 tube acting as an intermediate-frequency oscillator. An additional 37 tube is used as an audio amplifier, the output of which feeds into the primary of an electrostatically-shielded audio output transformer, the secondary of which will accommodate either 600-ohm or 20,000-ohm telephones.

C—The overall sensitivity is better than two microvolts, over the entire frequency range, for a six milliwatt output into 20,000 ohms when carrier modulated 30% at 800 cycles, under which conditions the noise level will not exceed 1.5 milliwatts when the modulation is removed from the test carrier, it is stated.

D—The materials used throughout this equipment are formed into parts which are especially designed for maximum resistance to the deleterious effects of salt air. This equipment is tested, and must perform normally under temperatures varying from minus 30 to plus 150 degrees Fahrenheit, and humidity up to 100% while being subjected to severe vibration and shock.



A 2-KW OSCILLATOR-AMPLIFIER MULTIPACTOR. TUBES OF THIS TYPE WERE DESCRIBED BY PHILO T. FARNSWORTH AT A RECENT MEETING OF THE NEW YORK SECTION OF THE IRE.



Photo, Courtesy Rudy Arnold.

PORTABLE RADIO DIRECTION FINDER.

## "THE DETECTION OF SINGLE-SIDEBAND WAVES"

ON PAGE 7 of the February, 1936, issue of COMMUNICATION AND BROADCAST ENGINEERING, Equation (12) in Mr. Aiken's article, *The Detection of Single-Sideband Waves*, should read as follows:

$$V = [\,(C + P\cos pt + Q\cos qt + R\cos rt)^2 + (P\sin pt + Q\sin qt + R\sin rt)^2\,]^{\frac{1}{2}}$$



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# VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGonigle, Secretary. 112 Willoughby Avenue, Brooklyn, N. Y.

## BOSTON

UNDER THE very capable leadership of Charles C. Kolster, Chairman, Guy R. Entwistle, Vice-Chairman, Harry Chetham, Secretary, and Raymond F. Trop, Treasurer, the Boston Chapter of the Veteran Wireless Operators Association is forging ahead to new heights, stimulated by two very successful Dinner Cruises, the latter of which was held simultaneously with the Eleventh Annual of the New York group on February 11, 1936, a comprehensive report of which follows:

Harry Chetham, Secretary of the Boston chapter very kindly wrote and sent us a second report on the Second Annual Cruise of the group, the first copy of which was apparently lost in the mails.

"Had sixty present at our Second Annual Banquet here. Receiver connected up for messages. We got Washington and New York fine. T. R. McElroy, World's Fastest Radio Operator and I copied the messages.

"Howard W. Thornley, Thomas E. Prior, Robert Henderson and J. Frank Sullivan, owner of the Rhode Island Radio School, all came up from Providence. M. Hisomoto, a naturalized Japanese, from Honolulu and a graduate of MIT enjoyed the affair.

"The various police departments were well represented. The Somerville Police Department by Harry Chetham, Chief Operator, and Mr. Campbell; Chief Radio Operator Arthur H. Vickerson represented the Boston Police Department; Edward F. Tierney, Chief Operator, and Operator Patro were there from the Cambridge Police Radio.

"The Federal Communications Commission was represented by Supervisor of Radio, Charles C. Kolster, Boston Chairman and Inspectors Walter Butterworth and Nathan A. Hallenstein and their Chief Clerk Bart McCarthy.

"Vice-Chairman Entwistle, Treasurer Raymond F. Trop and Harrison E. Kent represented the Massachusetts Radio and Telegraph School, and Samuel Curtis, Jr., and R. G. Webster were there from the Samuel Curtis Radio School.

"J. Smith Dodge, Chief Engineer of WNAC-WAAB, was in attendance and enjoyed the proceedings immensely. Also Robert Philbrook of the staff of WNAC.

"J. Frank Rigby, John S. Carter and J. A. Loyall of RCA Communications and Daniel J. DeCoste and Mr. Rice of Radiomarine were there, too.

"Others in attendance included: J. J. Tegins, formerly of NBC now with WPEH; from the National Guard, Lieut. Col. Davis S. Boyden and Herman L. Bruning; and some of the real oldtimers—Arthur E. Ericson, F. V. Rigler, Arthur Ridley, Elmer H. Walters, Larry S. Bennett, A. A. Stockellburg, who is in charge of the Ford Radio Plant in Somerville, Harry W. Fuller, Dr. Arthur W. Summers, Henri Jappe, Steve Crowell, R. S. Hood from WIM-Chatham, R. J. Cowie, Wallie Battison of the General Radio Company and J. A. Campbell.

"Pictures were shown by the U. S. Coast Guard. Charles Kolster's son 'The Little Chief' played the accordion and received a great hand. His rendition of 'Shipmates Forever' made a wonderful hit.

"Captain George W. Morris, U. S. Army Signal Corps represented the Army Amateur Radio System and delivered an interesting talk.

"J. Frank Sullivan made the 'Theme' speech of the evening and brought sad memories back to many of us."

In addition to the above very comprehensive report, HC also included numerous notes on the recent activities of many of the Boston members in rendering assistance by placing their radio facilities at the disposal of the Red Cross and other relief agencies during the recent floods.

We will include these notes, as well as additional newsy items which Vice-Chairman Entwistle has consented to provide, in the next issue.

## MIAMI

V. H. C. EBERLIN, Chairman of the Miami Chapter, informs us of the recent arrival of an heiress. Congratulations, VHC, and best of health and luck to you three. "Flying" Bill Ehmer, Co-Pilot with the Pan American Airways, formerly located in China, recently returned to the United States and took unto himself a bride. Good luck, Bill.

C. J. Corrigan, Miami Secretary, writes: "Am enclosing two applications with four dollars. (The applications are those of Geo. H. Rogers, who started his radio operating career in 1910 on ships of the United Wireless Company and continued with the United Fruit Company and is at present employed at the Miami station of the Tropical Radio Company, and Lester J. Bergman, who also operated with the United Wireless Company back in 1912 and until the present has been engaged in radio in the ship, shore and broadcast branches.)

"We have all been very busy during our 'season' down here but we plan to have a get-together about the middle of April. This will be our first quarterly meeting. We will probably meet at the old operators' hotel of the Tropical Company through the courtesy of G. H. Rogers, their superintendent. We will have it very informal—with a keg of beer and a Dutch lunch for the gang.

"We expect quite a gathering which should result in some more applications for membership.

"I have just been appointed R. M. C. A. representative for this district."

FB, CJC and VHC—best of success to you all with your first quarterly meeting and "beer party."

## CHICAGO

CHICAGO SECRETARY, B. R. Donges, reports: "The Chapter is coming along nicely, and we expect to eventually have a chapter here second to none. (Secretary's Note: Noble sentiments, BRD.)

"R. Dalton, whom you mentioned in the magazine, is with the National Broadcasting Company here in Chicago. (Glad to hear of RD's whereabouts.)

"Due to the press of personal business Sidney Winsberg has been obliged to resign as Treasurer of the Chicago Chapter. Mr. E. J. Necker, of the Mackay Radio and Telegraph Company, has been elected to the office of Treasurer.

"We are sadly in need of application blanks.—(Will send some right long—Secretary.)

"I will write soon again and give some interesting dope on the individual members."

With the sentiments expressed in the above letter and the many applications already sent in by Chairman Martin and Secretary Donges, it is reasonable to anticipate an early realization of the objective outlined in the first paragraph of BRD's communication.

## PERSONALS

"FOR THE FIFTY-FIFTH . . . and last . . . time . . . let it be recorded . . . that even if Charles Pannill did get that first radio license . . . nevertheless . . . and notwithstanding . . . the first United States Certificate of Skill . . . in radio operating . . . was issued a year earlier . . . to the guy whose picture appears . . . way up top in this page and column." Quoted from George Clark's column in the RCA Family Circle . . . Congratulations and best wishes to M. L. Muhleman, a veteran wireless operator, formerly Editor of this magazine, as well as RADIO ENGINEERING and SERVICE, on his new assignment as Editor-in-Chief of an up-and-coming magazine designed to appeal to all interested in radio from the novice to the most experienced—*All-Wave Radio*. An extremely interesting and comprehensive article concerning our Eleventh Annual Dinner-Cruise at the Montclair Hotel appears in the March issue of *All-Wave Radio*. We suggest you get a copy and get a glimpse of the affair. Two pictures are included, both taken at the Cruise. . . . And to Ray Rettenmeyer, formerly Associate Editor of this magazine, we extend our sincere wishes for success in his assignment as Editor of COMMUNICATION AND BROADCAST ENGINEERING. . . . Charles J. Pannill, Life Member, sailed recently for a meeting of the Comite International Radio Maritime, of which he is Executive Vice-President, in London. . . . Ben Beckerman is one of the busiest of our members rounding up new members. He doesn't just hand out application blanks—but signs them up immediately. Fine work BB. We appreciate your support. . . . Thomas B. Linklater, formerly located at Sioux Lookout, Ontario, Canada, is now with the Canadian National Telegraphs, Amos, Quebec, Canada. Hope you like the new assignment, TBL. . . . Lester H. Nafzger, Chief Engineer of WBNS in Columbus, Ohio, inquires re our Year Books. . . . There is still a lot of mail the Secretary must answer. Please be patient. And until this time next month—watch the time go by. 73-MC.



