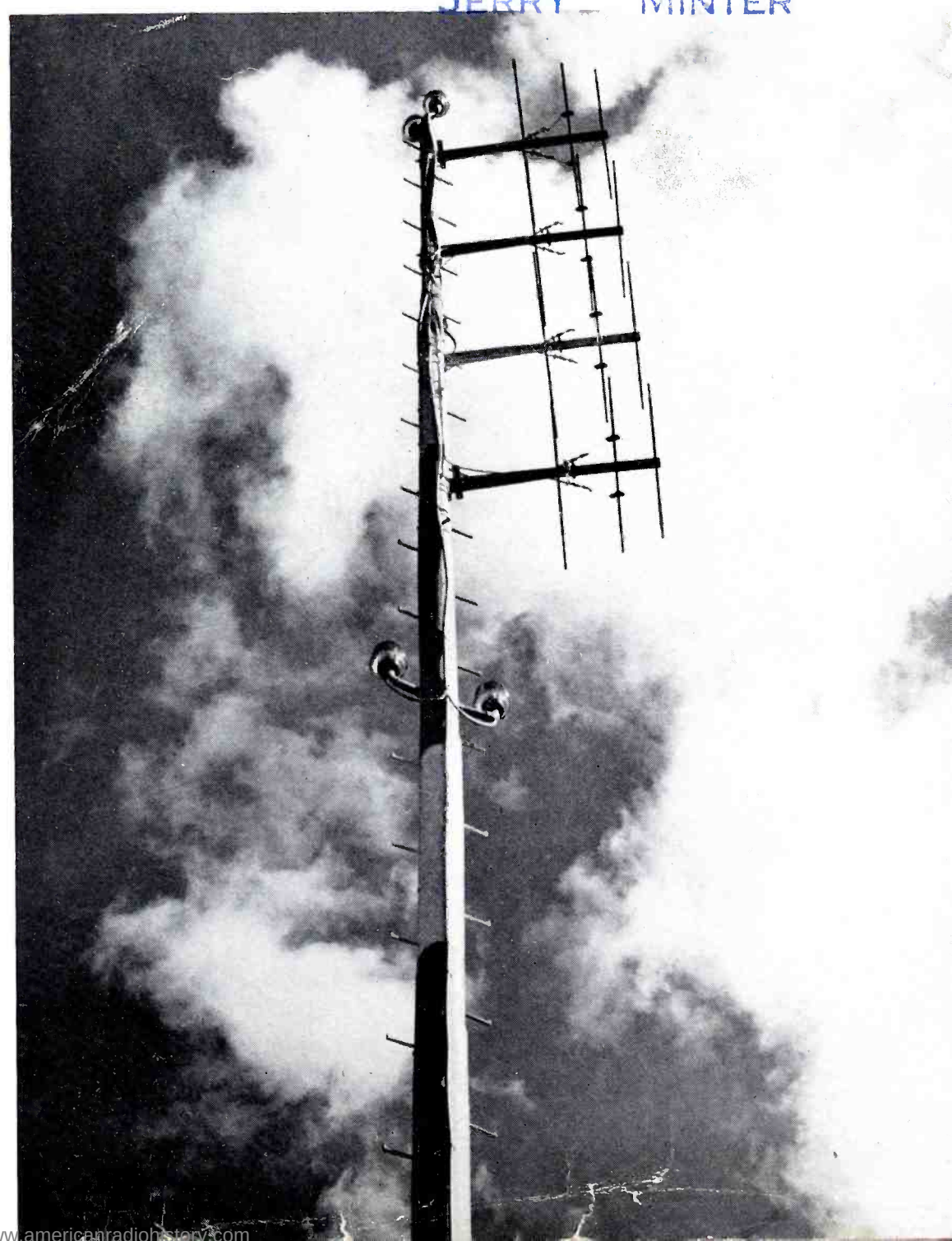
COMMUNICATIONS

including

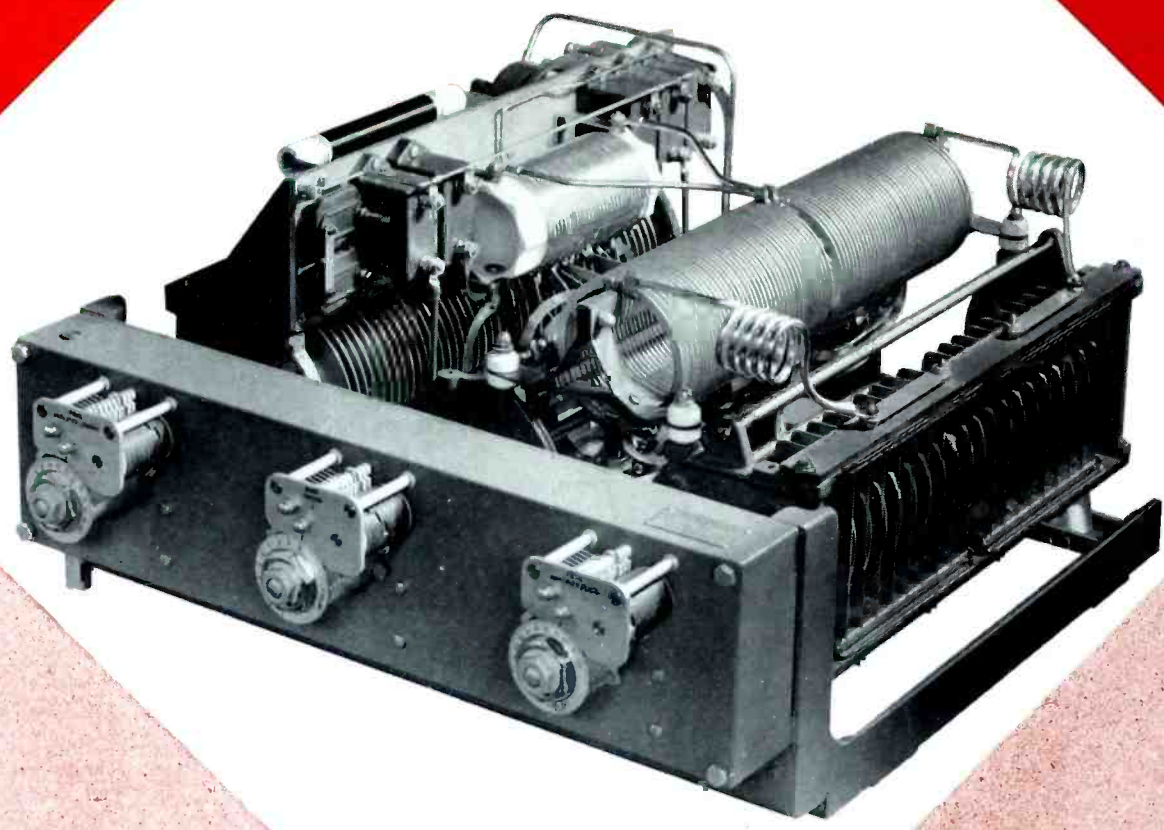
TELEVISION ENGINEERING

APRIL

1940



Collins 231C Autotune Transmitter



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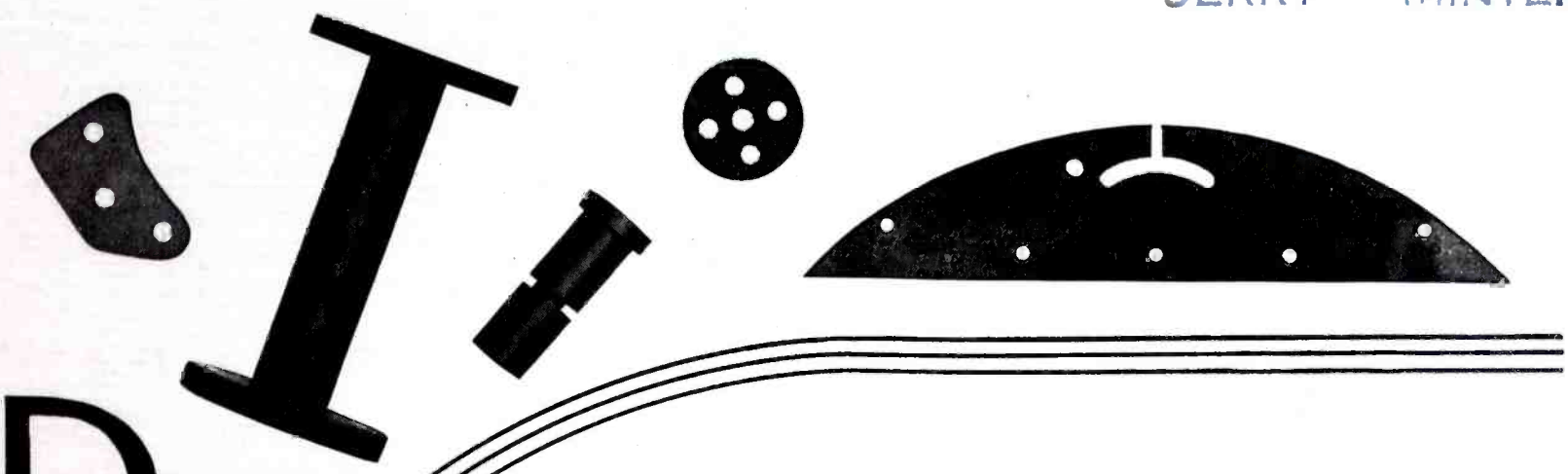

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VOLUME 20
NUMBER 4

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

The directional antenna for the 132-megacycle frequency-modulated relay station WEOD atop the Yankee Network studios in Boston, Mass. This station is used for sending programs to WIXOJ, Paxton, Mass.—an airline distance of approximately 45 miles. See article on page 11.

• Editorial Comment •

THE Spring Convention of the Society of Motion Picture Engineers is being held from April 22 to 25 at Haddon Hall, Atlantic City, N. J. In addition to a very interesting program featuring many technical papers dealing with the motion picture art, some five television articles have been scheduled.

And while on the subject of conventions, it should be noted that the Institute of Radio Engineers are holding their annual gathering at the Hotel Statler, Boston, Mass., on June 27, 28 and 29. Although no details are available at this time, an unusually good program is promised. Further data will, of course, appear in a later issue of COMMUNICATIONS.

It should also be noted that the convention of the National Association of Broadcasters is being held in San Francisco, California, August 4-7. Arrangements have been made to hold this meeting at the St. Francis Hotel. Details are not available at this time.

MUCH attention is being given to the action of the Federal Communications Commission regarding television.

Following extensive hearings and tours of television laboratories earlier this year, the Commission decided not to set standards but to permit limited commercial sponsorship of television programs beginning September 1. Hence their more recent decision to suspend the above ruling and to hold further hearings came as a distinct surprise. The reason for this action by the FCC was apparently based upon certain promotional activity in connection with the sale of television receivers which did not meet with the Commission's approval.

After having received such a setback, it is needless to say that the entire radio industry is much concerned over the action of the Commission. On the whole, the trade and press seem to feel that the FCC has exceeded its authority in this matter. Further developments will be watched with interest.

BRYAN S. DAVIS, President
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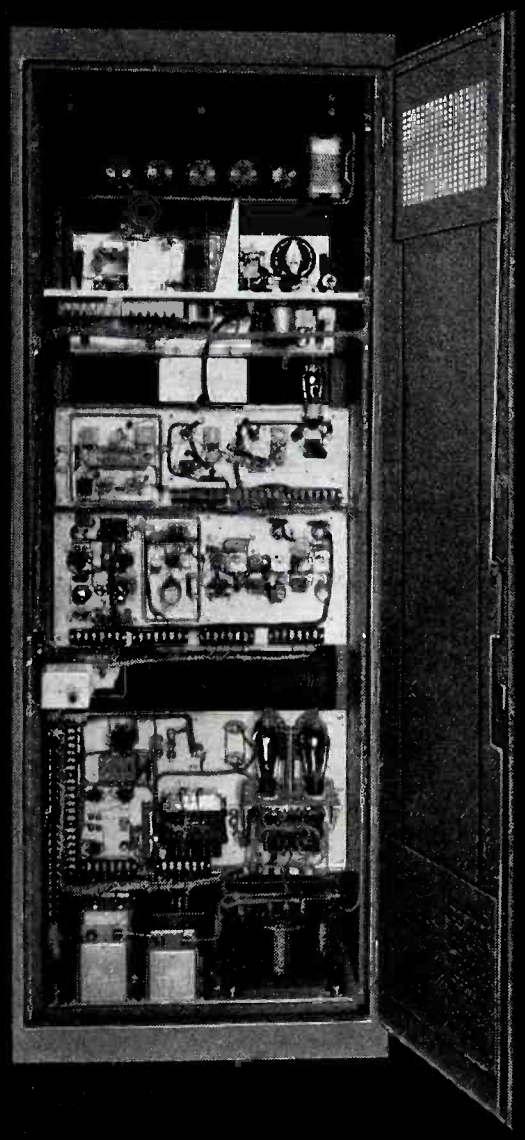

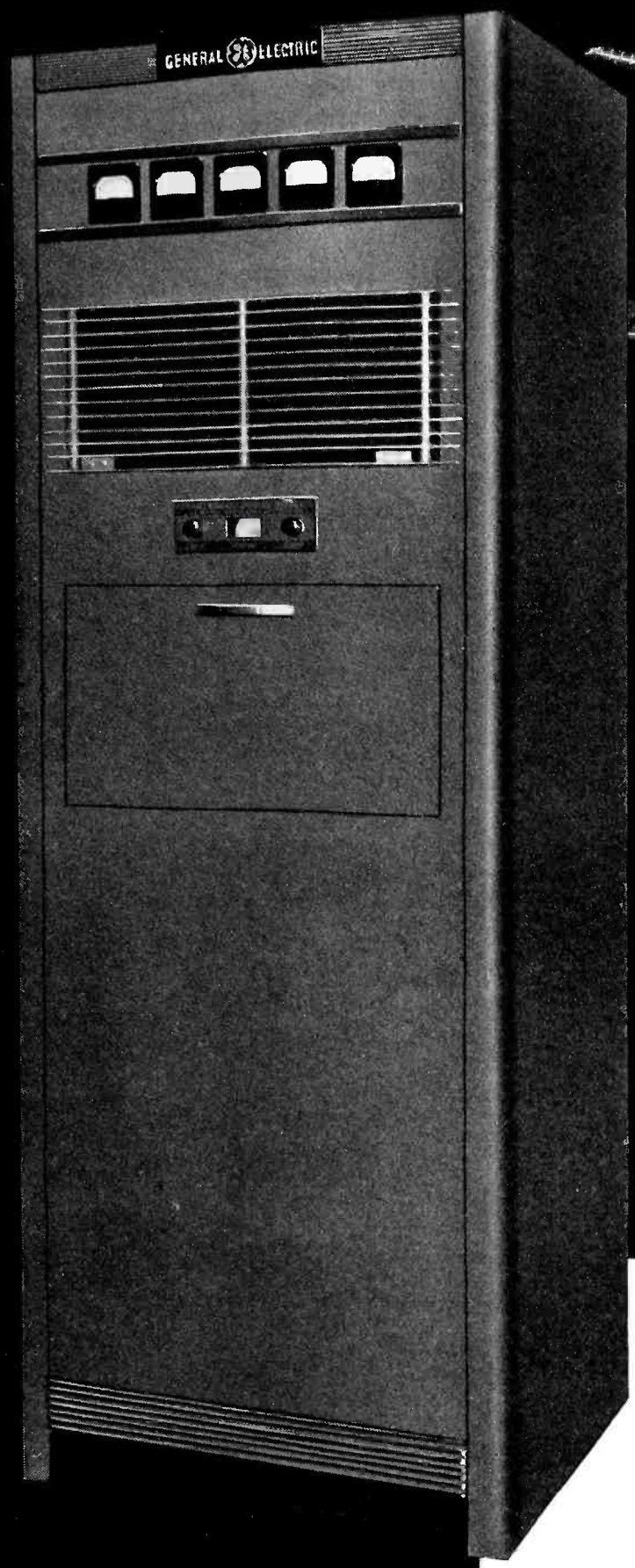

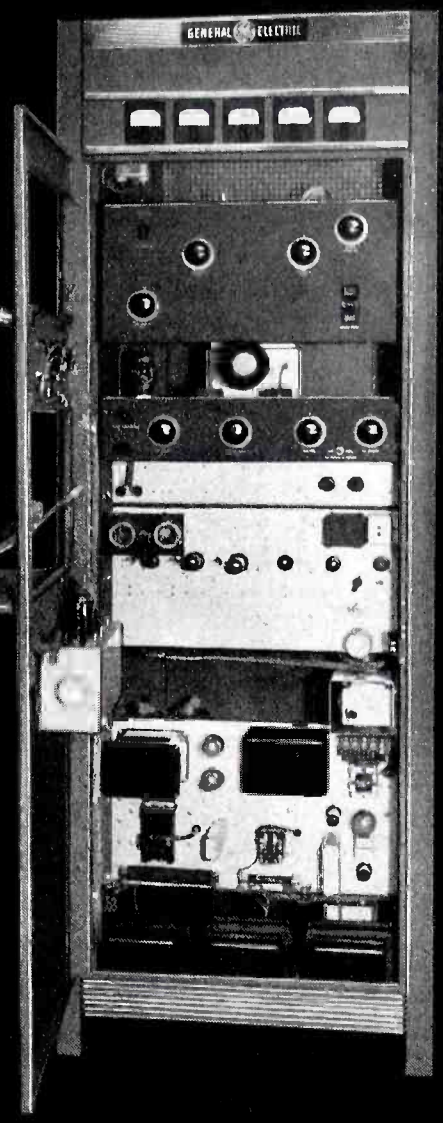

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GENERAL ELECTRIC

160-1

GROUND WAVE PROPAGATION CHARACTERISTICS

A graphical method of determining the field intensity as a function of ground conductivity, ground inductivity, radial distance, operating frequency, and operating power or unattenuated field intensity at one mile.