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# *Is your pulse strong and steady?*


JUST as the human pulse is dependent on proper heart action, so the carrier frequency of your transmitter is dependent on the proper functioning of its crystal.

Crystals mounted in holders made of ISOLANTITE generate frequencies of greater amplitude and precision than where other insulating materials are employed.

Actual comparison in performance between crystals mounted in holders of ISOLANTITE and of organic materials has shown more than 75% increase in transmitter output where ISOLANTITE was employed.

Avoid frequency drift and assure increased output by insisting on ISOLANTITE crystal mountings. Isolantite, Inc., 233 Broadway, New York, N. Y. Factory at Belleville, N. J.

**Isolantite**
**CERAMIC INSULATORS**



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# OVER THE TAPE . . .

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

### IRE CONVENTION

The eleventh annual convention of the Institute of Radio Engineers will be held at the Hotel Statler in Cleveland, Ohio. The convention is scheduled for May 11, 12, and 13, registration beginning on Sunday, May 10. Exceptionally interesting programs and technical sessions have been arranged.

### WESTERN ELECTRIC BULLETIN

A new bulletin recently published by the Western Electric Company illustrates and describes radio-telephone transmitting equipment No. 309A for use by police departments. The equipment covered by this comprehensive booklet is suitable for installations to serve metropolitan centers, counties or states. The 90A radio-frequency amplifier included in the description and the 630A non-directional microphone are new additions to the already extensive line of Western Electric police-radio equipment offered for sale by the Graybar Electric Co.

### CROWE BULLETIN

The Crowe Name Plate and Manufacturing Co., 1749 Grace Street, Chicago, Illinois, have available their Bulletin No. 72, "Crowe Remote Controls for Automobile Radios." The Crowe Series 600 and 250 remote controls are discussed. Also included is information relative to accessories for remote-control installations.

### "GREEN SEAL DISCS"

The Presto Recording Corporation, 139 West 19th Street, New York City, N. Y., have just issued an interesting 4-page bulletin entitled "Green Seal Discs."

The Presto "Green Seal Disc" is a heavily-coated disc on an aluminum base. The coating is of high-quality material and is suitable for instantaneous recording. The disc is coated on both sides and therefore can be recorded on both sides. The coating is soft enough to permit smooth cutting and yet hard enough for immediate playback.

Special sections in the bulletin describe the process of cutting the disc, recording at 33⅓ rpm, and the processing. Also included is information on the Presto cutting stylii and playback needles.

A complete catalog on equipment, discs, and all latest developments for recording on wax aluminum, acetate, is available.

### ALLIED RADIO CATALOG

Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois, has just issued a new 136-page "Spring and Summer Radio Catalog." The latest lines of receivers, sound equipment, test instruments, replacement parts, kits, amateur equipment, and the like, are covered. Copies may be obtained from the above company.

### JOINT IRE-URSI MEETING

A joint meeting of the American Section of the International Scientific Radio Union and the Institute of Radio Engineers will be held on May 1, 1936. There will be two sessions at the building of the National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington, D. C., beginning at 10 a.m. and 2 p.m. Papers will be limited to fifteen minutes each to allow time for discussion.

Reduced railroad rates will be available to members of the IRE and URSI from April 20 to May 2 and tickets so purchased will be good for thirty days. The certificates required for validation may be secured by application to S. S. Kirby, Technical Secretary, American Section URSI, National Bureau of Standards, Washington, D. C.

### "TRANSFORMERS"

The United Transformer Corporation, 72-78 Spring Street, New York City, N. Y., have just issued Bulletin U1100C, entitled "Transformers." This attractive 40-page publication gives complete technical information on the UTC products. Its pages are abundant with circuit diagrams, charts, curves, and the like.

### MERCURY RECTIFIERS

The United Electronics Company, 42 Spring Street, Newark, N. J., have announced a four-page pamphlet devoted to United Svea metal mercury rectifiers, and describing the technical features of the following United tube types: 966, 966A, 972 and 972A. This bulletin may be obtained on request from the above organization.

### GENERAL CABLE BULLETIN

The General Cable Corporation, 420 Lexington Avenue, New York City, N. Y., have just issued Bulletin CRE-1 entitled "Copper Conductors for Rural Lines." This publication presents the electrical and physical properties of, and sag-tension charts and line design data for, hard-drawn copper conductors of the sizes and forms suitable for rural distribution lines. Besides some 53 pages of text, this bulletin also includes some 36 full-page charts of various sorts. In nature and scope this bulletin will be found both valuable and timely.

### TURBINE-GENERATOR SETS

Direct-current turbine-generator sets of from 10 to 400 kw are described, and their operating advantages enumerated, in a new four-page folder, Bulletin GEA-2295, published by the General Electric Company, Schenectady, N. Y.

### HOME STUDY COURSE

During the past year and a half, a home study course, for radio engineers and operators, has been developed by Mr. Carl E. Smith, Ass't. Engineer, Radio Station WHK, Cleveland, Ohio.

This course consists of a number of mimeographed pamphlets, each concluding with exercises and examination for grading.

This course is said to have been enthusiastically received in Cleveland, where a class is well advanced. Interested persons should write Mr. Smith.

### COLLINS BULLETINS

The Collins Radio Company, Cedar Rapids, Iowa, have available four very interesting bulletins on broadcast and speech equipment, and amateur transmitters.

One 4-page bulletin covers the 30FXC transmitter. A great deal of technical information is given on this 200-watt unit.

Another bulletin covers the 45A, a new small-sized transmitter. This unit is quite compact and has an output of 40 watts telephone and 125 watts telegraph.

A third bulletin is entitled "Broadcast Transmitters." The Collins Radio Company has designed a new series of transmitters specifically for local and regional broadcast stations. These transmitters, which are discussed in this bulletin, are designated as the 300D (100-watt), the 300C (100/250-watt), the 20C (1000-watt) and the 20A (500-watt). Each is intended for use in connection with the 12 series speech-input equipment.

A fourth bulletin is devoted to speech equipment, and covers the 12 series. Also included in this bulletin are descriptions of amplifiers, mixing panels, power supplies, volume-level indicator panels, etc.

These bulletins are available from the Collins Radio Company.

### IDEAL COMMUTATOR DRESSER CATALOG

The Ideal Commutator Dresser Company, Sycamore, Illinois, have just made available their new catalog. This catalog and reference book has been completely revised because of improvements, additions and developments in the Ideal line. It gives up-to-date information on commutator and slip-ring maintenance. This catalog may be obtained from the above organization.

### P-A EQUIPMENT CATALOG

The new Operadio Catalog No. 10 is just off the press. This complete p-a equipment and radio-set replacement speaker catalog is available to the trade.

Copies may be had by addressing Operadio Manufacturing Company, St. Charles, Ill.



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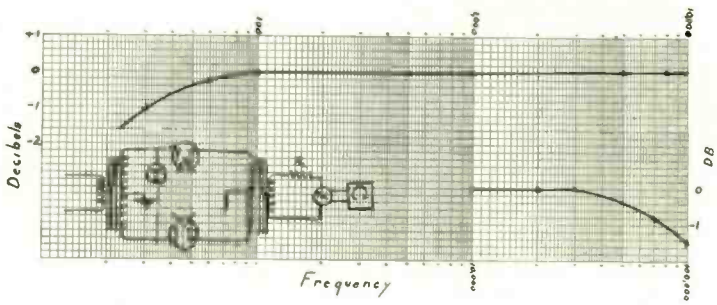
UTC