By CARL E. SMITH*
Assistant Chief Engineer
The United Broadcasting Company

THE most important type of ground wave is a vertically polarized wave such as radiated from a vertical antenna over a perfect conducting earth. In vertically polarized waves the electrostatic lines of force are normal to the surface of the perfect conducting earth, hence are not absorbed or reflected. Such a wave has associated with it a charge density which travels along in the surface of the earth and a magnetic field which travels along above and parallel to the surface of the earth. In this case, the surface is the guiding conductor just as the case of propagating energy along a transmission line of metal conductors, with this exception—that the surface of the earth is continuously increasing and the vertically polarized field must diminish in magnitude inversely with distance from the transmitting antenna.

For the practical case of an imperfect earth, the wave front (electrostatic field) has a slight forward tilt which results in a downward component of energy to supply earth losses. The same thing happens to the wave front along a transmission line to supply the conductor losses. Since the earth losses are such an important factor in determining the field intensity at a distance, it is paramount that they be given adequate consideration.

The field intensity can be determined from the well known equation:

$$E = \frac{K\sqrt{P}\,A}{d} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where E = millivolts per meter field intensity.
K = antenna constant which is the unattenuated field in millivolts per meter at one mile when the power input is one watt.
= 5.9 for a vertical doublet close to the surface of the earth.
= 6.17 for a vertical quarter-wave antenna with its base at the surface of the earth.

P = power input to the antenna in watts.

$K\sqrt{P}$ = the unattenuated field intensity at one mile in millivolts per meter.

A = Sommerfeld Attenuation Factor which takes into account earth losses.

d = radial horizontal distance from the transmitter in miles.

If the power is expressed in kilowatts, then the antena constant K = 186.4 millvolts per meter, the unattenuated field at one mile for one kilowatt input for a vertical doublet or stub antenna near the surface of the earth. For a vertical quarter-wave antenna this constant is K = 195 millivolts per meter per kilowatt input at one mile.

The Sommerfeld Attenuation Factor is a complicated function of the conductivity, dielectric constant, frequency, and distance from the transmitting antenna. With certain simplifying approximations and modifying assumptions A can be expressed graphically in terms of the numerical distance p for various values of the phase constant b. Such a set of curves appears in Fig. 3.

A fair analytical approximation given by Van der Pol with a correction factor given by Norton is:

$$A \cong \frac{2 + 0.3\,p}{2 + p + 0.6\,p^2} - \sin b \sqrt{\frac{p}{2}}\; e^{-5p/8} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

*President, Smith Practical Radio Institute.

SAMPLE COMPUTATION: $f_{mc} = 1 \rightarrow \sigma = 10^{-13} \rightarrow X = 180 \rightarrow \epsilon = 15 \rightarrow b = 5.1°$

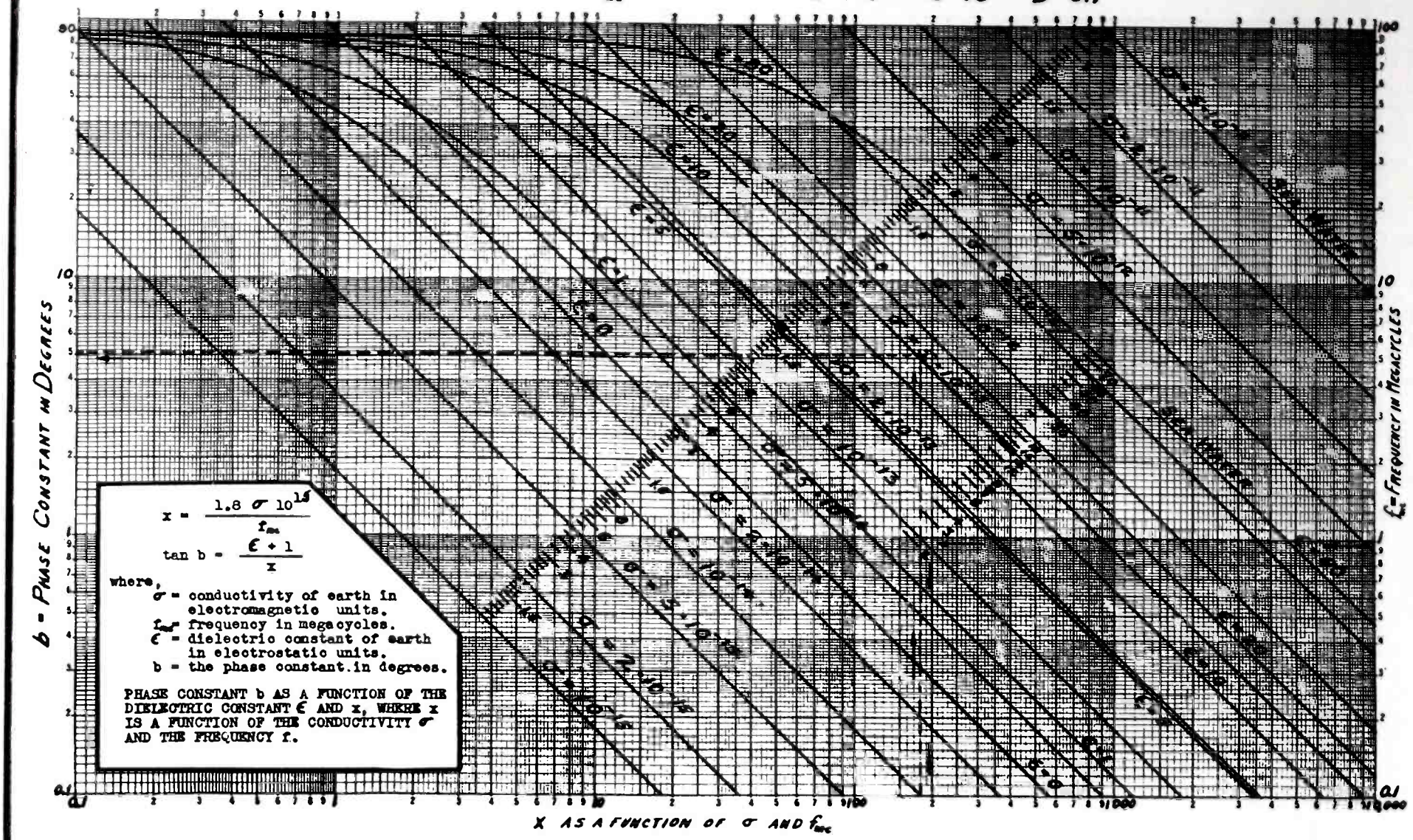


Fig. 1

SAMPLE COMPUTATION: $f_{mc} = 1 \rightarrow \sigma = 10^{-13} \rightarrow y = 3.26 \rightarrow z = 0.98 \leftarrow d = 10$

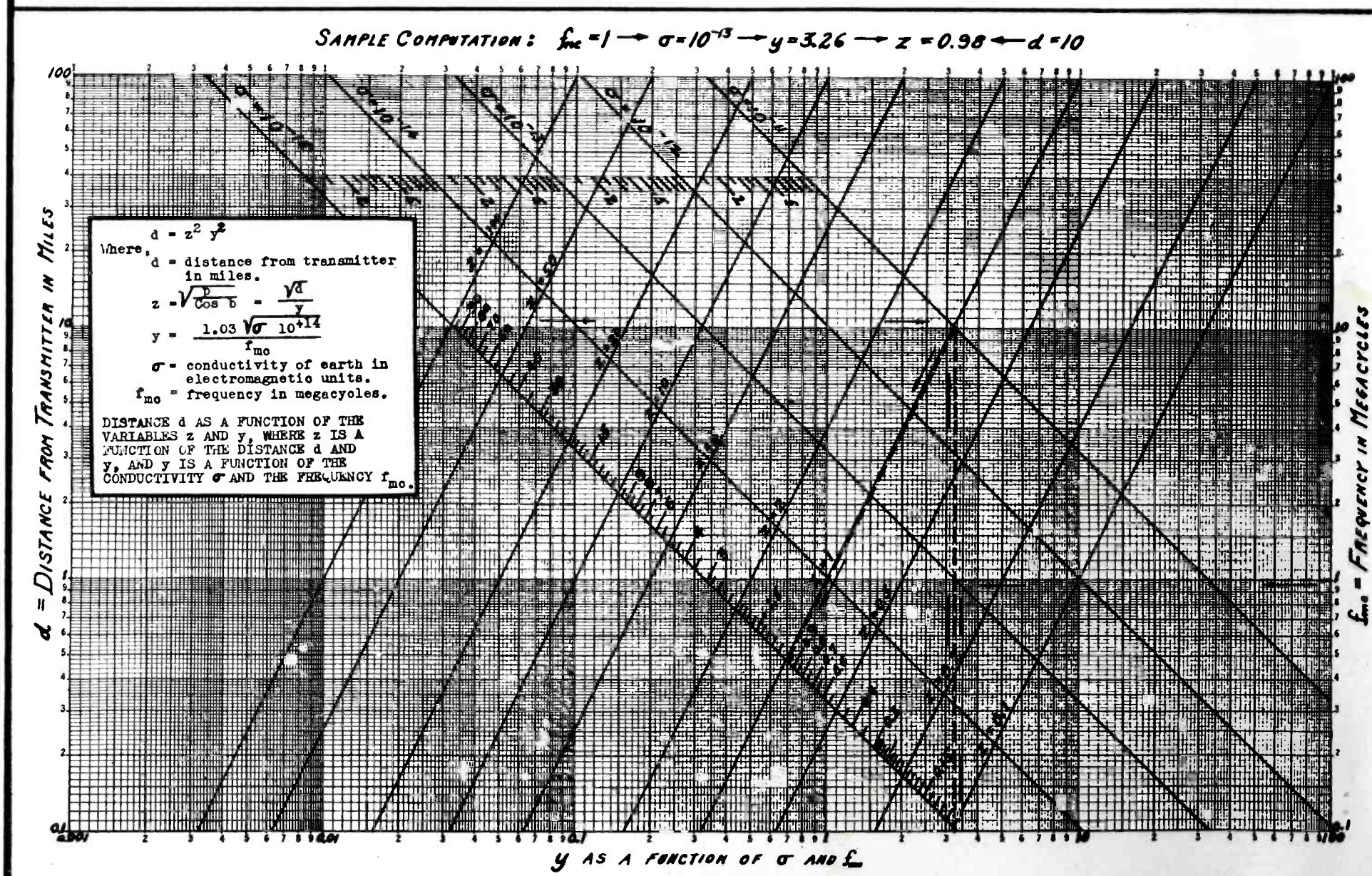
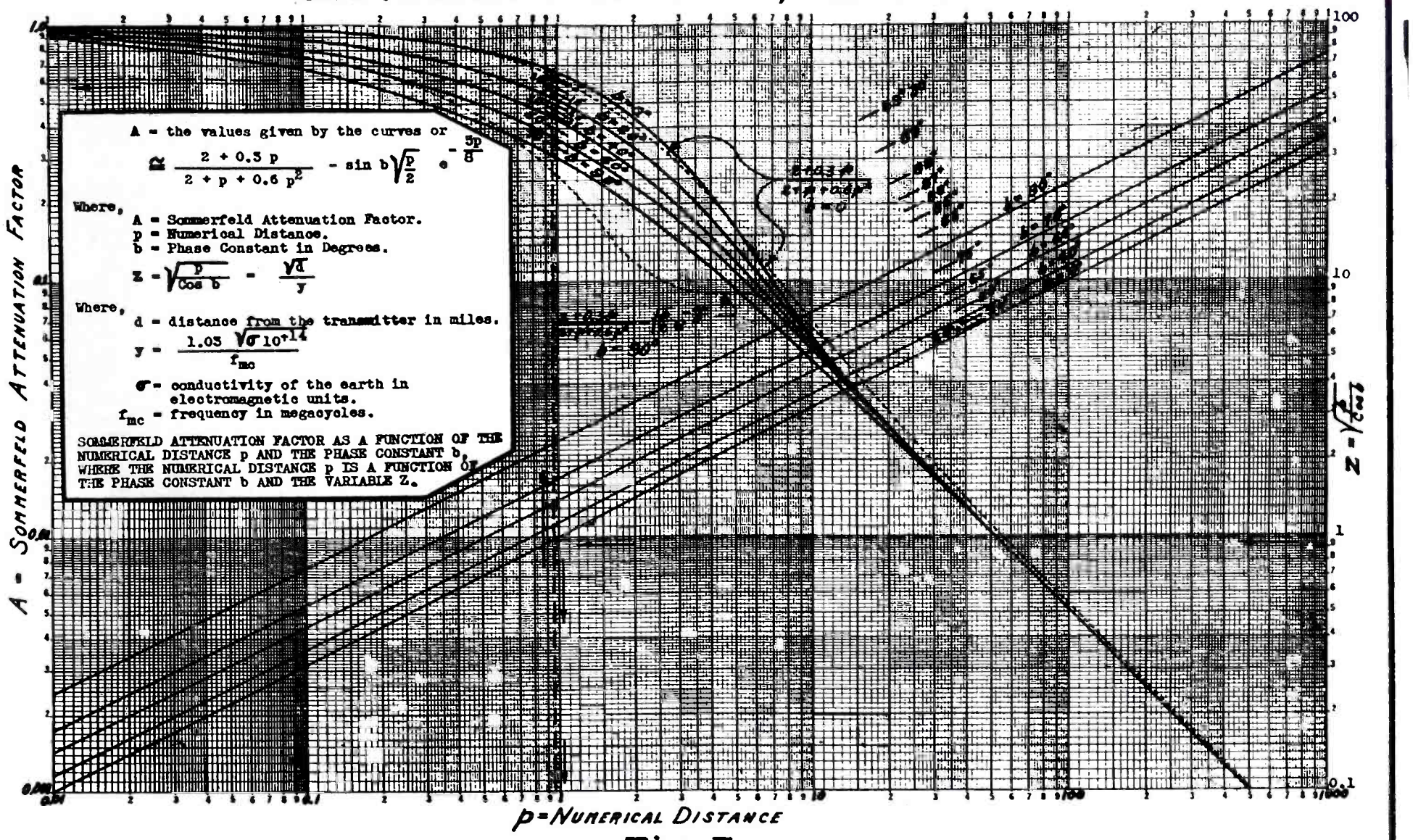


Fig. 2

SAMPLE COMPUTATION: $z = 0.98 \rightarrow b = 5.1° \rightarrow p = 0.96 \rightarrow b = 5.1° \rightarrow A = 0.62$



$$A \cong \frac{2 + 0.3\,p}{2 + p + 0.6\,p^2} - \sin b\sqrt{\frac{p}{2}} \cdot e^{-\frac{5p}{8}}$$

Where,

A = Sommerfeld Attenuation Factor.
p = Numerical Distance.
b = Phase Constant in Degrees.

$$z = \sqrt{\frac{p}{\cos b}} - \frac{\sqrt{d}}{y}$$

Where,

d = distance from the transmitter in miles.

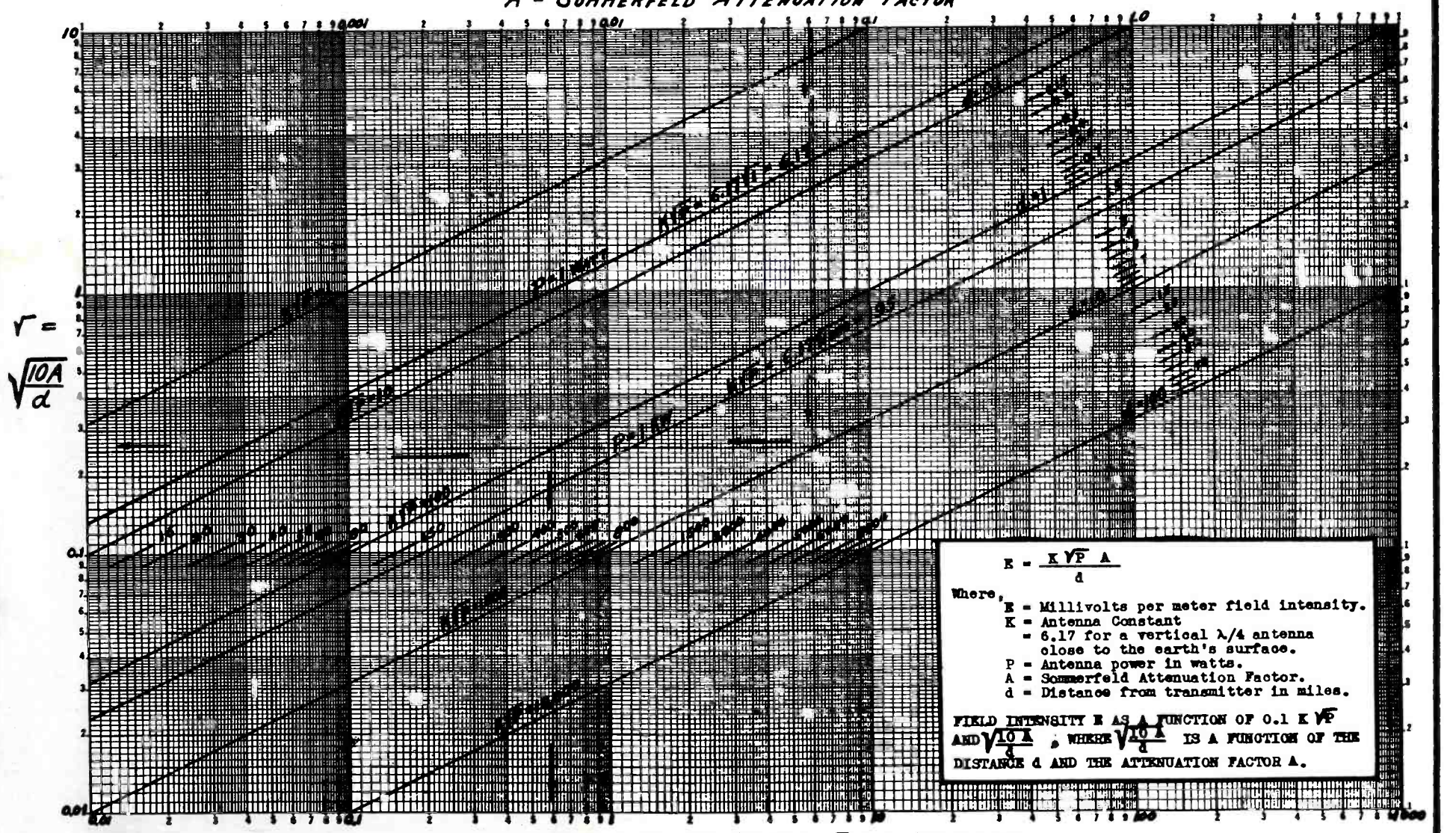
$$y = \frac{1.05\sqrt{\sigma 10^{+14}}}{f_{mc}}$$

σ = conductivity of the earth in electromagnetic units.
f_{mc} = frequency in megacycles.

SOMMERFELD ATTENUATION FACTOR AS A FUNCTION OF THE NUMERICAL DISTANCE p AND THE PHASE CONSTANT b, WHERE THE NUMERICAL DISTANCE p IS A FUNCTION OF THE PHASE CONSTANT b AND THE VARIABLE Z.

Fig. 3

SAMPLE COMPUTATION: $A = 0.62 \rightarrow d = 10 \rightarrow r = 0.25 \rightarrow K\sqrt{P} = 100 \rightarrow E = 0.62$



$$E = \frac{K\sqrt{P}\,A}{d}$$

Where,

E = Millivolts per meter field intensity.
K = Antenna Constant
= 6.17 for a vertical $\lambda/4$ antenna close to the earth's surface.
P = Antenna power in watts.
A = Sommerfeld Attenuation Factor.
d = Distance from transmitter in miles.

FIELD INTENSITY E AS A FUNCTION OF $0.1\,K\sqrt{P}$ AND $\sqrt{\frac{10A}{d}}$, WHERE $\sqrt{\frac{10A}{d}}$ IS A FUNCTION OF THE DISTANCE d AND THE ATTENUATION FACTOR A.

Fig. 4

Where

$$p = \frac{\pi\, d \cos b}{x\,\lambda} = \frac{\pi\, d \sin b}{\lambda\,(\epsilon + 1)} \quad \ldots\ldots (3)$$

$= $ numerical distance

$$\tan b = \frac{\epsilon + 1}{x} \quad \ldots\ldots (4)$$

$$x = \frac{1.8\,\sigma\, 10^{15}}{f_{mc}} \quad \ldots\ldots (5)$$

$\sigma =$ conductivity of the earth in emu

$\epsilon =$ inductivity (dielectric constant) of the earth in esu. ($\epsilon = 1$ for air)

$f_{mc} =$ frequency in megacycles

$d/\lambda =$ distance from transmitting antenna in wavelengths

$e =$ base of natural logarithms

From these equations it is readily seen that a number of things must be taken into consideration. A simplifying approximation at low frequencies is to treat the earth as a pure resistance, hence $b = 0°$ and Equation (3) simplifies to

$$p = \frac{\pi d}{x\lambda} \quad \text{for a resistive earth when } b = 0° \quad \ldots\ldots (6)$$

There is a radio engineers slide rule designed by Morrison based upon this approximation.

At frequencies in and above the standard broadcast band the phase constant b becomes effective until at the higher frequencies the impedance of the earth is primarily capacitive and Eq. (3) simplifies to:

$$p = \frac{\pi d}{(\epsilon + 1)\,\lambda} \quad \text{for a capacitive earth when } b = 90° \quad \ldots\ldots (7)$$

The approximate equation for A as given in Eq. (2) has been plotted as a fine dotted line in Fig. 3 for the case of a pure resistive earth ($b = 0$) and for the case of a pure capacitive earth ($b = 90°$). For a pure resistive earth this approximate equation gives values too small when the numerical distance p is less than 5 and it gives values too large for values of p greater than 5. For a pure capacitive earth this approximate equation gives values too large when p is less than 0.65 or greater than 5.2. Between these values of p the values of A are considerably too low. An inspection of Fig. 3 will reveal the magnitude of these errors for various numerical distances.

Since the object of this paper is the presentation of a graphical method, the more exact curves replotted from K. A. Norton's paper[1] on "Propagation of Waves" can be utilized. Then in order to eliminate computations several curve sheets have been perpared. By the use of these curve sheets ground wave characteristics can readily be determined for most conditions existing in practical radio communication.

This graphical solution is superior to using the approximate equation of Van der Pol even with the correction factor given by Norton. It also gives more accurate results than the radio engineers slide rule based upon the assumption of a pure resistive earth.

A sample computation has been carried through the curve sheets with a dashed line. The arrows have been drawn along the dashed line indicating the direction to follow the line through the curve sheets. The typical example illustrated in the curve sheets is as follows:

EXAMPLE: It is desired to determine the theoretical field intensity at a radial distance of 10 miles from a transmitter operating on a frequency of 1000 kilocycles and a power which produces an unattenuated field at one mile of 100 millivolts per meter. The conductivity of the soil is 10^{-13} emu and its inductivity is 15 esu.

GIVEN: From the example

$f_{mc} = 1$ megacycle
$\sigma = 10^{-13}$ emu.
$\epsilon = 15$ esu.
$d = 10$ miles
$K\sqrt{p} = 100$ mv/m.

DETERMINE: The field intensity E in mv/m.
Solution:
Fig. 1- $f_{mc}=1 \rightarrow \sigma = 10^{-13} \rightarrow x = 180 \rightarrow \epsilon = 15 \rightarrow b = 5.1°$
Fig. 2- $f_{mc}=1 \rightarrow \sigma = 10^{-13} \rightarrow y = 3.26 \rightarrow z = 0.98 \leftarrow d = 10$
Fig. 3- $z=0.98 \rightarrow b = 5.1° \rightarrow p = 0.96 \rightarrow b = 5.1° \rightarrow a = 0.62$
Fig. 4- $A=0.62 \rightarrow d = 10 \rightarrow \sqrt{\frac{10A}{d}} = 0.25 \rightarrow K\sqrt{P} = 100 \rightarrow E =$ 0.62 mv/m
Answer: E = 0.62 mv/m

In the above the equal sign gives the value of the variable to use and the arrow indicates the direction to proceed along the dashed line through the respective curve sheets.

If the assumption is made that $b = 0°$ the result from Fig. 3 gives $A = 0.67$ and from Fig. 4 $E = 0.66$ mv/m. It is interesting to note that the radio engineers slide rule for this problem gives $A = 0.672$ and $E = 0.66$ mv/m. This shows that even at 1000 kilocycles, in the middle of the standard broadcast band, the error due to this assumption may be 6 to 8 percent.

It is also interesting to note that for this case the Van der Pol approximate equation for A as indicated by the fine dotted line in Fig. 3 gives $A = 0.64$ a value that is fairly accurate and if the Norton correction for b is used, the value becomes $A = 0.61$ which is a more accurate value. However, in other cases the inaccuracy of this approximate equation may increase to approximately 40 percent.

This example bears out the fact that the phase constant b should be taken into consideration in most problems even though it necessitates the use of one more curve sheet (Fig. 1.). This is also in line with the tendency of good engineering practice today to consider both the inductivity and conductivity of the earth over which the field intensity is to be determined.

In the foregoing analysis the curvature of the earth has been neglected. If this correction is taken into account the calculated field will be slightly less. However, in most practical cases it is of little consequence since the sky wave usually becomes the dominant factor at these distances and tends to increase the field intensity—thus minimizing the effect of this error.

[1] *Proc. I.R.E.*, Vol. 24, pp. 1367-1387; October, 1936.

NOTES ON F-M TRANSMITTERS

By FRANK A. GUNTHER

Engineering Department
Radio Engineering Labs., Inc

IN November, 1935, Major Edwin H. Armstrong announced and described a system of frequency modulation as a new method of reducing the effect of all kinds of disturbances in the communication art; and it is the purpose of this article to review some of the progress that this invention has made in the broadcast field since its inception five years ago.

For such a revolutionary development, it created very little comment at the time. Certainly, the art did not accept it for its worth, nor did it attempt to investigate its advantages. The Yankee Network in New England were the first to see the vast potentialities of frequency modulation, and launched their program with the building of a relay transmitter in Boston, and a broadcast station at Paxton, Mass., 43 air miles distant. Time, however, has created quite a different picture, and since then, many other broadcasters have started operations.

F-m has been known to the radio art practically since its beginning. But, it was not until Armstrong's development of wide swing frequency modulation, plus numerous other developments of his, particularly in the receiving circuits, that this new system of communication came into its own.

In the Institute of Radio Engineers Proceedings of May 1936, the transmitting and receiving arrangements of the system, together with the theory regarding the process of noise reduction, were discussed in full detail. In this paper Armstrong has listed five laws which must be fulfilled to place frequency modulation on a comparative basis with amplitude modulation. These are very important, and we are, therefore, enumerating them:

(1) It is essential that the frequency deviation shall be about a fixed point. That is, during modulation there shall be a symmetrical change in frequency with respect to this point and over periods of time there shall be no drift from it.
(2) The frequency deviation of the transmitted wave should be independent of the frequency of the modulating current and directly proportional to the amplitude of that current.
(3) The receiving system must have such characteristics that it responds only to changes in frequency and that for the maximum change of frequency at the transmitter (full modulation) the selective characteristic of the system, responsive to frequency changes, shall be such that substantially complete modulation of the current therein will be produced.
(4) The amplitude of the rectified or detected current should be directly proportional to the change in frequency of the transmitted wave and independent of the rate of change thereof.
(5) All the foregoing operations should be carried out by the use of aperiodic means.

All of these rules, pertaining either to a f-m transmitter or a f-m receiver, must be incorporated in order to secure the full capabilities of this system.

At this point it should be said that there are two systems with which to obtain wide band frequency modulation. One is known as the free oscillator type of modulator, which consists of a tuned circuit controlled oscillator with a reactance tube for varying the inductive or capacity reaction of the circuit. The frequency of this free oscillator is therefore varied in accordance with the modulating frequency. On account of the drift of circuits of this type, it is necessary to have some controlling means for holding them on the proper frequency. This is accomplished by means of a crystal controlled oscillator as a reference point and a discriminating circuit for hold-

Date of Installation and Call Letters	Location	Freq. MCS	Power output	Proposed power	Hrs./ day av.	Cycles variation	Antenna Type	Polarization	Ant. height above ground	Height above sea level	Length transmission line	Type transmission line
Nov. 1936—W2XAG	Yonkers, N. Y.	117	3 to 5 KW	5 KW	Intermittent	..	7 bay turnstile	Horizontal	130′	430′	80′	400 ohm open
Apr. 1938—W2XMN	Alpine, N. J.	42.8	30 KW	40 KW	7 to 8	1000	6 bay turnstile	Horizontal	400′	900′	600′	450 ohm open wire line
May 1939—WEOD	Boston, Mass.	132	250 W	250 W	18	..	4 bay 3 element (see cover)	Horizontal	170′	180′	220′	Dual 7/8″ concentric
June 1939—W1XOJ	Paxton, Mass.	43	50 KW	50 KW	18	1000	4 bay turnstile	Horizontal	400′	1800′	900′	4, 7/8″ concentric
June 1939—W1XPW	Meriden, Conn.	43.4	1 KW	50 KW	8	1000	6 bay turnstile	Horizontal	100′	1200′	100′	open up mast and 7/8″ concentric under gnd.
Aug. 1939—W3XO	Washington, D. C.	43.4	1 KW	1 KW	Intermittent	1000	WE KS-10017	Vertical	75′	...	120′	7/8″ concentric
Nov. 1939—W2XQR	Long Island City, N. Y.	43.2	1 KW	1 KW	5	2000	1 bay turnstile	Horizontal	125′	135′	300′	600 ohm open wire
Nov. 1939—W8XVB	Rochester, N. Y.	43.2	1 KW	2 KW plus	8	500	WE KS-10017	Vertical	200′	...	225′	7/8″ concentric
Jan. 1940—W9XAO	Milwaukee, Wis.	42.6	1 KW	Plus	6-8	300 to 2000	RCA MI-7823	Vertical	320′	...	60′	7/8″ concentric
Jan. 1940—W8XAD	Rochester, N. Y.	42.6	1 KW	2 KW plus	18	1000	RCA MI-7823	Vertical	350′	...	750′	7/8″ concentric
Feb. 1940—W9XEN	Chicago, Ill.	43	1 KW	Plus	12	1000	WE KS-10017	Vertical	500′	...	125′	7/8″ concentric
Feb. 1940—W2XOR	Carteret, N. J.	43.4	1 KW	50 KW	12	1000	Half wave dipole	Horizontal	100′	110′	200′	7/8″ concentric
Mar. 1940—W2XWF	New York City	42.18	1 KW	1 KW	16	1000	Half wave dipole	Vertical	458′	...	60′	7/8″ concentric

ing the free oscillator at a fixed frequency difference from the crystal controlled oscillator. The main oscillator is not, therefore, crystal controlled, but is controlled by a discriminator circuit using a crystal controlled oscillator as a point of reference.