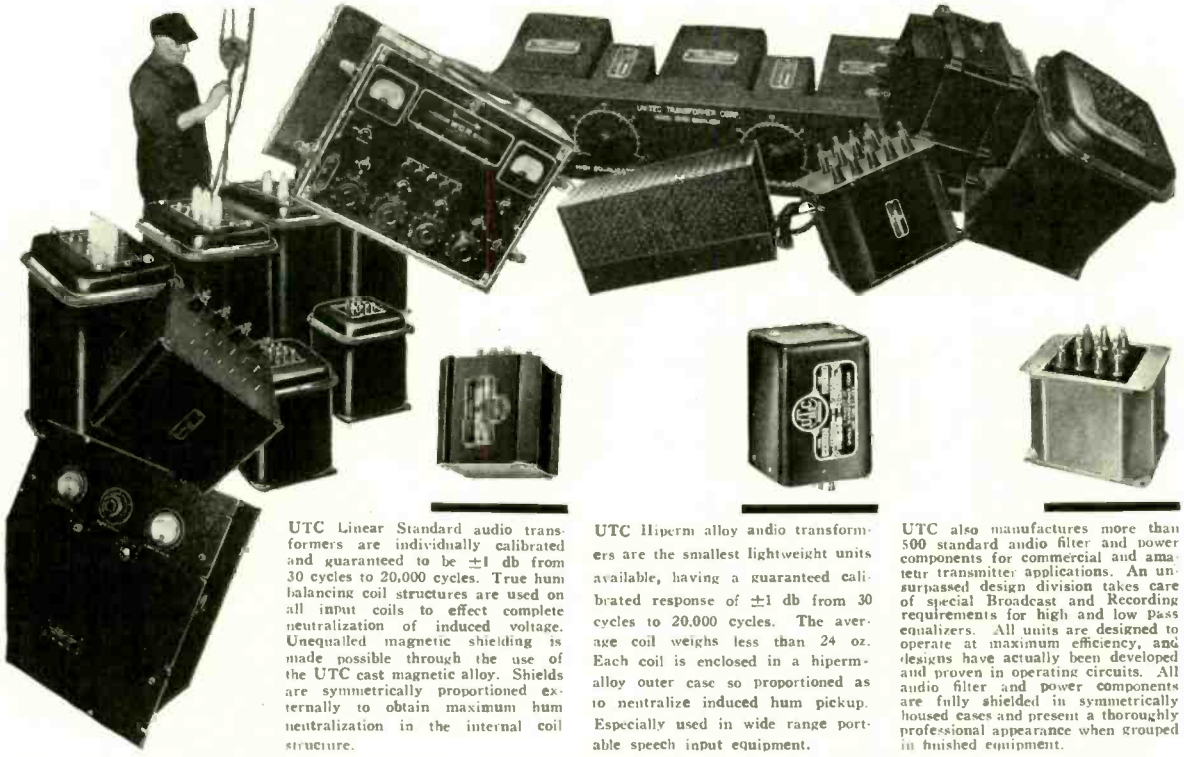
*Most Complete Transformer Line in the World*

QUALITY · RELIABILITY

# *Examine this Curve . . .*

**While all UTC Linear Standard and Hiperm Alloy transformers are conservatively GUARANTEED to have uniform frequency response within ± 1 db from 30 to 20,000 cycles, many items far exceed this rating. The curve shown, illustrates one of these better units. Detailed curves on all units are shown in our Bulletin U1100D.**



UTC Linear Standard audio transformers are individually calibrated and guaranteed to be ±1 db from 30 cycles to 20,000 cycles. True hum balancing coil structures are used on all input coils to effect complete neutralization of induced voltage. Unequalled magnetic shielding is made possible through the use of the UTC cast magnetic alloy. Shields are symmetrically proportioned externally to obtain maximum hum neutralization in the internal coil structure.

UTC Hiperm alloy audio transformers are the smallest lightweight units available, having a guaranteed calibrated response of ±1 db from 30 cycles to 20,000 cycles. The average coil weighs less than 24 oz. Each coil is enclosed in a hiperm-alloy outer case so proportioned as to neutralize induced hum pickup. Especially used in wide range portable speech input equipment.

UTC also manufactures more than 500 standard audio filter and power components for commercial and amateur transmitter applications. An unsurpassed design division takes care of special Broadcast and Recording requirements for high and low pass equalizers. All units are designed to operate at maximum efficiency, and designs have actually been developed and proven in operating circuits. All audio filter and power components are fully shielded in symmetrically housed cases and present a thoroughly professional appearance when grouped in finished equipment.

**UNITED TRANSFORMER CORP.**

72 SPRING STREET NEW YORK, N. Y.

EXPORT DIVISION – 15 LAIGHT STREET, NEW YORK, N. Y.



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# THE MARKET PLACE

## NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

### CONTROLLED RECTIFIER

The Ward Leonard Electric Co., Mount Vernon, New York, have announced a con-

trolled rectifier for providing low-voltage d-c from an a-c power supply using a copper-oxide rectifier unit.

This power unit consists of a double-wave rectifier, transformer, voltage regulator, filter and associated apparatus assembled in a metal enclosure arranged for wall mounting and provided with terminal connections.

This unit has a continuous-duty capacity for any load between 0 and 4 amperes. For any given line voltage between 110 and 120, the d-c output voltage does not vary more than ±0.2 volt for any load between 0.1 and 4.0 amperes. The output voltage at any load from 0 to 0.1 ampere does not exceed 5.5 volts nor fall below 4.5 volts.

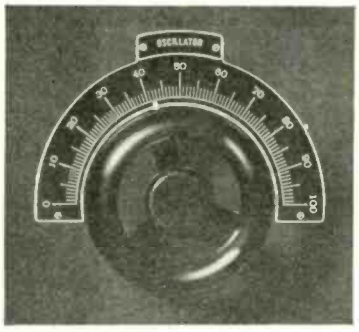
The operation of the power unit is said to be satisfactory and the temperature rise and d-c output is within the specified limits at any a-c voltage between 110 and 120 volts effective, having a frequency of from 57.5 to 62.5 cycles.

The full-load efficiency of this unit is not less than 35 percent, while the power factor is not less than 50 percent at full-load output, it is stated.

### CONTROL WHEEL TRANSMITTING DIAL

The control wheel transmitting dial shown in the accompanying illustration has been made available by the Coto-Coil Company, Inc.

The control wheel itself is molded from pure bakelite, highly polished and provided with brass insert for ¼-inch condenser shaft. (For ⅜-inch shaft, this wheel can be supplied on special order.) A conventional set screw is used for fastening the wheel to the shaft. The dial pointer is pinned to the control wheel.




The dial scale, which is 180°, 0 to 100 graduations, is made of 20 guage aluminum, finished in black, anodized with natural aluminum finished graduations and numerals. One feature of this dial scale is the provision for an indicator plate to become an integral part of the dial scale. The following are the indicator plates available: *Antenna, Buffer, Doubler, Grid, Neutralizer, Oscillator, Plate, and Tank.*

The overall diameter of the control wheel is 3-3/16 inches with an overall depth of 1½ inches. The diameter of the dial scale at its greatest width is 5¼ inches with a maximum height of 3⅜ inches. The width of the scale proper is ⅞ inch.

Further information may be obtained from the Coto-Coil Company, Inc., 2 Broadway, New York City, N. Y.

### VELOCITY MICROPHONE

The Electro-Voice velocity microphone, shown in the accompanying illustration, is

said to be new in design and construction, and to be adapted to high-fidelity sound pickup. The directional qualities, according to the manufacturer, make it ideal from an operations standpoint. Reverberation is decreased by over ⅓, it is stated.

The velocity microphone incorporates the following features: ribbon assembly suspended from frame in a shock-proof mounting; magnetic circuit combines cobalt magnets with soft iron pole-pieces; transformer mounted in aluminum housing to provide shielding; and a closely-woven screen to protect ribbon and eliminate cavity resonance. The unit is finished in baked black crystal and chromium. It is available in four models.

For further information write to The Electro-Voice Mfg. Co., Inc., 324 E. Colfax Ave., South Bend, Indiana, for Catalog 19.

### "RECORDING MICROSCOPE"

Radiotone Recording Co., 6103 Melrose Ave., Hollywood, Calif., announce a new low-priced microscope as an aid in instantaneous-recording work.

This microscope comes ready to fasten

to the bed plate of any recording machine, equipped to pivot over the turntable and swing free when desired. A lamp properly placed gives good illumination of the record grooves and a 0.006-inch comparative scale is incorporated in the lens system so that measurements may be taken of the work being done.

By use of this glass the operator will be able to discover the cause of various defects in recording such as "ghosts," high-surface noise and improperly modulated cuts.

### RECORDING HEADS

The Sound Apparatus Company's recording heads, for both wax and direct playback recording, are said to be made with a high precision of workmanship. They are oil-damped and retain their frequency response over a long period. By means of a special mounting plate they can be attached to any recording machine. The weight of each head is seven ounces and the size is ¾ inch by 1⅝ inches by 2 inches. They are usually manufactured with electrical impedances of 15 and 500 ohms, but can be furnished with other impedances upon request. They require about one watt of driving power.

The Type R12A recording head, shown in the accompanying illustration, is for direct playback discs, Duralotone included. This head is provided with a clamping screw for holding the cutting stylii in place, and any type cutting stylus will fit this unit.



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# THE
*Complete and Reliable Source of Supply of*
## CAREFULLY COORDINATED RECORDING EQUIPMENT

" . . . I'm glad I found one source of supply upon which I can centralize responsibility", says Mr.....*

** Name furnished upon request.*

**YOU,** too, can rely upon Presto . . . for whatever you need in Recording . . . Presto manufactures it. Here, the coordinated efforts of an extensive engineering department and a manufacturing division, steeped in the wealth of experience gained through years of specialized production of recording equipment, are at your service. Remember, at Presto you have a source of supply for everything in Recording and an organization on which you can place responsibility for the solution of your recording problems. Presto cheerfully assumes this responsibility.

- **INSTANTANEOUS RECORDERS:** Portable and stationary, two speeds, cutting aluminum, acetate or wax, overhead feed mechanism, motor filtered to completely eliminate vibrations.
- **RECORDING AMPLIFIERS:** 3 stages of class A amplification, each stage in "push-pull," 85 db gain, hum level –63 db below maximum output, frequency response curve flat from 30 to 12,000 cycles within plus or minus 2 db.
- **GREEN SEAL DISCS:** Chemically coated, brilliant, faithful in reproduction, low surface noise, non-inflammable, packed in air-tight metal containers assuring cutting qualities indefinitely. Can be processed in all sizes.
- **NEEDLES:** Special steel cutting needles with polished points, sapphire cutting needles, red shank playback needles, also bent needles for acoustical playback.

***Send for latest catalogs, just released.***

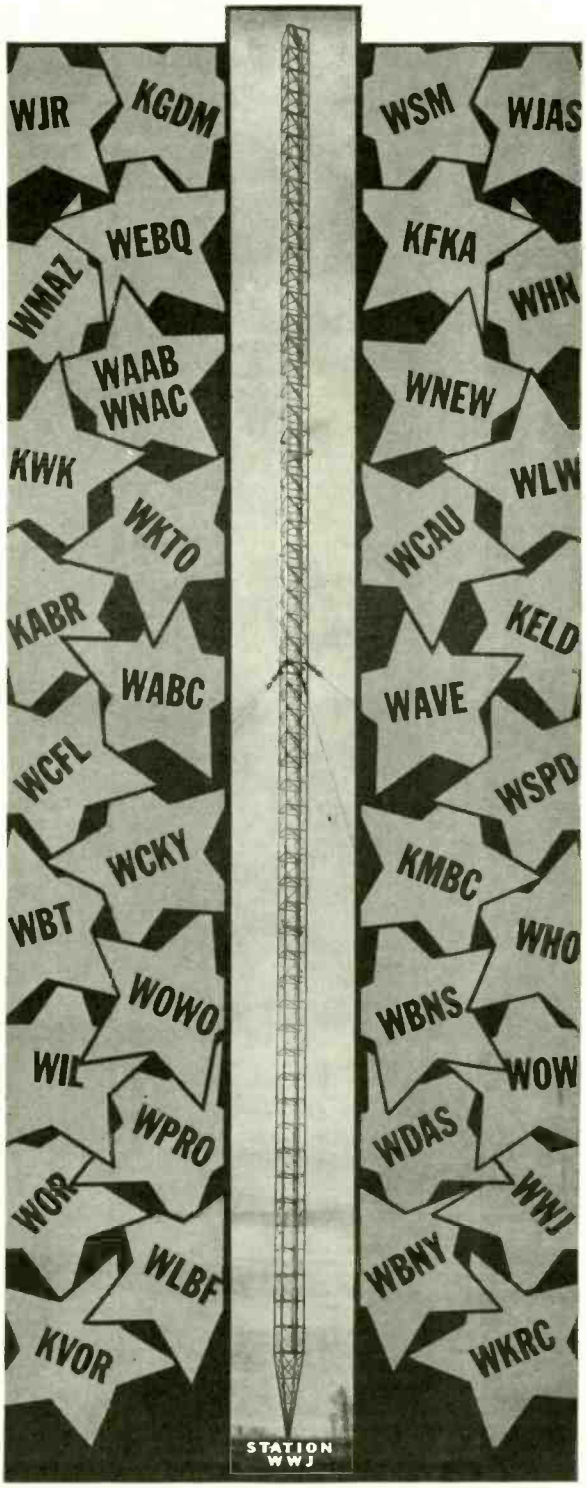
MANUFACTURERS OF EVERYTHING FOR RECORDING FROM A NEEDLE TO A COMPLETE STUDIO INSTALLATION.

EXPORT DIVISION (except Australia and Canada):
M. SIMONS & SONS CO., INC.
25 Warren St., N. Y. C. Cable: Simontrice, N. Y.

# PRESTO
RECORDING CORPORATION
139 West 19th Street, New York, N. Y.



# BLAW-KNOX VERTICAL RADIATORS
FOR MAXIMUM EFFICIENCY




# BLAW-KNOX COMPANY
2065 FARMERS BANK BUILDING, PITTSBURGH, PA.





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### "HARMONIC SUPPRESSORS"

Radio Engineering and Manufacturing Co., 26 Journal Square, Jersey City, N. J., have just announced a new series of "harmonic suppressors" in standardized mechanical form for broadcast stations of one-kilowatt power and under. These units are series filters and said to be efficient.

They are available for single and balanced feed lines of all types and made for convenient wall mounting in a totally-enclosed metal cabinet.

These "harmonic suppressors" are easily installed and adjusted; and supplied with specific instructions, they provide a correct and economical solution toward the reduction of harmonic radiation and are further said to permit a station now emitting excessive harmonics to comply fully with the new requirements of the Federal Communications Commission which go into effect in November of this year.

Complete information will be supplied upon application to the manufacturer.

### LAPEL MICROPHONE

Engineers of The Brush Development Company, Cleveland, Ohio, have introduced a lapel microphone that permits lecturers, convention and after-dinner speakers to move about on the platform, without interfering in any way with the response.

The lapel microphone, known as the BL1, is extremely small—only 1½ inches by 1¼ inches in cross section, by ⅜ inch thick. It weighs less than 1 ounce and is provided with a hooking attachment that enables it to be fastened securely to the clothing.

Special cushioning of the internal members and the use of a protecting rubber jacket on the case is said to insure quiet operation. Additional details may be secured from The Brush Development Company.

### AMATEUR RECEIVER

A deluxe amateur receiver, Type ACR-175, has recently been announced by the RCA Manufacturing Company. The Type ACR-175 includes the following features: crystal filter, magic eye, metal tubes and iron-core i-f transformers.

The electron-ray tube is used in the dual function of tuning meter and as an indicator for measuring the strength of the incoming signals. The sensitivity control is calibrated logarithmically in terms of microvolts of signal input to the receiver. The value of signal input voltage is read when a deflection on the face of the electron-ray tube just becomes noticeable.

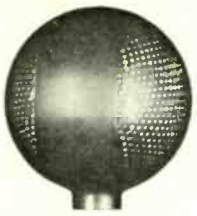
Another refinement is the calibration of the heterodyne oscillator control in cycles, thus enabling pre-determination of the desired pitch of the beat note. A switch is likewise provided to cut out the avc.

### "TRANSVERSE" VELOCITY MICROPHONE

The Eastern Sound Company, 94 Portland Street, Boston, Mass., have announced their new "Transverse" velocity microphone.

In performance this microphone is said to be capable of good reproduction over the frequency range of 20 to 14,000 cycles. A shock-proof mounting inside the case has removed the necessity for external mounting fixtures.

The standard high-impedance model operates directly into the grid of tube. Other impedances, 200-250 or 50 ohms,



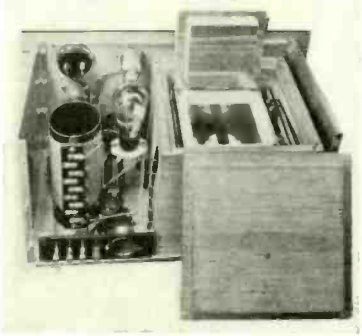
are available on order. Literature is available from the above organization.

### TEMPERATURE-CONTROLLED CRYSTAL OSCILLATOR

The Premier Crystal Laboratories, Inc., 55 Park Row, New York City, N. Y., have

announced a new crystal oscillator with temperature control.

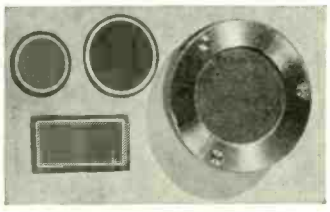
This crystal oscillator features, among other things, the following: aperiodic plate circuit, mercurial-type precision thermostat, special a-c relay for heat control, instrument-type thermostat having a range from 40° to 60° Centigrade, heavy-duty heat-control rheostat to compensate for changes in ambient temperature, 0-100 ma plate-current meter, toggle switch and pilot indicator for heater circuit, toggle switch and pilot indicator for oscillator, and pilot lamp to indicate heating cycle.



On request, the manufacturer will supply complete information.

### DRY-DISC PHOTOELECTRIC CELLS

Self-generating photoelectric cells in



a great variety of sizes and shapes are offered under the trade name "Electrocell" by Dr. F. Lowenberg, 10 East 40 Street, New York City, distributor for the United Sates. These cells are of the dry-disc barrier-layer type and consist of a selenium compound deposited on an iron disc and overlayed by a semi-transparent platinum film. Thus, the cells have the form of plain, coin-like metal discs without any fragile parts, such as glass bulbs, etc.

The main characteristic of the "Electrocell" elements consists in their sensitivity and power output, the current delivery being 480 microamperes per lumen and the maximum voltage 0.6 volt. The round sizes range from ⅜ inch to 2⅝ inches diameter, rectangular shapes being available up to 1½ x 2 inches.

The cells give continuous service under any light for any length of time, their permanent stability being assured by a special pre-aging process, it is stated. The color sensitivity extends from the visible range into the invisible part of the spectrum.

The time lag of "Electrocell" elements is said to be negligible and they are claimed to follow faithfully light fluctuating at a frequency as high as 6,000-8,000 cycles, which makes them applicable to sound recording and reproduction.

### INDICATING INSTRUMENTS

It has come to the attention of the FCC that in several cases the instruments supplied with broadcast transmitters for indicating the plate current and plate voltage of the last radio stage and the antenna current, have such scale divisions that where indications fall between divisions, it is impossible to estimate the reading within plus or minus 2%, which is the acuracy required for these instruments.