The other system is known as the true Armstrong phase shift method of generating f-m signals. It is the only crystal controlled method of producing f-m. It is this latter system that we will further discuss.

Fig. 1 shows a block diagram arrangement of the entire system. Panel 1, starting at the top left, contains the audio equipment. It consists of a studio line amplifier and a pre-distorter amplifier. This latter unit emphasizes the higher audio frequencies and by means of a corrector or equalizing network in the broacast receivers, an appreciable increase in signal-to-noise ratio is further obtained over the system without the use of pre-distortion. Finally in Panel 1, a corrector amplifier is included. This is incorporated to conform with Armstrong's rule No. 2, and insures that the frequency deviation will be independent of the modulating audio frequency, and directly proportional to the amplitude of this audio current. This is accomplished by correcting the audio frequency amplifier in such a manner that its output will be inversely proportional to increases in audio frequency.

Panel 2 is the "heart" of the modulator and contains a 200-kc temperature crystal controlled oscillator with the necessary buffer amplifier. A balanced modulator is employed at this point, it being excited by the source of fixed frequency, namely, the 200-kc crystal oscillator. With no modulation, the balanced modulator has zero output, but with modulation it produces side bands only and arrangements are made for selecting these side frequencies at the output of the modulator and combining them in the proper phase with the unmodulated current secured from the original 200-kc carrier source.

The phase relations which must exist where combinations of the modulated and unmodulated currents take place, are such that at the moment the upper and lower side frequencies produced by the modulator are in phase with each other, the phase of the current in the crystal controlled carrier frequency with which they are combined is different from these by 90 degrees.

This phase shift represents a very linear but small frequency change, which must be multiplied through a series of frequency doublers in order to produce the required frequency change in the radiated wave. The initial frequency, which of course is 200 kc in all transmitters, is multiplied through a series of six doublers to 12.8 mc through Panel 3 and into Panel 4.

Here in Panel 4, a second temperature controlled crystal oscillator is employed to heterodyne down the frequency to 1/48th of the output or working frequency desired. For the 40-mc band this is the order of 900 kc, which enters Panel 5. Here it is multiplied by four doublers and a tripler up to the 40 mc operating frequency.

With this arrangement of beat back or heterodyne frequency created by the second crystal, sufficient multiplication is secured to permit the required wide band f-m at the operating frequency. It also greatly facilitates production of all modulator units in that every one is built exactly around a 200 kc crystal, regardless of the output frequency. Furthermore, if it becomes necessary to change the working frequency, it merely involves substituting another frequency in the crystal employed in Panel 4, and making the slight changes in the stages thereafter. One never has to adjust the circuits involved anywhere in Panels 2 and 3 for this purpose.

The output of the last doubler in Panel 5 is arranged to supply about 10 watts of radio-frequency energy at the output frequency. This is sufficient to drive a 300-watt screen grid intermediate power amplifier in the right-hand or power portion of the layout in Fig. 1. Beyond this, it is merely necessary to employ the necessary well designed Class "C" power amplifier stages to develop the power required.

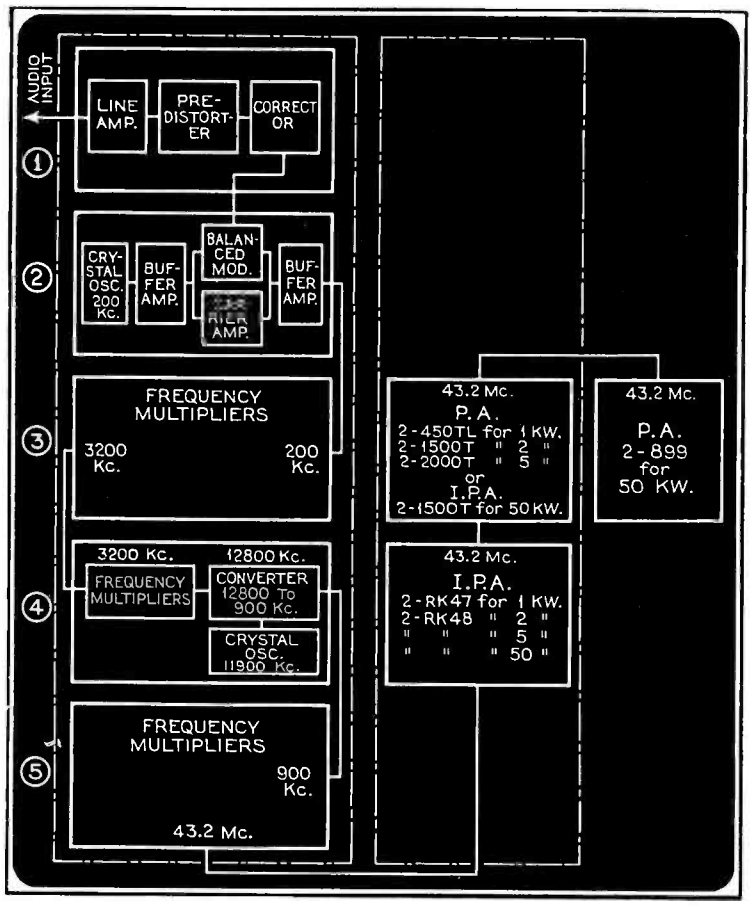
All of the tubes in the modulating equipment up to the two final output stages, are low power receiving tubes of the glass type operating at a maximum of 180 volt plate supply, so that a condition of reliability is always maintained. These same tubes are employed in broadcast receivers with 250-volt plate potentials, and in many cases with much less ventilation. The two final output tubes are type 807's.

Due to the fact that both oscillators are controlled only by the crystals themselves, and not by any intervening or interdependent circuits, it is not possible for the transmitter to jump frequency and the only drift which can occur is the drift of the crystals themselves.

After all the multiplications, a stability of at least twice as good as that required by the Federal Communications Commission is being obtained in the transmitters now in the field. In several transmitters, a stability of four times as great as required by the regulations is regularly obtained, and steps are being taken whereby this figure will be improved.

The Armstrong type phase shift frequency modulator has in the past been termed a "Frankenstein" by some, who, incidentally, were not too familiar with the inner workings of the unit. This was probably due to the number of tubes employed. As a matter of fact, we have sufficient evidence under actual operating conditions in the field, that this modulator system is exceptionally fool-proof, and it has won for itself the reputation of being the most trouble-free portion of the entire broadcasting system, not excluding studio equipment,

Fig. 1. Block diagram of Armstrong circuit as applied in equipments from 1 to 50 kw.



telephone lines and other appurtenances that engineers in the art have become accustomed to believe were the height of reliability.

The design of the entire modulator equipment is such that it permits extreme flexibility in operation. If changes in development occur, it is merely necessary to remove a single panel containing the section to be replaced, thus permitting an economical means of keeping up with the advances in this art.

The modulator unit as manufactured, is a well shielded and well filtered device. These two latter items are very important when it is considered that in practically every case, the frequency modulator unit will have to be operated in conjunction with fairly high powered ultra-high-frequency power amplifiers and antenna arrays.

One does not have to stress the imagination too far to realize the necessities of this efficient shielding and filtering, particularly when increases in power can and very likely will be made once operation has commenced on a large scale.

Fig. 2 shows a photograph of the modulator unit with power amplifier for outputs of 1, 2 or 5 kw at the 40 mc band. This modulator unit, which contains the true Armstrong type crystal controlled phase shift unit, when used in conjunction with any power amplifier from 1 to 50 kw, will have under actual every day conditions in the field, the following performance characteristics:

Frequency Stability—Will maintain frequency to within better than 4,000 cycles of the assigned frequency.

Fidelity—Flat within plus or minus 1 db—From 30 to 16,000 cycles.

Fig. 2. WHEC's f-m transmitter, W8XAD, in operation at Rochester, N. Y.

Distortion—Less than 2% and usually in the order of 1% as measured at 400 cycles with 150 kc frequency swing.

Noise Level—66 db or better as measured at the output of a monitor receiver.

Frequency Swing—Maximum 150 kc.

Many of the stations in operation are operating at 1 kw due to present experimental license limitations; but it has been proven that power will pay big dividends to this system. Therefore, we can expect wider use being made of high power with f-m transmitters.

Fundamentally, it is economical to secure these increases in power because all amplifiers at the operating

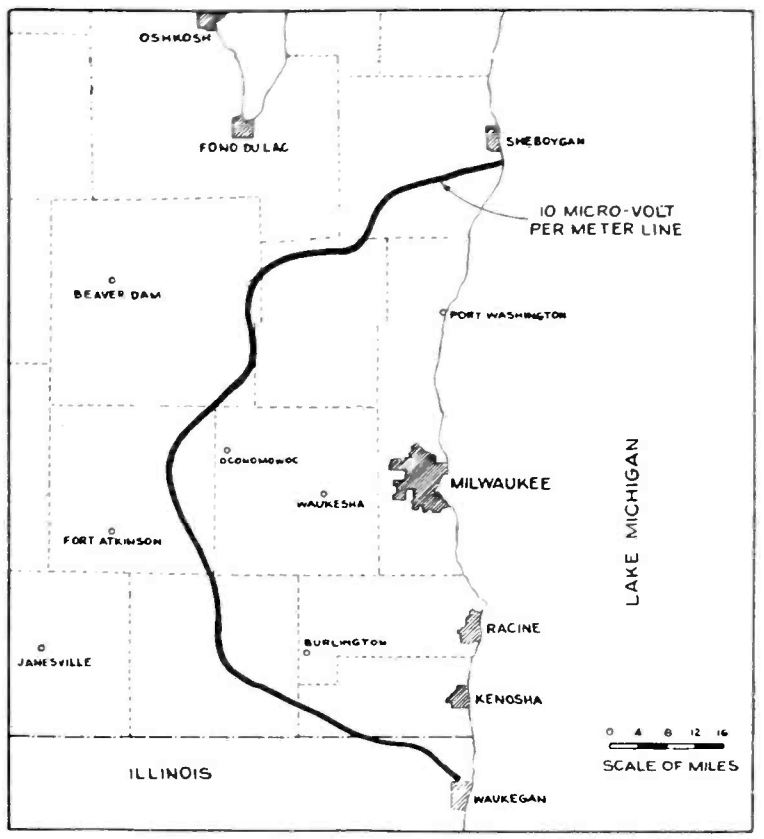


Fig. 3. Service area of WTMJ's 1-kw f-m transmitter, W9XAO, Milwaukee, Wis.

frequency are operated in Class "C". Another advantage is that the tubes in the final amplifier can be operated to the extreme limit of their usefulness, inasmuch as they are operating in a similar manner to a telegraph service with the key locked. No longer will the final amplifier filaments be required to furnish sufficient emission for four times the carrier power in order to take care of 100% modulation peaks. Many a high-power amplifier tube that is no longer useful in an a-m broadcast station, would furnish hundreds of hours of use in f-m service.

Fig. 3 shows a map of a typical 1-kw f-m installation at Station W9XAO, Milwaukee, Wisconsin, Station WTMJ's experimental f-m transmitter. The antenna is located 320 feet above the streets of Milwaukee, and is of the single bay vertically polarized type. The map shows the 10 micro-volt per meter line drawn at the considered limit of the service area for the present power, antenna system and location.

10 micro-volts per meter furnished extremely satisfactory service in all but unduly noisy locations with the more sensitive type of f-m receivers. By the end of the calendar year 1940, it is safe to say that most f-m receivers will have incorporated in their design the necessary features to permit satisfactory noise-free reception under practically all conditions with 10 micro-volts per meter at the receiver antenna terminals.

The 10 micro-volt line denoting the limit of W9XAO's service area will be greatly extended due to an increase in the power and antenna improvements. The vertical directivity will be lowered considerably and an array will be incorporated to remove the circular horizontal pattern in order to discontinue serving whatever audience resides in Lake Michigan.

The accompanying table shows a list of the transmitting stations now in operation, employing the Armstrong phase shift modulation system. This table gives other factors which is felt will be of interest to those contemplating installations of f-m equipment.

At the present time, there are four f-m transmitters regularly serving the New York area, all of which employ the Armstrong Modulator described in this article.

A UNIVERSAL AUDIO BROADCAST AMPLIFIER

By L. C. SIGMON
Chief Engineer
KCMO Broadcasting Co.

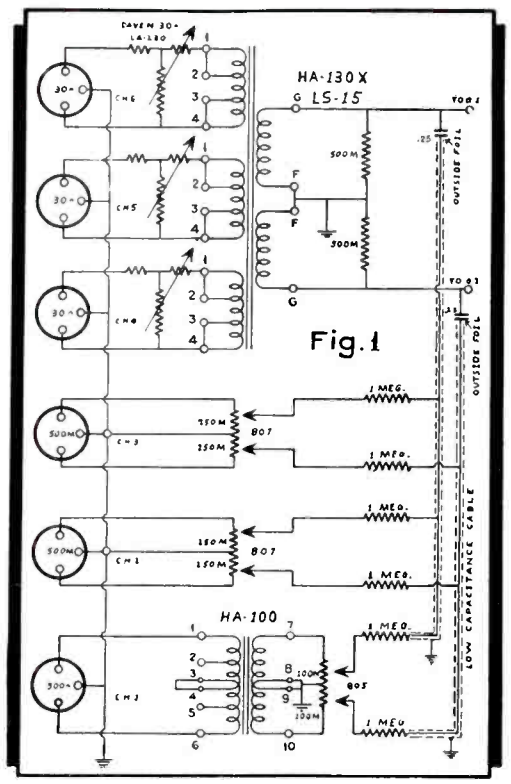


Fig. 1. Input circuit.

THE high-fidelity audio amplifier described in the following article should prove of interest to broadcasting and recording engineers, as the author believes it is the first time an input and output circuit of this particular design has been used. There are many applications for such a circuit arrangement and no doubt readers of this article will think of a number of varied uses.

The amplifier has the following features: (1) high fidelity, (2) twelve watts of undistorted power, (3) six input channels, (4) push-pull operation of audio tubes, (5) regulated voltage on the first two stages, (6) universal output circuit whereby a remote broadcast line may be fed simultaneously while feeding monitor speakers and a recorder cutting head, (7) amplifier is portable. Figs. 9 and 14 show the amplifier.

Specifications

Gain: 118 decibels.

Input Impedance:

(1) 500 ohms.
(2) 500,000 ohms balanced to ground.
(3) 30 ohms.

Output Impedance:

(1) 500 ohms (12 watts) distortion less than 5%, or
(2) 250 ohms (6 watts each).

Power Output: (+33 db are 12 watts) (+6 db are .023 watts for remote line).

Noise:

—48 db below zero level at maximum gain.

Noise level in normal operation —60 to —75 db below zero level. (6-mw reference level).

Frequency Response: 30 to 15,000 cycles per second within 2 db.