The scale divisions should be as small as practical and of such value as to permit accurate interpolation at a glance.

Attention is also invited to the requirement that the full-scale readings of the direct-current instrument shall not exceed five times and the full-scale reading of the antenna ammeter shall not exceed three times the minimum normal indications.

The function of each instrument shall be permanently and plainly marked thereon or on the panel immediately adjacent thereto.

All future equipments should be supplied with instruments in accordance with the above.

### AUDIO TRANSFORMERS

Ferranti Electric, Inc., announces a complete line of high-fidelity audio transformers and reactors to be known as "Super High-Fidelity—Series A."

Each of these units is said to have a frequency response within ± 1 db from 30 to 12,000 cycles, and is designed and manufactured to recognized Ferranti standards of quality and performance.

Each transformer is mounted in a completely reversible through-type case and is supplied complete with four 8/32 bolts and nuts. The listing is complete and includes units for nearly every need.

This series employs the new self-shielding, core-type construction. Each unit is fitted with electrostatic shields between windings and is designed for low insertion loss.

Four-page folder will be sent on request to the above organization at 130 W. 42nd St., New York City.



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# ROCKE INTERNATIONAL ELECTRIC CORP.

15 LAIGHT STREET

NEW YORK CITY - CABLE, "ARLAB"

**Export Department for leading manufacturers of communication and broadcast transmitters, receivers and components.**

ROCKE CERTIFIED — MADE IN U.S.A.

**ALLEN-BRADLEY COMPANY**
Carbon Compression Rheostats
Remote Control Relays

**AMPEREX ELECTRONIC PRODUCTS, INC.**
Complete line of Transmitting Tubes

**ATLAS RESISTOR COMPANY**
Wire Wound Heavy-Duty Resistors

**AUDIO RESEARCH, INC.**
Dynamic Microphones

**CORNELL-DUBILIER CORPORATION**
Mica, Dykanol and Electrolytic
Transmitting Condensers

**THE DAVEN COMPANY**
Precision Resistors
Attenuators, Volume Indicators

**THE ELECTRO-VOICE MFG. CO., INC.**
Carbon and Velocity Microphones
Stands and Fittings

**THE HAMMARLUND MFG. CO., INC.**
"Pro" and "Super-Pro" Professional Receivers
Variable Condensers, Chokes, etc.

**HICKOK ELECTRICAL INSTRUMENT CO.**
Indicating Meters, Oscillographs and Testers

**MARINE RADIO COMPANY**
Complete Transmitters 20 Watts to 10 KW

**PREMIER CRYSTAL LABORATORIES, INC.**
Precision Crystals, Holders, and Ovens

**RADIO RESEARCH COMPANY**
CW Portable Transmitters

**RADIO TRANSCEIVER LABORATORIES**
Ultra H-F Portable Duplex Phone and CW Transmitter-Receivers

**UNITED TRANSFORMER CORPORATION**
Full Line of High Quality Transformers and Transmitter Kits, Chokes and Reactors



# Audio Circuit Analysis

## with these low priced CLOUGH-BRENGLE INSTRUMENTS

### Cathode-Ray Oscillograph

MODEL CRA Oscillograph is an improved design featuring higher input sensitivity (.38 rms volts per inch of deflection on both vertical and horizontal plates). Built-in linear sweep and synchronizing circuits. All controls on front panel. Dual voltage rectifier circuit assures freedom from interlock of circuit controls. Removable calibration plate on tube screen. Portable type, MODEL CRA, net complete with all tubes .....$84.50
Rack model listed below.

### Beat-Note Audio Oscillators

MODEL 79, new compact type beat-note oscillator for frequencies up to 10,000 cps. Direct reading dial, zero-beat indicator and correction control. High output, 27 volts at 5000 ohms, (150 milliwatts). Self-contained power supply for operation from 110 volts, 60 cycle. Maximum variation of output over entire frequency range, 2 db. Low distortion content. Net price complete with all tubes $51.90
Rack model listed below.

MODEL OB, extended frequency range beat-note audio oscillator, 20 cycles to 15,000 cycles. Less than 1 db variation of output and not to exceed 2% distortion content. Hand calibrated with Cathode-ray oscillograph. Output 5 volts at 500 ohms. Matching transformers for higher and lower levels. Net price complete with tubes .....$112.50
Rack model listed below.

MODEL UD Power Level Indicator with range from minus 12 to plus 40 db. Meter scale range from minus 12 to plus 10 db. Additional range secured with constant impedance 3 db step attenuator (5,000 ohms). Supplied with correction curves for other impedances. Also curves for conversion to watts power and voltage. Net price complete .....$24.60
Rack model listed below.

### New Rack Mounting Types

All the above instruments are also available in rack mountings to fit standard 19" relay racks. Completely enclosed in shielded housings.

| | |
|---|---|
| MODEL CRA-R Cathode-Ray Oscillograph, net | $ 97.50 |
| MODEL 79-R Beat-Note Audio Oscillator | 57.50 |
| MODEL OB-R Beat-Note Audio Oscillator | 127.50 |
| MODEL UD-R Power Level Indicator | 32.10 |

### Write for complete literature

The new C-B complete catalog describing in full these and many other instruments will be sent to you upon request.

**The CLOUGH-BRENGLE CO.**

1130-P W. Austin Ave. Chicago, Ill.





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# PURCHASING DIRECTORY

*The following pages contain information which we believe will be of value to broadcast stations, recording and sound studios, and all phases of communications. The companies listed are recognized sources of supply whose products have acquired a reputation for satisfactory performance.*

*In presenting this information,* COMMUNICATION AND BROADCAST ENGINEERING *assumes no responsibility for omissions. We have attempted to give comprehensive and accurate information in a usable and complete form. If we have unintentionally omitted information, please bring it to our attention.*

## ACOUSTIC MATERIAL and TREATMENT

ARMSTRONG CORK PRODUCTS CO.
Lancaster, Pa.
Acoustical ceilings, insulation.

CELOTEX CO.
919 North Michigan Avenue, Chicago, Illinois
Acoustical material.

ELECTRICAL RESEARCH PRODUCTS, INC.
(See *Recording Equipment.*)

JOHNS-MANVILLE CO.
22 East 40th Street, New York, N. Y.
Acoustical treatment, sound and vibration isolation treatment.

NORTHWEST MAGNESITE CO.
*Thermax Division*
1912 Farmers Bank Bldg., Pittsburgh, Pa.
Acoustical corrective.

## AMPLIFIERS and P-A EQUIPMENT

THE BRUSH DEVELOPMENT CO.
(See *Microphones*, etc.)

DENCOSE INCORPORATED
(See *Recording Equipment.*)

ELECTRO-ACOUSTICS PRODUCTS CO.
Fort Wayne, Indiana
Centralized radio and public-address systems, portable p-a systems.

FEDERATED PURCHASER, INC.
25 Park Place, New York, N. Y.
Amplifiers, modulators, communication receivers and transmitters, transmitting supplies, microphones, oscillators, oscillographs.

GATES RADIO & SUPPLY CO.
Quincy, Illinois
Speech-input equipment, remote equipment, transcription equipment, microphones, power supplies and accessories, p-a systems.

MORLEN ELECTRIC COMPANY, INC.
60 West 15th Street, New York, N. Y.
Trade Name—MORLEN
Audio and public-address amplifiers, transformers, modulators.
BRANCH OFFICES—Buffalo, Louisville, San Francisco.
EXPORT OFFICE—60 West 15th Street, New York City.

RACON ELECTRIC CO., INC.
52 East 19th Street, New York, N. Y.
Horns and all types of loudspeakers, filters, public-address equipment.

RADIO ENGINEERING & MFG. CO.
(See *Transmitters.*)

RADIO RECEPTOR CO., INC.
(See *Microphones*, etc.)

RADIO TELEVISION INDUSTRIES CORP.
2 Linden Street, Reading, Mass.
Amplifiers, microphones, sound equipment.

REMLER COMPANY, LTD.
2101 Bryant Street, San Francisco, Calif.
Microphones, amplifiers, turntables, tuners, recording and speech-input equipment, attenuators, plugs, sockets, etc.

S. H. COUCH COMPANY, INC.
North Quincy, Mass.
Microphones, recording equipment, amplifiers, p-a systems.

THE TURNER COMPANY
(See *Microphones.*)

TRIMM RADIO MFG. CO.
1770 West Berteau Avenue, Chicago, Ill.
Electro-acoustic products for radio and public address.

UNITED TRANSFORMER CORP.
(See *Transmitters.*)

WESTERN ELECTRIC CO.
(See *Transmitters.*)

WHOLESALE RADIO SERVICE CO., INC.
100 Sixth Avenue, New York, N. Y.
Public-address equipment, tubes, parts, accessories.

## ANTENNAS

AMERICAN BRIDGE CO.
Frick Building, Pittsburgh, Pa.
Radio Towers.

BLAW-KNOX COMPANY
Pittsburgh, Pennsylvania
Radio towers.
BRANCH OFFICES—New York City, Chicago, Birmingham, Philadelphia.
EXPORT OFFICE—Pittsburgh.

HOKE VERTICAL RADIATORS
Petersburg, Virginia
Fabrication and erection of vertical radiators.

INTERNATIONAL STACEY CORP.
875 Michigan Avenue, Columbus, Ohio
Radio towers, vertical radiators, antenna systems.

LEHIGH STRUCTURAL STEEL CO.
17 Battery Place, New York, N. Y.
Radio towers, vertical radiators.

TRUSCON STEEL COMPANY
Youngstown, Ohio
Self-supporting vertical radiators.
BRANCH OFFICES—In all principal cities.
EXPORT OFFICE—155 East 44th Street, New York City.
CANADA—Truscon Steel Co. of Canada, Ltd., Walkerville, Ont.



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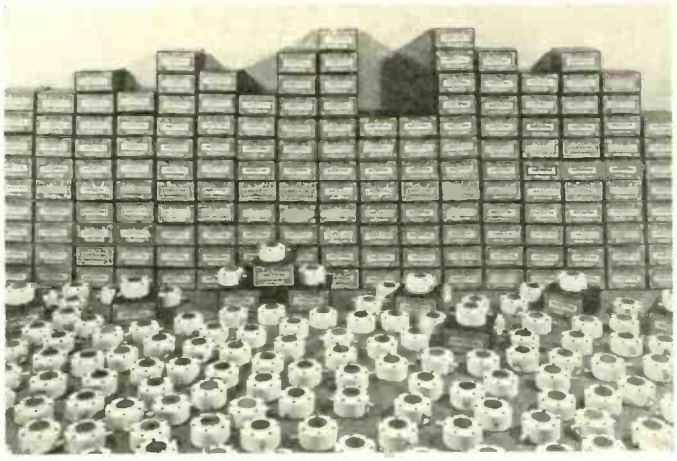

**Type 157-A Precision Air Gap Holder**

This commercial precision holder is furnished with calibrated Crystals to Broadcast Stations, Police Departments, U. S. Airways, Coast Guard, etc. The body is of glazed Isolantite. The base electrode is specially heat treated monel metal, ground and lapped to a high degree of accuracy. The top electrode, having a precision cut micrometer thread, permits extremely fine adjustment of the air gap. These Holders are usually equipped with a metal guide ring 3/32" thick and a 1¼" diameter, blanked hole to maintain crystal plates in position. The ring may be notched to accommodate crystals up to 1⅛" (28.5 m/m) square. Guide rings of varying thicknesses and sizes of blanked holes can be supplied on special order. Dimensions: Body Diameter 2¼". Height overall 1⅛". Terminals: Diameter ⅛", length ½", spaced 180° apart.

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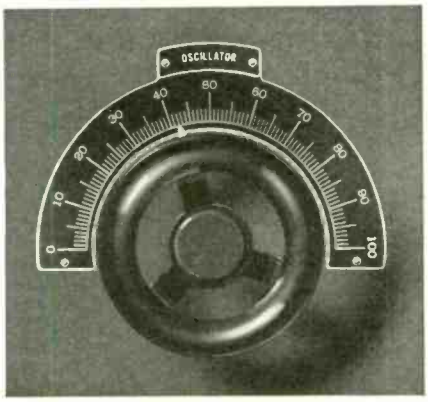


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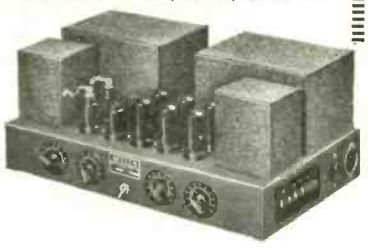
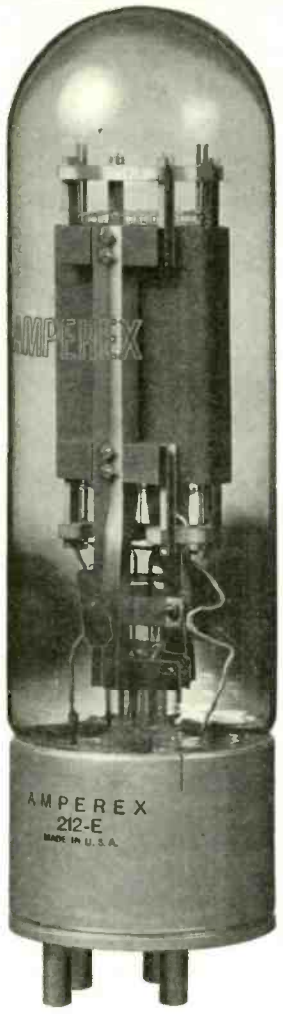


**MC38 P.A. Amplifier, 38 - 45 watts output.**

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| Filament Current, Amperes | 6 |
| *Average Characteristics with Plate Voltage of 1500 Volts and Grid Bias* | 60 |
| Amplification Factor | 16 |
| Plate Resistance, Ohms | 1900 |
| Mutual conductance, Micromhos | 8500 |
| Maximum D.C. Plate current, Milliamperes | 300 |
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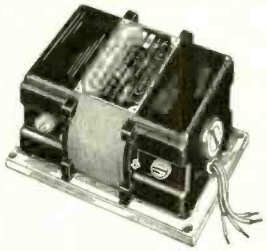

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Write for Bulletin G-8

**BLILEY ELECTRIC COMPANY**

UNION STATION BUILDING ERIE, PA.





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### UNITED ELECTRONICS COMPANY
(See *Transmitting Tubes.*)

### UNITED TRANSFORMER CORP.
(See *Transformers.*)

### WARD-LEONARD ELECTRIC CO.
37 South Street, Mount Vernon, N. Y.
Control panels, relays, rectifiers, electric control devices.
BRANCH OFFICES—In all principal cities.

### WESTERN ELECTRIC CO.
(See *Transformers.*)

### WESTINGHOUSE ELEC. & MFG. CO.
(See *Transmitters.*)

### WILLARD STORAGE BATTERY CO.
246-286 East 131st Street, Cleveland, Ohio
Storage batteries for all purposes.

## RECORDING AND TRANSCRIPTION EQUIPMENT, NEEDLES, RECORDS, STYLII, PICKUPS, ETC.

### ANSLEY RADIO CORP.
240 West 23rd Street, New York, N. Y.
Electric phonographs and radio-phonograph combinations, portable battery radios.

### ASTATIC MICROPHONE LAB., INC.
(See *Microphones.*)

### AUDAK COMPANY, INC.
500 Fifth Avenue, New York City, N. Y.
Trade Name—AUDAX
Electrical and acoustical reproducing and recording apparatus.
BRANCH OFFICES—Chicago, Dallas, Los Angeles, San Francisco, Louisville, Seattle, Tampa, Denver, Buffalo, Minneapolis, Boston, Philadelphia, Detroit, Kansas City.
EXPORT OFFICE—M. Simons & Son Co., Inc., 25 Warren St., New York.

### CELLUTONE RECORD MFG. CO.
1135 West 42nd Street, Los Angeles, Calif.
Trade Name—CELLUTONE
Record blanks, stylii cutting heads, recording microphones, needles.

### DENCOSE INCORPORATED
1650 Broadway, New York City, N. Y.
Trade Name—VIBRO-MASTER
Portable recording and reproducing units, processed alloy recording discs, public-address systems.
BRANCH OFFICES—Boston, Washington (D. C.), Chicago, New Orleans, Dallas, Portland (Ore.), Los Angeles.

### ELECTRICAL RESEARCH PRODUCTS, INC.
250 West 57th Street, New York City, N. Y.
Trade Name—ERPI
Western Electric broadcast reproducing system, including 33⅓ rpm lateral and vertical and 78 rpm turntable and associated equipment.
BRANCH OFFICES—Chicago, Los Angeles.
EXPORT OFFICE—250 West 57th Street, New York City.

### GATES RADIO & SUPPLY CO.
(See *Amplifiers.*)

### MEYER KOULISH CO., INC.
64 Fulton Street, New York, N. Y.
Saphire and diamond needles for cutting, recording and reproducing on blank aluminum, pregrooved discs, composition, acetate, etc.

### MIRROR RECORDING SUPPLY CO.
58 West 25th Street, New York, N. Y.
Aluminum discs for recording purposes.

### PHONOGRAPH NEEDLE MFG. CO.
42-46 Dudley Street, Providence, R. I.
Cutting, reproducing needles, discs.

### PRESTO RECORDING CORP.
139 West 19th Street, New York City, N. Y.
Trade Name—PRESTO
Instantaneous recording discs (coated), recording and reproducing equipment, recording and playback needles.
BRANCH OFFICES—1656 N. Serrano St., Los Angeles, R. C. Powell, 815 15th St., N.W., Washington, D. C.
EXPORT OFFICE—M. Simons & Son Co., Inc., 25 Warren St., New York City.

### B. A. PROCTOR COMPANY, INC.
17 West 60th Street, New York City, N. Y.
Pickups, sound and recording equipment.

### RADIO ENGINEERING & MFG. CO.
(See *Transmitters.*)

### RADIOTONE RECORDING CO.
6103 Melrose Avenue, Hollywood, Calif.
Instantaneous recording machines, recording amplifiers, acetate recording discs, cutting stylii.
EXPORT OFFICE—Ad. Auriema, Inc., 116 Broad Street, New York City.