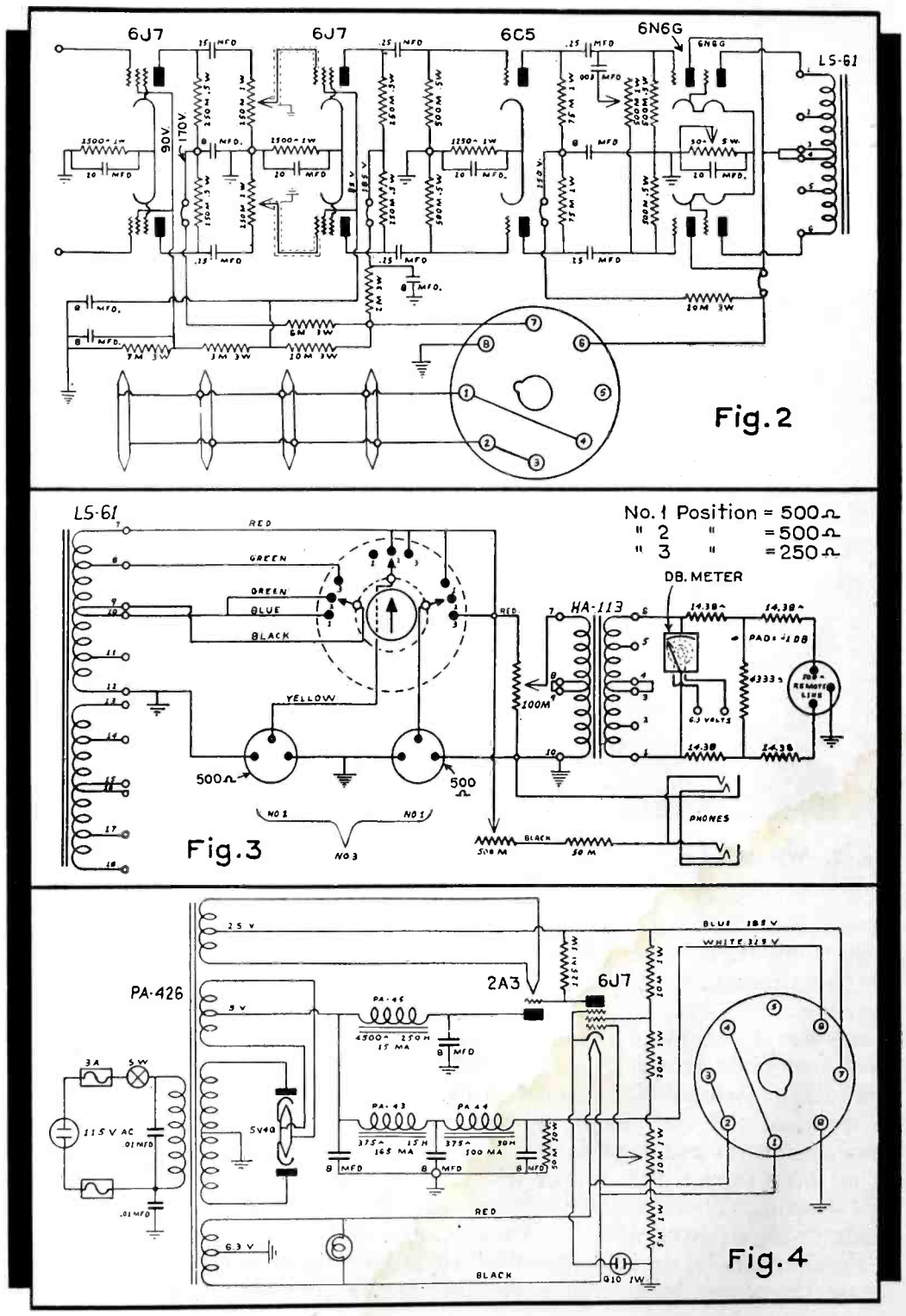
Tubes Used: (5) 6J7; (2) 6C5; (2) 6N6G; (1) 2A3; (1) 5V4G; and (1) G10 one-watt with base resistor removed.

Power Required: 110-120 volts, 60 cycles.

Fig. 2. Amplifier circuit.
Fig. 3. Output circuit.
Fig. 4. Power supply circuit.

Input

The input channels are No. 1, 500 ohms, No. 2 and No. 3, 500,000 ohms, balanced to ground. These channels No. 2 and No. 3 are used primarily as input channels from crystal pickup play-back heads, but may also be used for bridging broadcasting lines. Channels No. 4, No.



5, and No. 6 are 30-ohm input channels to be used with dynamic microphones with a level as low as —90 decibels.

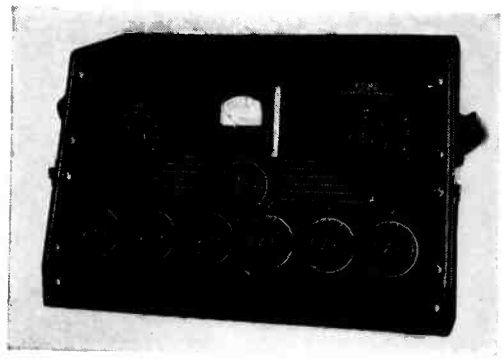
The first two 6J7 tubes in push-pull are the pre-amplifier tubes for all six input channels. The unconventional part of the input circuit is that three additional channels are shunted across the secondary of the input transformer HA-130X through Pi-Pads. Experimental circuits were first tested to determine if there was any reaction between the circuits or a loss of gain or any reaction on any frequency when using 1-megohm resistors as shown in the input circuit (Fig. 1). Naturally, there is a loss in the Pi-Pads matching networks and with the values used, this was approximately —46 decibels per channel. This loss was desirable in channels No. 1, No. 2 and No. 3 where the input level was high as compared to channels No. 4, No. 5, and No. 6. The input Pi-Pad circuit is not restricted to push-pull operation or three channels, and may be used with a single stage. The purpose of the two condensers in series with the Pi-Pad bridging network is to isolate the grids of the first two 6J7 tubes so that their bias will be obtained through the HA-130X transformer and resistors. A low capacitance shielded cable was used to connect the network circuits so that frequencies as high as 15,000 cycles can be transmitted without attenuation. It will also be noted in Fig. 1 that the .25-mfd. series condensers of the bridging circuit have their outside foil connected away from the grid circuit. This was done to eliminate shielding of the condensers.

The volume controls in channels No. 1, No. 2 and No. 3 are of the dual type with a left-hand taper, and are mounted so that they may be easily removed should they become noisy. The original controls are still in use without any trouble after a year of service.

The Amplifier

Fig. 2 shows a simplified diagram of the amplifier circuit minus the input, output, and power-supply circuit. The amplifier is of the push-pull design

Fig. 14. (Above) Amplifier in use.
Fig. 9. (Below) The amplifier.



throughout. The operation of tubes in push-pull has several advantages over the single-ended stage. There is low distortion of harmonics. By the balancing of hum from power supply the size and cost of filter components are reduced. Also, there is no fundamental or odd harmonic current through the d-c power supply to the cathodes provided the push-pull stage is balanced. The push-pull circuit has the advantage of not "motor-boating" as freely as the single-ended stage because of the impedance of the circuit. Another very important advantage of a push-pull stage is that push-pull tubes can be made to deliver more power to a load for a given amount of distortion than tubes in parallel.

The disadvantages of push-pull stages are as follows: Larger grid bias is required than for a single-ended stage, and, therefore, push-pull stages also require a higher input voltage; in this particular amplifier it was necessary to add additional push-pull voltage amplification stage. A good input transformer is needed for push-pull stages because the secondary voltage of the input transformer must be equal in magnitude and opposite in phase for all frequencies. If the transformer is not of the better grades, one side of the intput may deliver more voltage to one tube of the push-pull circuit than to the other. Since even harmonics add up in the common return to the cathodes the self-biasing resistor should be shunted with a capacitance sufficiently large to by-pass the even harmonics.

It must also be borne in mind that resistance-coupled push-pull operation is not the same as transformer-coupled push-pull in that in the former case the two sides of the circuit are not coupled to each other through the mutual inductance of the primary of the push-pull

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Figs. 6 and 7. Frequency response curves of amplifier.

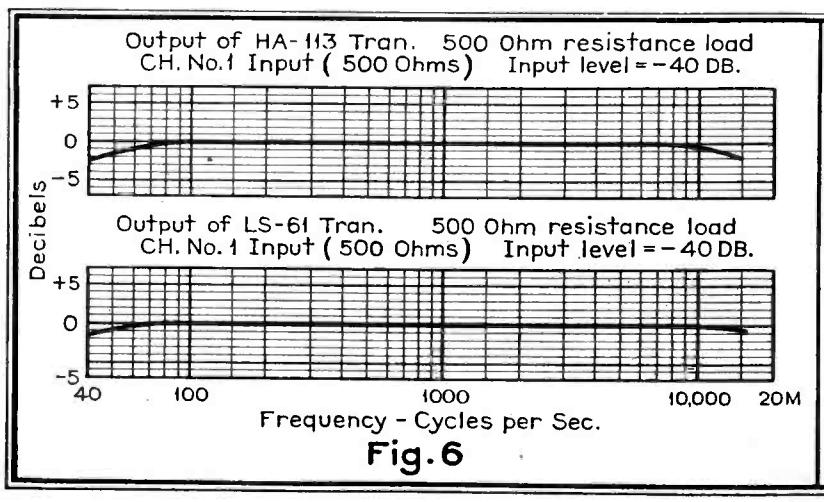


Fig. 6

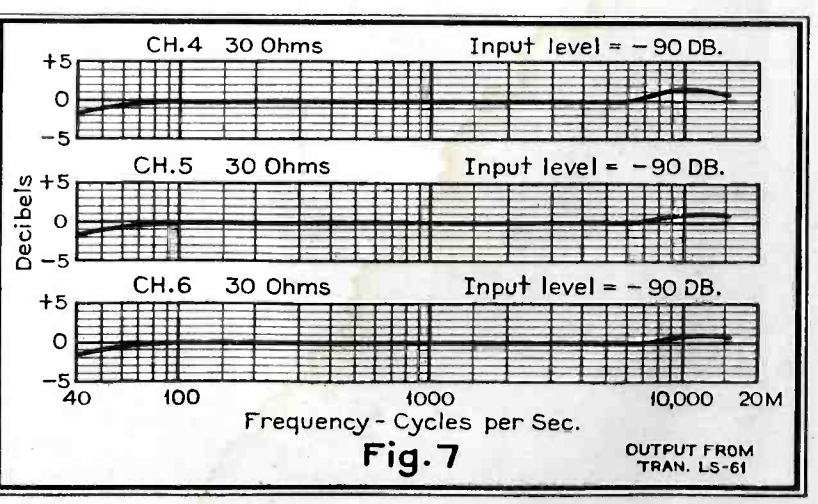


Fig. 7

1940 SOUND

"SOUND" IDEAS

By S. GORDON TAYLOR

THE editors report wide evidence of interest in the special section of the February issue, in which the advantage to sound men of "keeping their ears to the ground" as a means of keeping up with the parade was emphasized. There were described a number of modern sound installations, with some discussion of trends.

It is the purpose of this article to present a number of other installations which have recently come to attention. These have been selected to include in almost every case some feature of novelty.

One of the first that comes to mind is the sound installation in a trailer church employed by the Catholic Diocese of Richmond, Va., to carry The Gospel to the remote mountain communities where churches are the exception rather than the rule.

The sound equipment was installed during construction of the trailer which is special principally in that the rear end is reserved for the altar and pulpit, the latter formed by the rear wall when opened, as shown in the Fig. 1. This equipment is mounted in a wall cabinet just behind the altar.

Included in the rack is a standard 30-watt amplifier, record player, radio tuner and monitor speaker. Microphone, phono and radio inputs provide for speech reinforcement, recorded musical accompaniment for hymns, chimes, etc., and the radio input serves to bring in educational and religious lectures for distribution through the external loudspeakers. These loudspeakers are built into the roof over the pulpit, with a cover over the open ends which protects the speaker units from dust while traveling and drops down to form an acoustic screen between speaker openings and microphone when the trailer is in service as a chapel.

Power not only for the sound system but also for the main lighting is obtained from a 110-volt gas-driven generator located in place of the rear seat in the coach which serves as the tow car. This system is fully automatic, with the result that when the sound system or main lights are turned on the generator starts itself, and cuts off when the equipment is turned off. This generator also charges an auxiliary storage battery which supplies power for the ordinary internal needs of the trailer. Provision is also made for operating the entire system from an external 100-volt a-c source when in trailer camps or other locations where line supply is available.

Contrasting with this rather pretentious job is the one shown in Fig. 2. This represents a new type of equipment just introduced which converts any car into a sound car, yet is no more cumbersome than the ordinary car radio. As shown, the amplifier mounts under the dash with its controls within easy reach of the driver. The miniature but

Fig. 3 (Above). A 60-watt mobile sound system. Photo from University Labs.

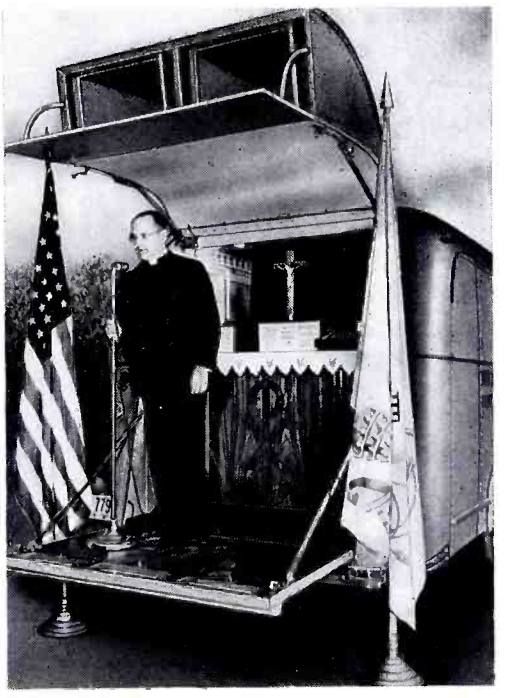


Fig. 1. The sound equipment (left) installed in the trailer church (right). Radio Wire Television photos.

Fig. 6 (Left). Equipment at LaGuardia Airport for dedication. Radio Wire Television photo.

Fig. 5 (right). Paging system at LaGuardia Airport. Western Electric photo.

highly efficient marine type speaker may be mounted under the hood as shown, or on the outside of the car if preferred.

A novel feature of this equipment is that although its rated normal output is only 5 watts, its effective output is said to be equivalent to that of a standard 12-18 watt system. The speaker design contributes materially to this but also important is the amplifier design which cuts off frequencies below 250 cycles. The relatively large proportion of the power normally dissipated in the reproduction of these low frequencies is thus concentrated in the normal voice and higher frequency ranges with their much greater carrying range.

Equipment such as this is destined to find many applications as mobile ballyhoo equipment, in police and safety crusade cars, as a street announcement system in busses, and perhaps even in private passenger cars whose drivers yearn for some means stronger than mental telepathy for transferring their thoughts to slow moving pedestrians who take delight in holding up traffic while they amble across street intersections against the lights.

Another mobile system of more than passing interest is one installed by John H. Brown of the All-State Distributing Co., Omaha, Nebr., in the ballyhoo car of Jimmy Lynch's Death Dodgers. (Fig. 3.) Although installed in a standard passenger car, the system is capable of 60-watts output for reproduction of voice or records through three large horn units on the roof. Power is supplied from a 600-watt gas driven generator mounted in the car trunk. The speakers are mounted on adjustable brackets which permits them to be trained in any direction during operation, but are so positioned that when not in use the horns do not extend beyond the width of the car and can even be folded back if desired when travelling.

Fig. 4 offers a highly practical suggestion to sound men who have occasional calls for sound car rentals, but not often enough to warrant tying up amplifier and generator equipment in a permanent truck installation. When this small delivery truck of the Will County Radio Service, Joliet, Ill., is required as a sound car the 30-watt combination amplifier-phono unit shown on the step is mounted inside in a twinkling and draws all operating power from the car battery through the medium of the dual 6/110-volt built-in power supply. At all other times the amplifier is available for normal indoor rental jobs, operating from the 110-volt light lines. The amplifier provides a sufficient variety of inputs and outputs to meet practically any rental requirements. Thus it combines real economy with diversity in application, doing its bit to keep "ol' man overhead" on a perpetual reducing diet.

Turning from mobile applications, attention is directed to what is believed to be one of the most comprehensive paging systems of modern times, recently installed by the Langevin Co. at New York's new LaGuardia Airport. Through 15 microphones and 85 loudspeakers announcements of plane arrival and departure times are carried to every part of the great field where passengers and their friends congregate. From the control tower (Fig. 5), which is in constant touch with planes headed for the field comes information as to the arrival times, departures are announced from the ticket desks of the different airlines and from microphones at the gangways which also are used to call taxis and porters for incoming passengers.

A unique feature of this installation is the push-to-talk button on each microphone which makes the entire loudspeaker system available to but one microphone at a time and thus eliminates interference and interruptions.

(*Continued on page* 36)

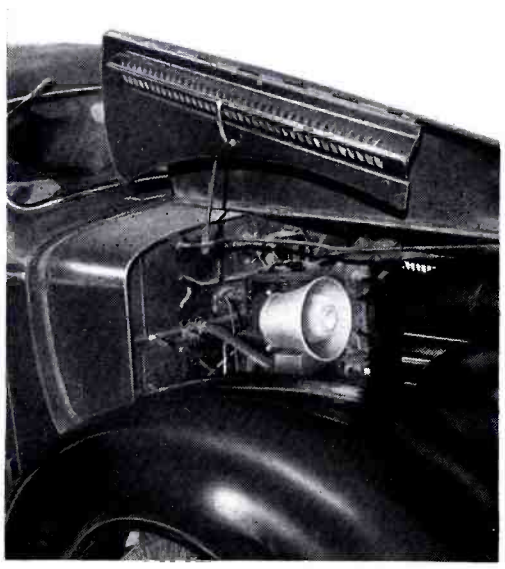
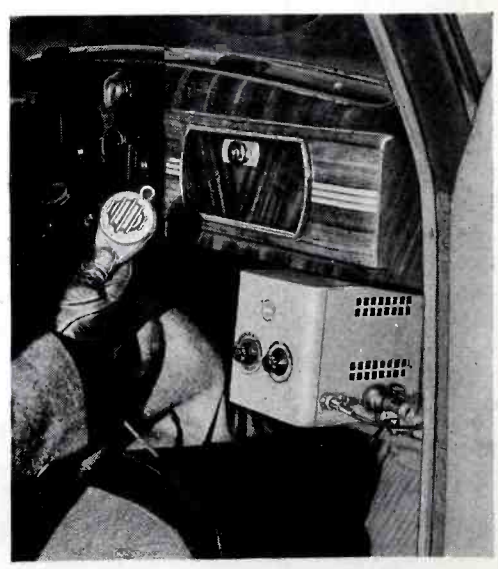


Fig. 2. Showing horn (left) and amplifier (right) of compact Lafayette sound system.

Fig. 4 (Below). The dual 6/110-volt Clarion system described above.



TELEVISION ENGINEERING

FUNDAMENTALS OF TELEVISION ENGINEERING

Part VIII: Television Transmission

By F. ALTON EVEREST
Department of Electrical Engineering
OREGON STATE COLLEGE

THE television picture transmitter, although utilizing the same basic radio principles as the aural broadcasting transmitter, has demands made upon it that place video transmission in a class by itself. In the first place, the frequency of operation based upon the recent tentative television channel allocation imposes severe handicaps. At the present state of the art it is very much more difficult to obtain a few kilowatts of radio-frequency energy in the range 44-108 mc than at the lower frequencies. This is near the boundary region beyond which the efficiency of the conventional triode and multi-element thermionic tubes decreases at an alarming rate. True, there are special circuits and modes of operation which tend to extend this region, but the fact remains that it takes a finite time for an electron to travel to the anode and at these high frequencies this transit time decreases the oscillator or power amplifier efficiency of the conventional vacuum tube. Decreasing the physical size of the tube appears to have definite practical limits, although for the above mentioned frequency range recently developed tubes of special design are serving well.

Band Width

A rather illuminating comparison can be made between sound broadcast transmitters and television transmitters in the matter of frequency band width. In the former, "high fidelity" is often the claim for transmitters that will reproduce faithfully frequencies up to the order of 10 or 15 kc. As far as the frequency range of the video signal is concerned, we have seen in Part II* that necessary energy resides in frequency components as high as 5 mc. To retain this band width throughout the modulator, modulated amplifier, and the linear stages is no small task.

Modulation System

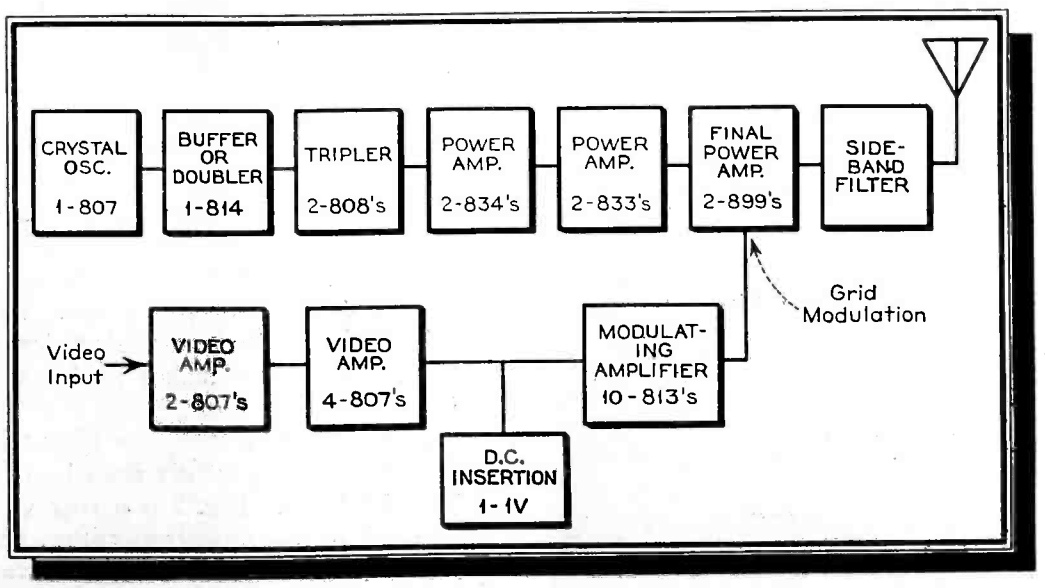
The usual method of plate modulation has been largely abandoned for television transmitters[1, 2, 4], because of the difficulty in developing sufficient video power fully to modulate the radio-frequency amplifier and to obtain a modulation reactor having proper characteristics over a wide band. A low-level plate-modulation scheme would entail the need of many wide-band linear amplifiers which are about as costly as the wide-band modulating channel necessary for high-level plate modulation. The reasons underlying these difficulties are bound up with the necessity for low amplifier load impedances in order that the wiring and tube capacitances do not unduly discriminate against the high frequencies.

The system of grid modulation has been adopted almost universally in this country, for with this system the side-band energy is derived from the modulated amplifier itself by the mechanism of changing its efficiency over the modulation cycle. The low power output per tube in the modulated stage is a limiting factor with this system of modulation, so it is not uncommon to see television transmitters having modulated amplifier tubes apparently far too large for the carrier power involved. This arises from the plate dissipation limit of the tubes and from the fact that a large voltage drop must be tolerated across the tube during low modulation periods in order that the modulation peaks be cared for. In spite of this low over-all efficiency of the grid system of modulation, for television purposes it offers the most economical and satisfactory combination at the present time.

D-C Component

In voice transmission the wave shape is essentially symmetrical with the axis at all times, the axis being defined as the line which equally divides the area under the wave. In television transmission this is usually not the case. The degree of symmetry is determined largely by the image being scanned at that instant[1]. This continuous axis shift may be considered as a varying d-c component. To improve the transmitter efficiency by reducing the dynamic modulation range, this d-c component may be used to shift the average carrier to follow the average illumination of the picture. At the receiver this d-c component is re-inserted at the cathode-ray tube grid so that a faithful video reproduction results. The d-c insertion at the transmitter is only

Fig. 3. Diagram of RCA 1-kw television transmitter.



*Part II of this article appeared in May, 1939, COMMUNICATIONS, p. 26.—Editor.

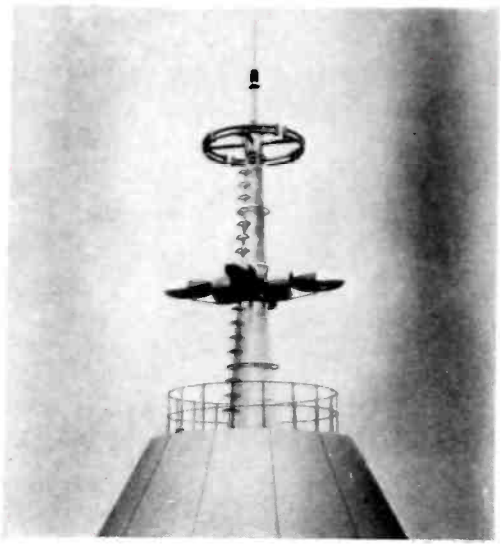


Fig. 7. Television transmitting antenna atop Empire State Building.

for more efficient operation of the transmitter, however.

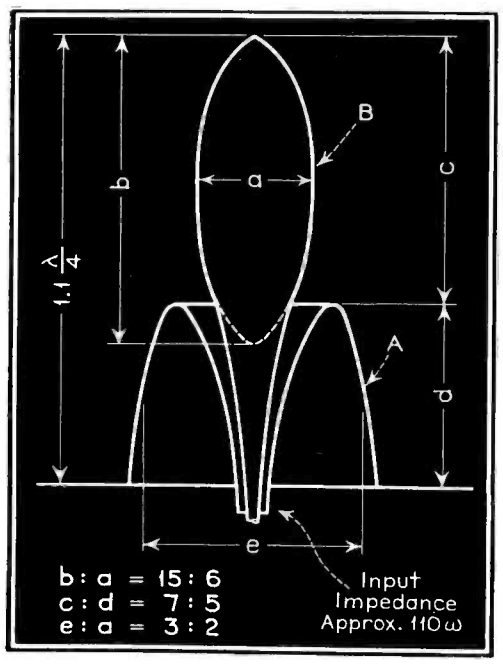
Vestigial Transmission

With the tentatively allotted television channels including an overall width of 6 mc, only a relatively low-definition image could be transmitted by the conventional double side-band system. Consequentially, it is the practice to send the upper side-band completely and the lower side-band "vestigially." That is, as much of the lower side-band as economically feasible is cut off. Here again is a relatively complex feature of the television transmitter which is not common to sound broadcasting. This side-band is removed by means of a filter in the antenna circuit. Coaxial transmission line segments of suitable lengths to give the required capacitance, inductance, or impedance are used as the elements of the filter.

Distortion Requirements

The hum-level requirements of a television transmitter are essentially the same as those of a high-quality broadcast transmitter. The harmonic distortion requirements for visual broadcasting are much less severe than for sound broadcasting. This arises from the fact that the detail of the picture will not suffer particularly from a non-linearity of the system, but only one degree of halftone reproduction at the reproducing tube. That is, details of the image transmitted through a non-linear system, although appearing in their proper position and size, may not have the proper degree of light and shade as compared to the other parts of the image. This relative insensitivity to a modest degree of nonlinearity also makes grid modulation more attractive.

Fig. 9. Optimum proportions of single radiator modified for supporting bracket.



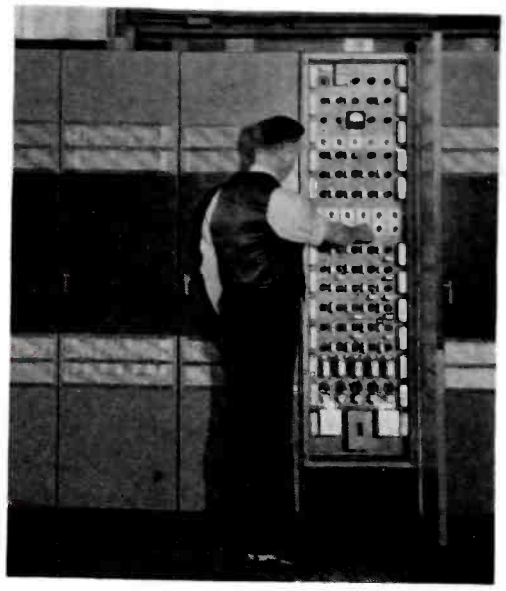


Fig. 6 (Above). Synchronizing impulse generator (RCA photo).

Fig. 5 (Below). Monitoring image and wave shape of video signal. See tubes above control panel of Fig. 4.

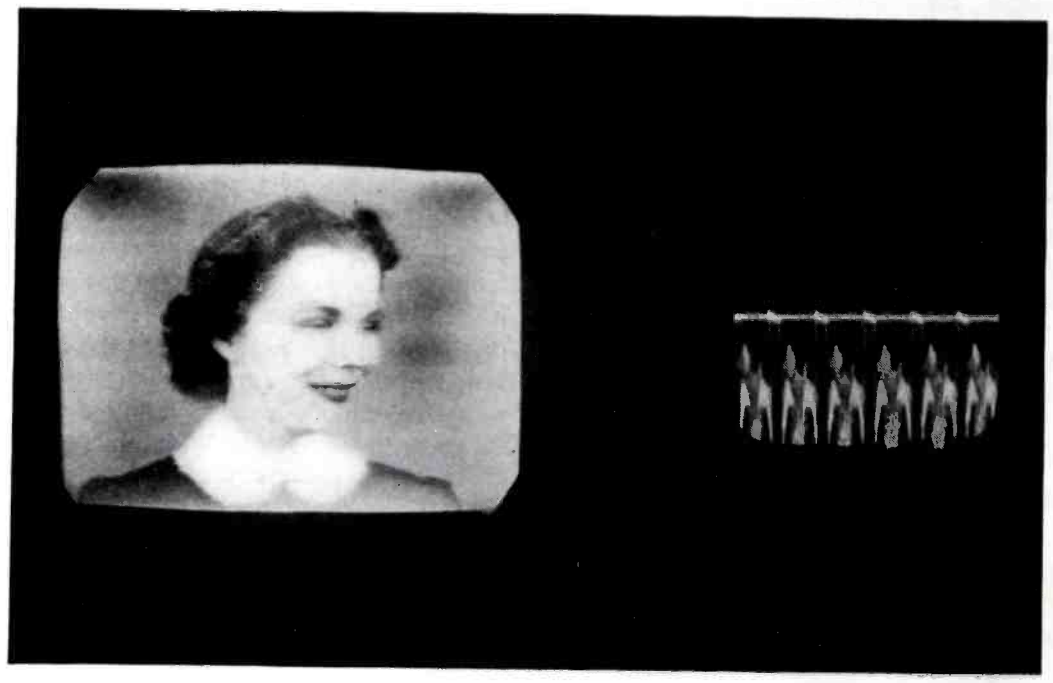
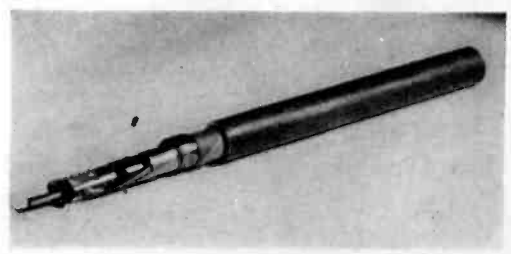


Fig. 4 shows video control position in the National Broadcasting Company's television studio 5. The operator has command of the studio floor through windows before him which are tinted to minimize glare from the highly lighted studio. The three knobs at the operator's left control the electrical focusing of the iconoscopes in the studio cameras. The operator is adjusting the brightness and video gain controls for best contrast and brightness in the image. The group of knobs to the right of the operator insert voltages of various shape and phase into the video signal to counteract the effect of spurious "shading" signals generated in the iconoscope. These spurious signals apparently are due to the fact that more secondary electrons are generated at the iconoscope mosaic than are supplied by the beam and a shower of electrons falls back on the mosaic. These electrons cause a random charge distribution over the mosaic which has no relationship to the video signal, but causes the "dark-spots." These dark spots are neutralized as well as possible by the adjustment of the knobs shown in Fig. 4. These spurious signals cannot be entirely eliminated as shown by the image of Fig. 5, which is the image appearing on the monitor tube above the operator of Fig. 3. The dark areas and the white borders on the picture are a

Fig. 1 is a photograph of a 1-kw television transmitter recently placed on the market by RCA. Fig. 2 is a rear view of one unit of this same transmitter. Fig. 3 is a highly simplified block diagram of the radio-frequency and video-frequency sections showing the tube complement utilized.

Fig. 10. Cutaway view of coaxial transmission line (RCA photo).



result of these effects and the attempt to neutralize them. The waveform of the video signal is constantly monitored by means of the oscillograph beside the image tube.

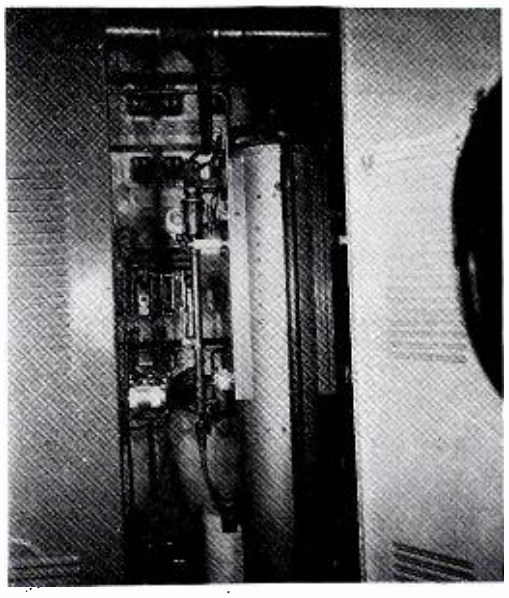
Fig. 6 shows a view of the synchronizing pulse generator which generates the pulses for both horizontal and vertical synchronization. The required regulated power supplies and amplifiers are included within the other cabinets.