### RANGERTONE, INC.
201 Verona Avenue, Newark, N. J.
Trade Name—RANGERTONE
Recording equipment, discs, "dated" records.

### RCA MANUFACTURING CO., INC.
(See *Transmitters.*)

### MIRROR RECORDING SUPPLY CO.
58 West 25th Street, New York, N. Y.
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### SOUND APPARATUS CO.
150 West 46th Street, New York City, N. Y.
Instantaneous recording equipment, "Saja" synchronous motors, "Duralotone" recording blanks, recording heads and reproducers, special recording amplifiers, etc.

### PAUL K. TRAUTWEIN
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### UNIVERSAL MICROPHONE CO.
(See *Microphones.*)

### U. S. SOUND RECORDING SUPPLY CO.
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### WEBSTER ELECTRIC CO.
Racine, Wisconsin
Phonograph pickups, transformers and chokes.

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### AEROVOX CORPORATION
(See *Condensers.*)

### ALLEN-BRADLEY COMPANY
1326 South Second Street, Milwaukee, Wis.
Control apparatus.

### AUDIO PRODUCTS CO.
4189 West 2nd Street, Los Angeles, Calif.
Mixer controls, attenuators, wire-wound resistors, relay-rack panels, relay racks, variable transmitting condensers, speech-input equipment, amplifiers, power-level indicators, etc.



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# NAME CONTEST ENDED MIDNIGHT, APR. 15th

## JUDGES NOW SELECTING WINNERS

### PHENOMENAL INTEREST SHOWN IN NEW AUDAX PICK-UP SYSTEM

**Prize Winner, Name of New Product and Details of Revolutionary Wide Range Principle to Be Announced Soon**

The large number of names suggested for the new Audax Pick-Up in response to the "best name" contest, which closed April 15th, was dwarfed by a far larger volume of inquiries about its revolutionary principle. Confidence thus indicated in the company's ability to eliminate moving mass in a pick-up is considered by Audak officials to be a gratifying recognition of Audak's long established leadership as pioneers in the electro-acoustical field.

*Have you the complete AUDAX catalog of models listing from* $9.50 *to* $390.00

*Special recording cutters made to order*

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*The standard by which others are judged and valued*

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OF NEW DESIGN—IMPROVED PERFORMANCE

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## DUPLEX RECEIVER TRANSMITTER

*Fixed or Mobile*

● Type TR-6A6 — 10 Watts Output Employing new 6E6 UNITY COUPLED P.P. oscillator, 6A6 Class B, 6A6 Class A. Phone or I.C.W. without external batteries. Four tube non-radiating receiver, 7½"x15"x8". ..... **$39.75**

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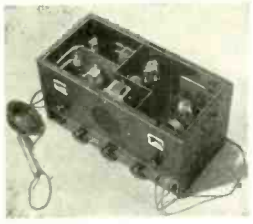

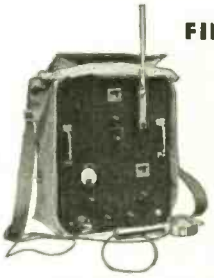

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**Transmitter and Receiver**
**Type PTR-19**

Frequency range 30-41 Mc, front panel control—special Hiperm Alloy Transformers having uniform freq. response 40 to 12000 cycles per second—Transmitter unity coupled push-pull 19 Oscillator, 19 class B Modulator, 19 class A driver and 30 class A microphone amplifier — Carrier power, 2 watts—peak, 8 watts—receiver; one 30 tube in super-regenerative circuit—ample battery provision, carrying case, etc. Weighs only 35 lbs. with batteries and all accessories.

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Export Division: 15 Laight St., New York, N. Y., U. S. A.

This Complete Family of **CRYSTAL MICROPHONES**

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BRANCH OFFICES—Representatives in all principal cities.

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(See *Transmitters.*)

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401 North Broad Street, Philadelphia, Pa.

Resistors.

### THE JEFFERSON ELECTRIC CO.

(See *Transformers.*)

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4238 Lincoln Avenue, Chicago, Ill.
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High-voltage transmitting fuses, aircraft fuses, radio fuses and mountings.
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EXPORT OFFICE—Ad. Auriema, Inc., 116 Broad St., New York City.

### MORRILL AND MORRILL

30 Church Street, New York, N. Y.

Fixed condensers, resistors.

### PRECISION RESISTOR CO.

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Resistors and rheostats.

### REMLER CO., LTD.

(See *Amplifiers.*)

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131 North Juniper Street, Philadelphia, Pa.

Relays, thermostats, timing devices, electrically-heated ladles and pots.

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703 Newark Avenue, Jersey City, N. J.
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Attenuators, volume controls, volume indicators, line equalizers, decade resistance boxes, decade condensers, precision resistors, microvolters, laboratory equipment, tap switches, r-f switches.
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EXPORT OFFICE—15 East 26th Street, New York City.

## WARD-LEONARD ELECTRIC CO.

(See *Power Supplies.*)

### WESTON ELEC. INST. CORP.

(See *Meters.*)

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Condensers, magnet wire, varnished insulation.

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500 South Throop Street. Chicago, Ill.

Bakelite and Steatite sockets, plugs, connectors, sound equipment.

## CENTRALAB

(See *Resistors.*)

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St. Charles, Illinois

Vacuum power switches, photocells.

## E. F. JOHNSON CO.

Waseca, Minn.

EXPORT OFFICE—M. Simons & Son Co., 25 Warren St., New York.
Insulators, sockets, plugs and jacks, inductors, condensers, etc.

### THE GAMEWELL COMPANY

1238 Chestnut Street, Upper Newton Falls, Mass.

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Cord sets for all electrical appliances, flexible insulated wire, rubber connecting plugs.

## HAMMARLUND MFG. CO., INC.

(See *Condensers.*)

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(See *Resistors.*)

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Transformers, chokes, equalizers, castings.

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1440 Hamilton Avenue. Cleveland, Ohio

Power and audio transformers and chokes.

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175 Emmet Street, Newark. N. J.
Trade Name—AMERTRAN

Transformers, rectifiers, reactors.
EXPORT OFFICE—Ad Auriema, Inc., 116 Broad St., New York, N. Y.

## COTO-COIL CO.

229 Chapman Street, Providence, R. I.
Trade Name—COTO

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EXPORT OFFICE—2 Broadway, New York City.

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### JEFFERSON ELECTRIC CO.

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General-purpose and specialty transformers, fuses, switches.

### KENYON TRANSFORMER CO., INC.

840 Barry Street, New York, N. Y.

Transformers, reactors, equalizers.

## MORLEN ELECTRIC CO., INC.

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**AN EFFICIENT, PORTABLE, INSTANTANEOUS RECORDING and PLAYBACK UNIT**

Complete with stand microphone. Recording on both acetate and aluminum. For artists, public speakers, voice and music teachers and commercial purposes.

**$395 COMPLETE**

DENCOSE INCORPORATED

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**"If it pertains to sound — SEE DENCOSE"**

# Oil-Filled!

In round and rectangular cans. ● High tension pillar insulators. ● Hermetically sealed. Seepage-proof joints and terminals. ● Conservatively rated. Honestly labelled. ● And NEW Low Prices!

AEROVOX transmitting condensers are oil-filled and so labelled. ● That means an oil-impregnated section in hermetically-sealed can filled with oil. ● Result: Constant, cool, safe operation over longest service life. ● Write for Catalog and sample of "Research Worker."

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## VELOCITY and CARBON MICROPHONES

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Universal's latest achievement—Ideal for stage use—Not affected by temperature or humidity—Flat frequency response curve from 40 to 10,000 c.p.s.; Output —63 db; Low impedance or direct to grid types. Compact, 2¾ x 4¾ in. by 1½ in. thick—Weight, less than 18 oz.—Head swings to any desired angle—Beautifully finished in black enamel and artistic chrome plate—Ask for new catalog sheet describing Models RL, RP, RH and CB—List $22.50—Latest model music type sectional stand for above microphones—List $10.00.

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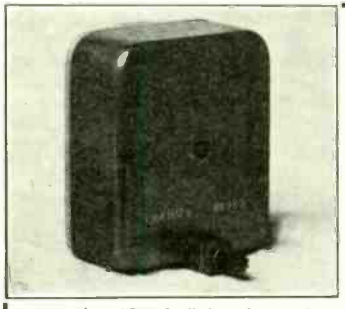
EXPORT OFFICE { Rocke International Elec. Corp. 15 Laight Street, New York City



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$75 LESS MOTOR DRIVE

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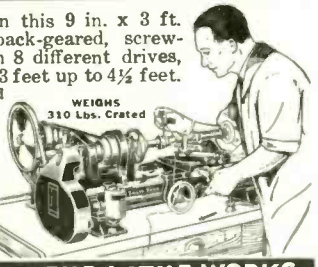
Easy Payment Terms arranged over extended period of time. Full details on request.

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Iron-core and gaseous-tube transformers.

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EXPORT OFFICE—Rocke International Electric Corp., 15 Laight Street, New York City.