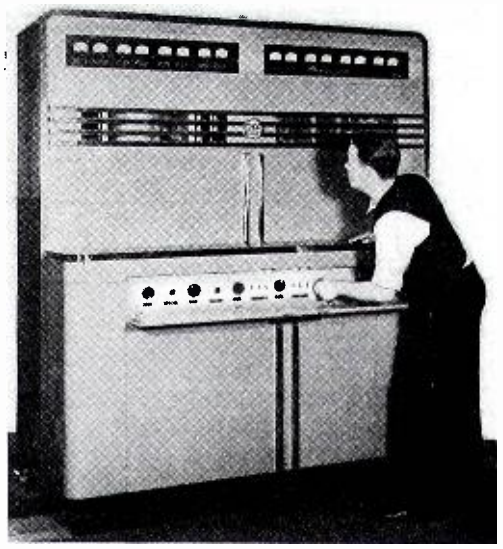
Television Transmitting Antennas

The antenna to be used with a television transmitter presents a problem in the relative difficulty in attaining constant characteristics over the necessary frequency band. Attaining these constant characteristics over a given band width becomes easier the higher the frequency of operation. Therefore, we can expect considerable simplification of vision antenna structures between the 44-50 mc channel and the 102-108 mc channel. As the trend is toward the higher frequencies, the extent of the experimental work that has been done is highly justified.

Fig. 1 (Right). A view of the 1 kilowatt television transmitter recently placed on market by RCA.

Fig. 2 (Below). A rear view of the 1-kilowatt television transmitter shown in Fig. 1.





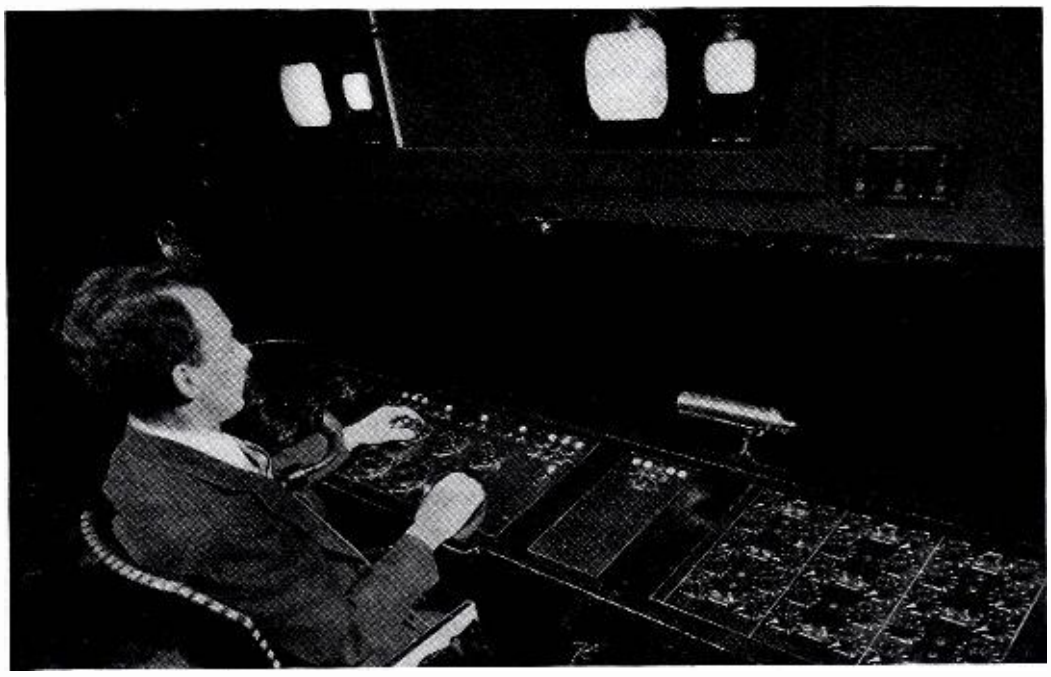


Fig. 4 (Above). The video control desk of the NBC television studios.

Fig. 8 (Below). Experimental steps in determining optimum proportions of antenna in Fig. 7.

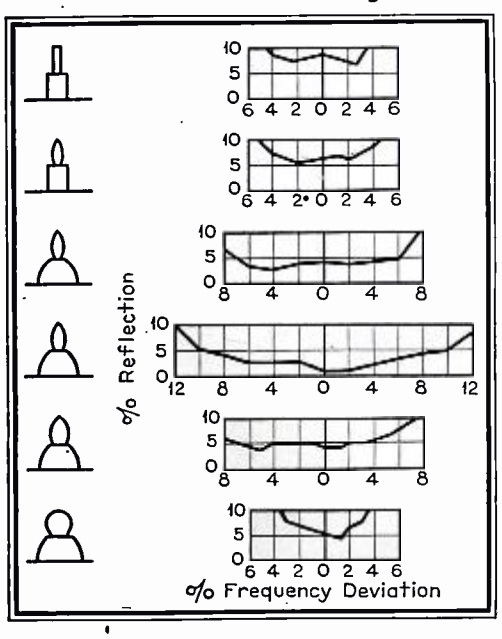


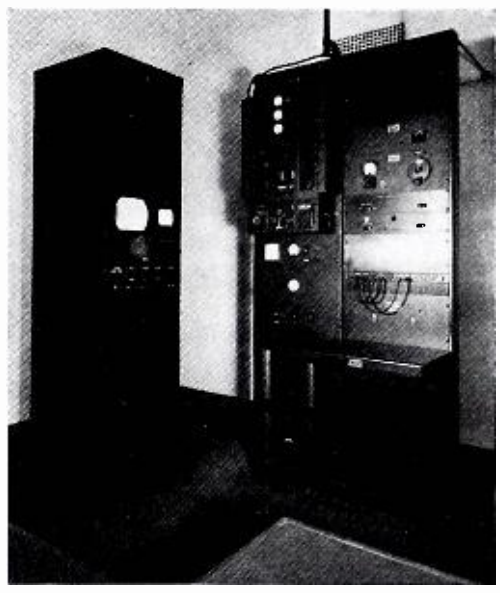
Fig. 7 shows a novel approach to the problem of attaining constant characteristics over a wide frequency band. This is a photograph of the vision and sound antennas atop the Empire State Building. The vision antenna is of particular interest and the neat experimental evolution of the final shapes as reported by Lindenblad is illustrated in Fig. 8, which is taken from his paper. In general, elliptical shapes of all of the radiator surfaces seemed to give the most constant impedance characteristics. In order that the protruding portion of the ellipsoid and the collar radiate equally, their relative lengths should be in the ratio of 7 to 5 as illustrated in Fig. 9, which is also taken from Lindenblad's paper. This gives an input impedance in the order of 110 ohms. The best ratio between major and minor axes of the ellipsoid is 15 to 6. The optimum ratio of mean collar diameter to ellipsoid diameter was found to be 3 to 2. The ellipsoid is bonded to the collar by a specially designed bracket for lightning protection. For vertically polarized waves, a single unit could be mounted vertically. For the desired horizontal polarization, 4 units were arranged around the tower excited in progressive phase quadrature as a "turnstile" antenna. It was found upon completion that this antenna had uniform characteristics over the range of about 30 to 60 mc, or 6 to 10 times that obtainable with other conventional designs with complicated correction networks. This truly represents a real advance in antenna technique.

Interconnecting Links

In the near future the problem of simultaneous network operation of a multiplicity of local television stations must be faced. This will be a particularly difficult economic problem in the United States because of the great distances and relatively low population density in most areas. The economic phase is even a

(*Continued on page* 36)

Fig. 11. 177-mc u-h-f transmitter linking Radio City studios with Empire State Building transmitter.



THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

WIRE STRIPPER

A new, low cost, power-driven, brush-type wire stripper, known as the Ideal 9-C Model, is announced by the Ideal Commutator Dresser Company, 4025 Park Avenue, Sycamore, Ill. This new unit greatly speeds up production work in stripping wires. A vacuum attachment draws the insulation materials into a drawer in the base of the unit, thus eliminating dust and dirt of stripping operations. The Ideal No. 9-C stripper strips cotton and enamel, silk and

enamel, string asbestos and other light insulations from round, flat or rectangular solid or stranded wire. It is especially effective in cleaning fine "Litz" wires, in removing gummy insulation imbedded in stranded wires and in cleaning the new "Formex" magnet wire.

SQUARE-WAVE GENERATOR

The Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Calif., has recently announced a square-wave generator for audio-frequency testing and development work. This instrument has a square-wave output of 50 volts peak-to-peak over the frequency range from 20 to 20,000 c-p-s. The time of rise of the voltage on each wave front is considerably less than one microsecond so that a square wave as high as 100,000 c-p-s can be obtained with sufficient squareness for many applications.

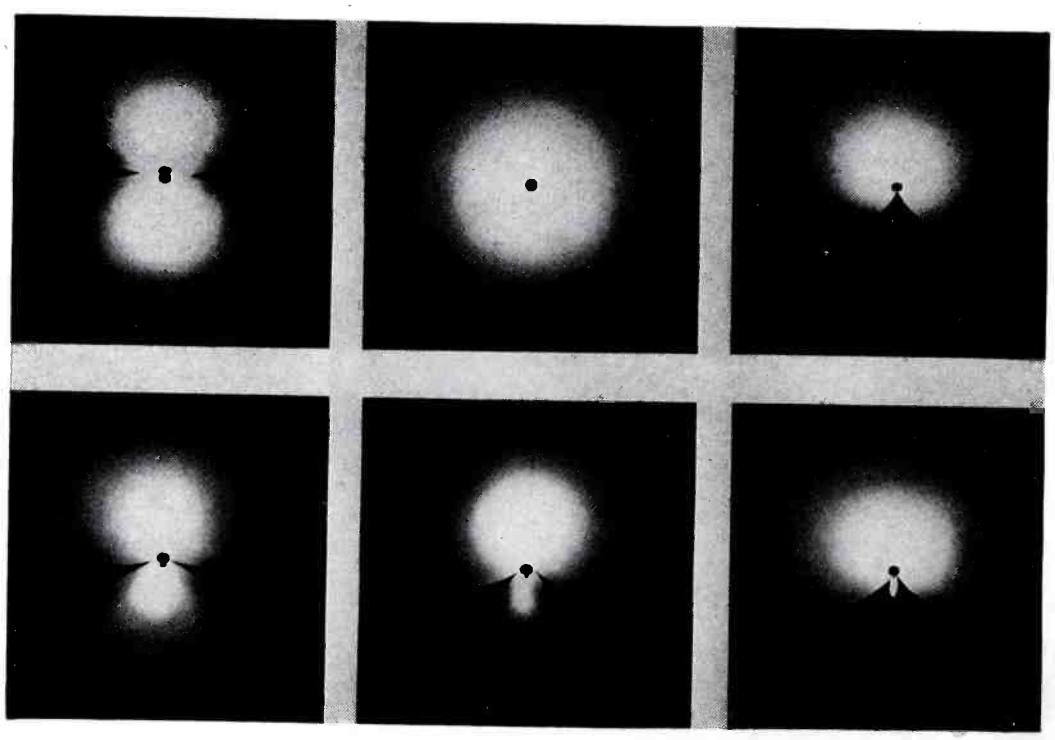
MIDGET ELECTROLYTICS

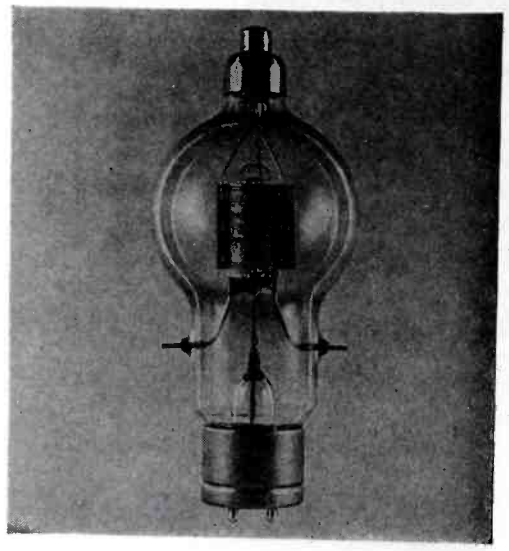
For applications calling for high-capacity values at low voltages, seven values and voltage ratings are now offered in the midget metal-can electrolytics by Aerovox

Corp., New Bedford, Mass. The capacities range from 1000 to 3000 mfd, with working voltages of 6, 12 and 15 d-c.

MULTIMIKE

By rotating a flush type selector switch imbedded in the rear of Western Electric's new "multimike," sound engineers may choose a sensitivity pattern suited to the acoustic characteristic of each studio or location. The diagrams illustrate how the sensitivity decreases (light to dark) in any plane drawn through the horizontal axis of the instrument for each switch position. Engineers designate the patterns as (left to right, upper row): bi-directional, non-directional, and cardioid directional. (Left to right, lower row) hyper-cardioid positions 3, 2, and 1. Note that in all but the non-directional and cardioid directional patterns, two areas of insensitivity exist. Western Electric Co., 195 Broadway, New York City.



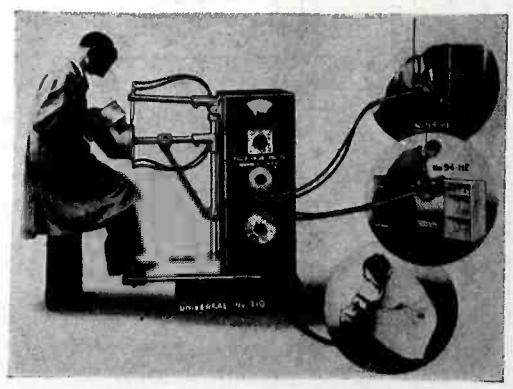


TETRODE POWER AMPLIFIER

The RK-65 is an ultra-high-frequency, high power gain tetrode having a thoriated tungsten filament, tantalum plate, grids, and shield and a hard glass bulb. Short heavy leads, directly through the bulb reduce the inductance and resistance of the grid leads as well as the plate lead. Reduced inductance and resistance of the screen grid lead allows for more effective screen by-passing in th u-h-f region. Lower input and output capacities, combined with low inductance, low resistance leads allow for optimum u-h-f circuit design and lower charging current lead losses. External grid seals eliminate grid dielectric losses in the standard stem, base and socket construction. The external seals also have the advantage of better ventilation and accessibility for forced air cooling, when necessary. Raytheon Production Corp., 55 Chapel St., Newton, Mass.

UNIVERSAL WELDER

The Eisler Engineering Co., 740-770 S. 13th St., Newark, N. J., has recently developed a universal spot welding machine known as the Universal Welder No. 310. This new type of spot welding machine is similar to a standard 10-kva spot welder with sliding horns adaptable for all kinds of sheet metal work. The new features on this machine are that on one machine not only spot welding, but also push welding, gun welding and arc welding can be performed.



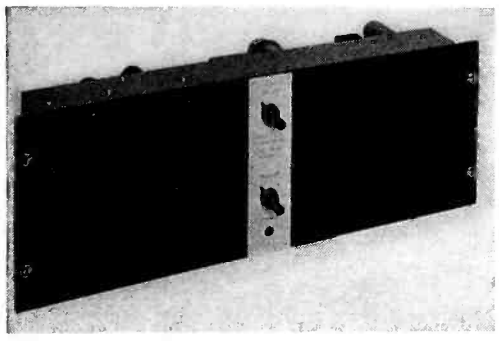
POLICE TRANSMITTER, RECEIVER

In the accompanying illustration are shown the Doolittle & Falknor 15X transmitter and PR-2C and PR-3C receiver for police use.

The 15X mobile transmitter uses filamentary-type tubes that require no power during standby periods. The 15X has 20

watts power output and operates on frequencies between 30 and 40 mc. The Q-188 control unit supplied with each 15X provides centralized operation of the 15X and also the PR-2 or PR-3 receivers.