WEBSTER ELECTRIC CO.
(See *Recording Equipment.*)

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Cedar Rapids, Iowa
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Complete line of broadcast equipment (including transmitters), marine and aircraft transmitters, amateur and commercial transmitting apparatus.
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EXPORT OFFICE—Cedar Rapids, Iowa.

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158 Summit Street, Newark, N. J.
Potentiometers, switches, rheostats, attenuators, faders, volume indicators, output meters, mixer panels, line equalizers, multipliers, speech-input control apparatus, resistances.

GATES RADIO & SUPPLY CO.
(See *Amplifiers.*)

### FEDERAL TELEGRAPH CO.
(*See Transmitting Tubes.*)

### GENERAL RADIO COMPANY
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EXPORT OFFICES—London, Santiago, Rio de Janeiro, Buenos Aires. Montreal, Shanghai.

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Water stills.

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Transmitters, speech-input equipment, microphones, tubes, frequency monitors, amplifiers, rectifiers, meters, resistances, transformers, motor-generators and associated apparatus, police-radio and aviation equipment.
BRANCH OFFICES—In all principal cities. Distributed by Graybar Electric Company, Inc.

### WESTINGHOUSE ELEC. & MFG. CO.
Chicopee Falls, Mass.
Trade Name—WESTINGHOUSE
Police-radio and aircraft receiving and transmitting equipment, high-voltage rectifiers and condensers (oil, air, nitrogen), transmitting inductances, electronic tubes (Bloomfield, N. J.), tower lighting and protective equipment, motor-generators, transformers and reactors, voltage regulators, instruments and meters, frequency monitoring, general consulting engineering service.
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EXPORT OFFICE—International Company, New York City.

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Transmitter and frequency-control equipment, cathode-ray oscilloscopes, concentric-cable transmission lines, frequency-measuring service.

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Antenna spreaders and radio-frequency feedline separators.

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79 Washington Street, Brooklyn, N. Y.
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Transmitting and industrial tubes.
BRANCH OFFICE—Los Angeles, Calif.
EXPORT OFFICE—Rocke Intl. Electrical Corp., 15 Laight St., New York, N. Y.

EITEL-McCULLOUGH, INC.
San Bruno, California.
Transmitting tubes.

### FEDERAL TELEGRAPH COMPANY
200 Mt. Pleasant Street, Newark, N. J.
Transmitting tubes, mercury-vapor rectifier tubes, power rectifiers, transmitters (export), direction finders.
EXPORT OFFICE—Int'l. Standard Elec. Corp., 67 Broad St., New York City.

HEINTZ AND KAUFMAN, LTD.
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Transmitting tubes, communication transmitting and receiving equipment, portable power supplies, aircraft electrical accessories.

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Transmitting tube reconditioning service.

### RCA MANUFACTURING CO., INC.
(See *Transmitters.*)

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Trade Name—UNITED
Transmitting tubes, mercury rectifiers, industrial control and power tubes.

### WESTERN ELECTRIC CO.
(See *Transmitters.*)

### WESTINGHOUSE ELEC. & MFG. CO.
(See *Transmitters.*)



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**THE "MIRROR" COATED DISC**
IMPROVED MATERIALS and REDUCED PRICES
SEND FOR COMPLETE PRICE LIST
**MIRROR RECORDING SUPPLY CO.**
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**ELECTRONIC MECHANICS, Inc.**
**COMPONENT PARTS**
MADE FROM THE FINEST COMMERCIAL INSULATOR
**—[L. D. S. MYCALEX]—**
Sockets, coil forms, standoff insulators, transmission line spacers, tube bases, etc. Mycalex fabricating service at your disposal. Write for quotation on your requirements.
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**PIEZO-ELECTRIC CRYSTALS**
GUARANTEED Accurate to BETTER than .01%
**SCIENTIFIC RADIO SERVICE**
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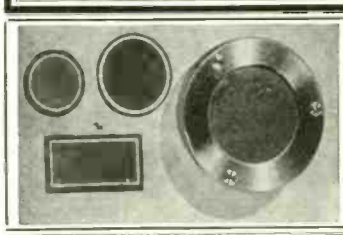
**Cellutone Record Mfg. Company**
*Manufacturers of*
7 sizes of Acetate blanks and 8 specifications of Stylii Microscopes. Shipments the world over delivered in perfect recording condition.
*Write for information and prices.*
1135 W. 42nd St. LOS ANGELES, CAL.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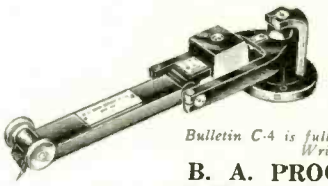
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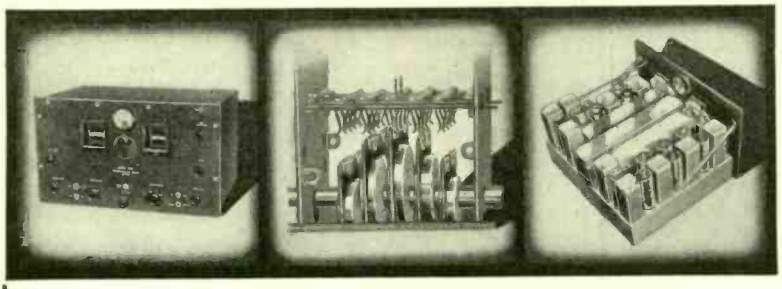
# Hammarlund "Super-Pro"



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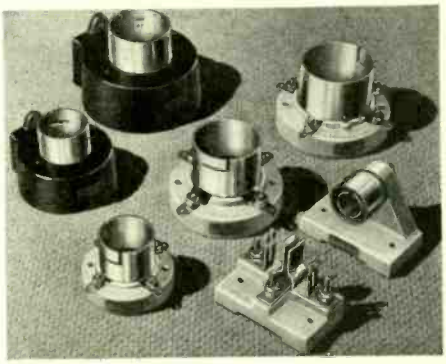

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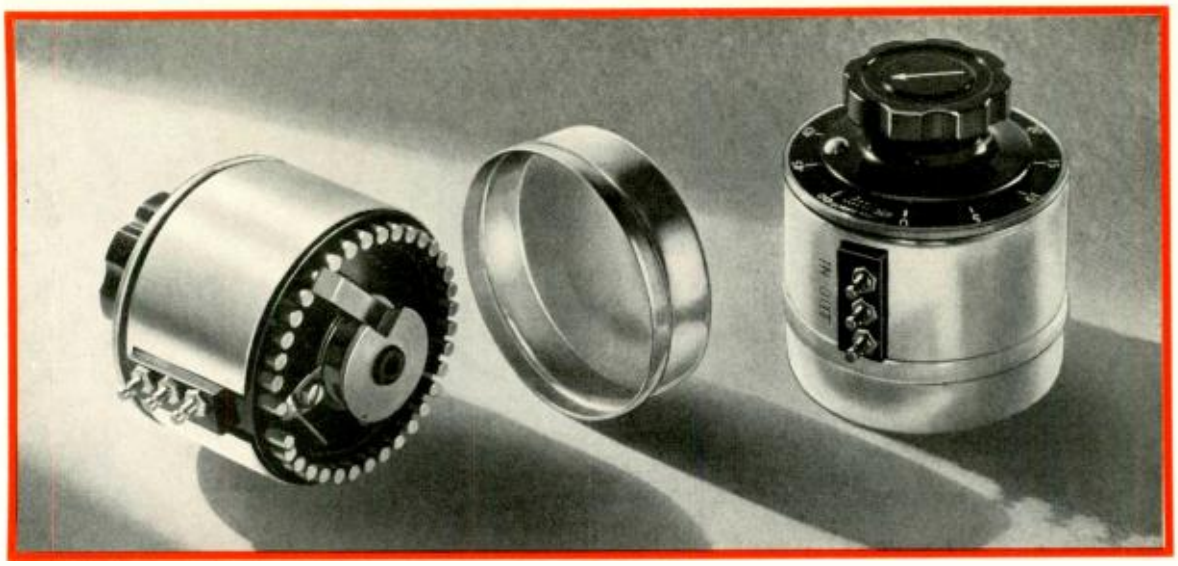

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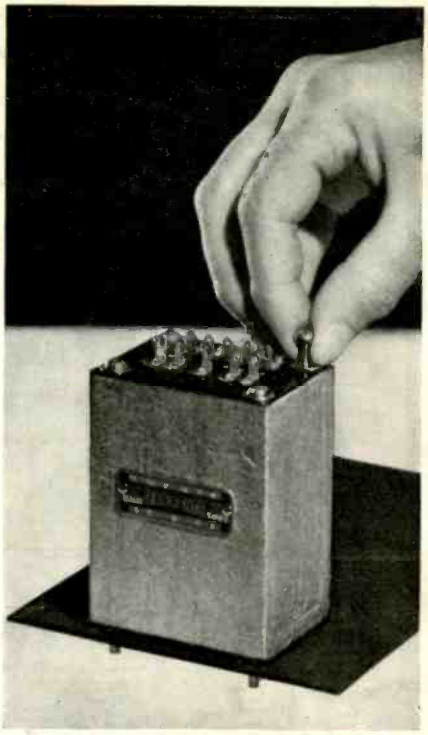

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