The PR-2C and PR-3C receivers are for fixed frequency station use on 1600 to 3000 kc and 30 to 40 mc respectively. Both

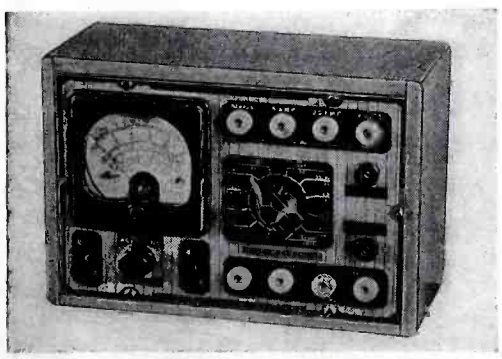


have integral power supplies, crystal controlled oscillators, squelch and noise elimination circuits Relay rack or cabinet mounting is optional.

Further information may be secured by writing to Doolittle & Falknor, Inc., 7423 S. Loomis Blvd., Chicago, Ill.

UNIVERSAL METER

An all-purpose portable multimeter for engineers, television technicians, industrial electricians, radio service men, auto electricians and radio amateurs, is announced by Radio City Products Co., Inc., 88 Park



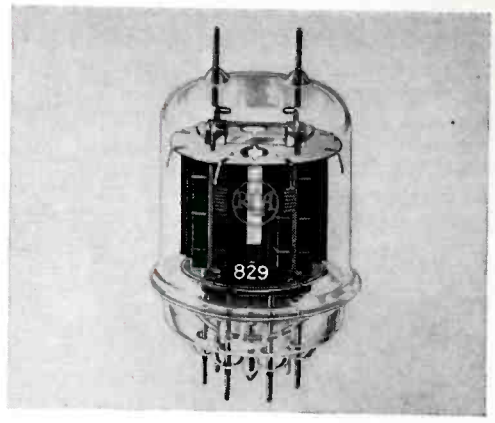
Place, New York City. This model 411P Supertester offers a full array of a-c and d-c voltage measuring ranges to 5000 volts, alternating and direct high-current ranges up to 25 amperes and a direct-current micro-range which permits measurement down to 4 microamperes. These are in addition to the more usual a-c and d-c milliampere, resistance, and decibel ranges.

MARINE RADIO

The Harvey-Wells Model MR-25 marine radio will provide general radio telephone communication for vessels making extended coastwise trips or cruising considerable distances off-shore. This model embodies features such as separate crystal holders for each channel, seven-tube superheterodyne receiver, noise-suppression circuit, single vibrator power supply for both transmitter and receiver, new type handset and choice of two cabinet colors. The MR-25 measures 16¼" wide x 11½" deep x 12" high. The power supply, which is mounted on a separate chassis, operates from all standard d-c inputs as well as from any 110-volt a-c outlet. A new output circuit lends itself to easy and efficient loading of the ship's antenna. Harvey-Wells Communications, Inc., Southbridge, Mass.

RCA 829

The RCA Radiotron Division, RCA Manufacturing Co., Inc., Harrison, N. J., have announced the RCA-829, a new push-pull beam-power amplifier tube having a total maximum plate dissipation of 40 watts. A single 829 operated in push-pull Class C telegraph service is capable of handling a power input of 120 watts with less than a watt of driving power at frequencies as high as 200 megacycles. Further information may be obtained from the above organization.



(*Continued on page* 30)

A LIGHT-PATTERN CALIBRATION CHART

(See page 26)

By A. JAMES EBEL
Chief Engineer
WILL

THE art of instantaneous recording has advanced so rapidly in the past few years that today standards for recording equipment are on a level with those of other reproducing equipment. No longer can the recorder employ hit and miss methods in determining the characteristics of his recording equipment. Much has been written concerning the light pattern method of determining the frequency response characteristics. Less has been written concerning methods of determining amplitude distortion using the same method. In either case it is necessary to know what power level is represented by the widths of the various bands. Fig. 1 is a photograph typical of a frequency response pattern. While inspection will show that the head records up to 10,000 cycles and has a peak at 5,000 cycles, the amount of equalization necessary can only be determined after evaluating in terms of db the power

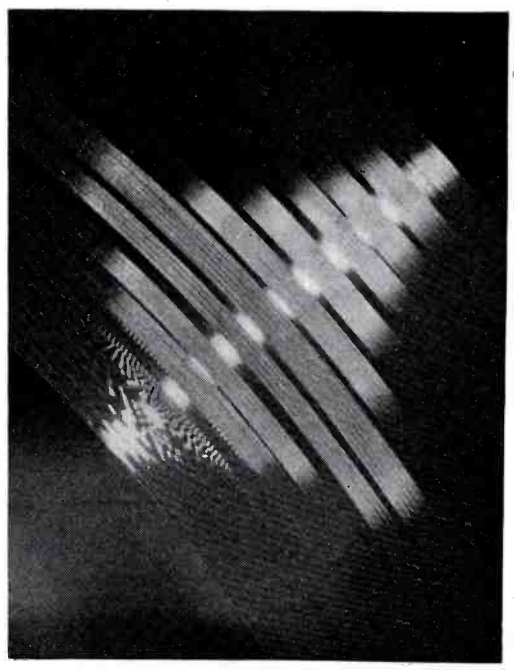


Fig. 1. A photograph typical of a frequency response pattern.

levels represented by the band widths.

In 1930 Buchmann and Meyer[1] described a method whereby the recorded velocity can be determined by inspection of the light pattern formed when oblique light falls on the record. It was shown that

$$V = \frac{W \pi N}{60} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

V Stylus velocity in cm/sec.
W Band width in cm.
N RPM at which recording was made.

A pickup device will, when playing the recording represented by (1) above, generate a voltage which is given by

$$E = \frac{K_p W \pi N}{60} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where

E = voltage generated by pickup device.

K_p = transformation constant of pickup device.

Since N is essentially constant during the recording, the constants may be combined and (2) written as

$$E = KW \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where K represents the combination of all the constants in (2). If width, W_o, gives rise to a voltage, E_o, then the constant, K, may be evaluated as follows:

$$K = \frac{E_o}{W_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Therefore, the voltage generated by any width band may be expressed in terms of E_o and W_o. Assuming for width W_o zero level output, we can express the output in db represented by any other lightband width.

$$\text{Recorded level (db)} = 20 \log W_o \quad (5)$$

The chart on page 26 shows the plot of this function when zero level equals one centimeter. It might be well to point out here that the chart is also valid for zero level equals one inch if the ordinates are taken as inches instead of as centimeters. It is not necessary, of course, that the 1,000-cycle value be at zero level since a frequency response curve can be drawn at any level.

The curve in Fig. 2 was taken from the pattern in Fig. 1. Since the picture was reduced in printing the levels scaled from the printed picture will not be the same as those scaled from the original but the frequency response curve will be exactly similar.

In a like manner the amplitude characteristics of a recording head can be obtained. At any given frequency, record a group of bands, each band representing a definite increase over the previous band, say in 3-db steps. Then by plotting the input as abscissas and the outputs, scaled from the light bands on the record, as ordinates, an amplitude response curve can be obtained. Any departure from linearity indicates the presence of amplitude distortion in the recording system.

[1] *E.N.T.*, 147, 1930.

LIGHT-PATTERN CALIBRATION CHART

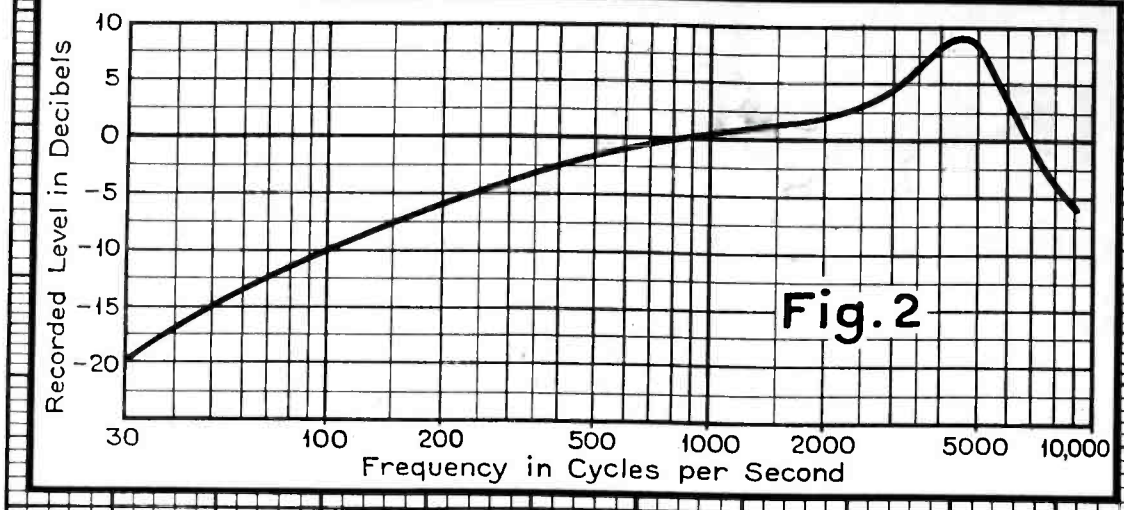
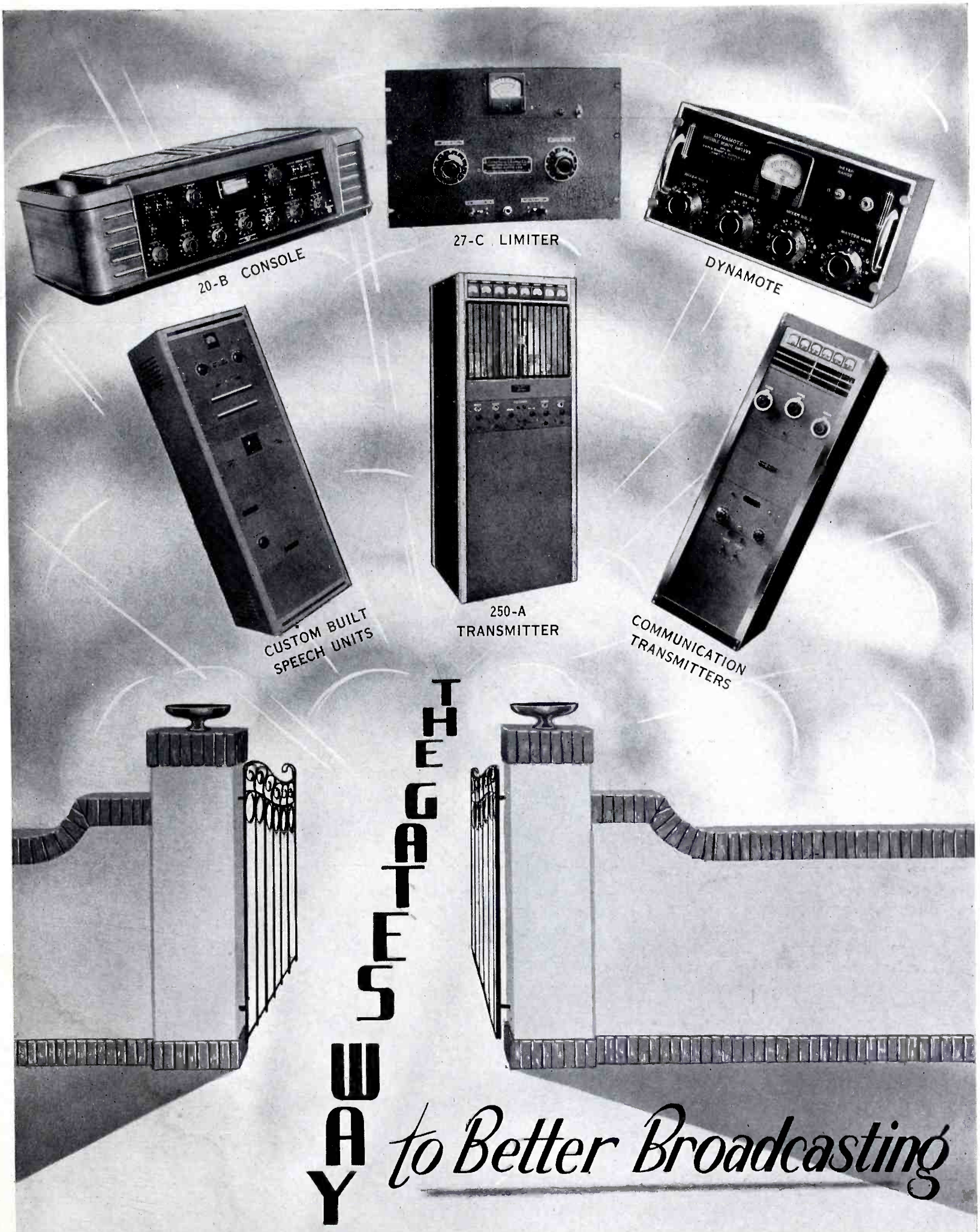


Fig. 2

Pattern Width in Centimeters
10
9
8
7
6
5
4
3
2.5
2
1.5
1.0
.9
.8
.7
.6
.5
.4
.3
.25
.2
.15
.1

-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16

Recorded Intensity in Decibels



The GATES Companies—

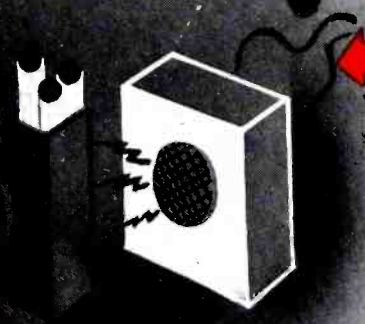
— GATES AMERICAN CORPORATION
— GATES RADIO & SUPPLY COMPANY

QUINCY, ILLINOIS, U. S. A.

CABLE ADDRESS . . . GATESRADIO.

BELIEVE IT OR NOT

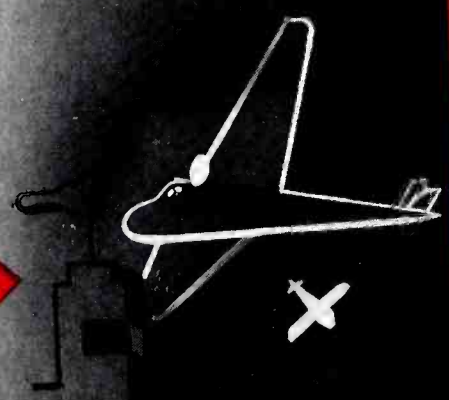
Of Weight and Such



Hearing aid units combining microphone and vacuum tube amplifier have been reduced in size to a point where they are no larger than a package of cigarettes. Part of this program was made possible by the UTC output reactors providing 75 HYS.-.5 MA. in a 6/10 OUNCE unit.

One of the devices, now being manufactured with UTC transformers makes possible physical measurements of ONE MILLIONTH INCH.

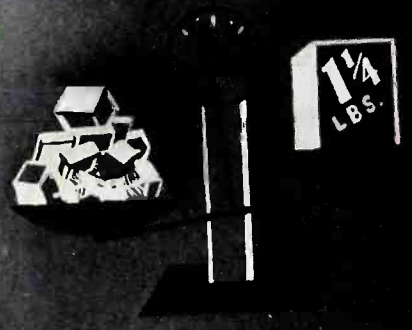
Brain wave amplifiers require negligible phase shift and amplitude distortion down to one-half cycle. Output coupling for these units has been made possible by new UTC transformers suitable for HALF CYCLE operation.

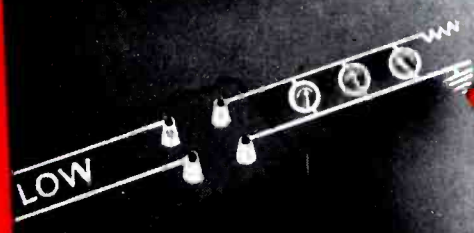


Power transformers for aircraft equipment must be light. A typical 100 WATT UTC unit now weighs 1½ POUNDS.

One special UTC output reactor weighs only 35 OUNCES PER 100 UNITS, yet employs 8,000 TURNS of wire in the coil.

A still unparalleled UTC aircraft filter weighs only 1¼ POUNDS, yet contains TWO OUTPUT TRANSFORMERS, SIX HIGH "Q" CHOKE COILS, and SIX CONDENSERS totalling FOUR MFDS.





The capacity loss of shielded cable is generally important only at high frequencies. In a special high gain SIXTY CYCLE UTC transformer, however, the capacity loss of the shielded lead is over 2 DB PER FOOT. COAXIAL CABLE is needed in this case, FOR 60 CYCLES.

UNITED TRANSFORMER CORP.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

AUTOMATIC TIME SIGNALS

By ROY BATTEAU
Engineering Staff
WSAZ, Incorporated

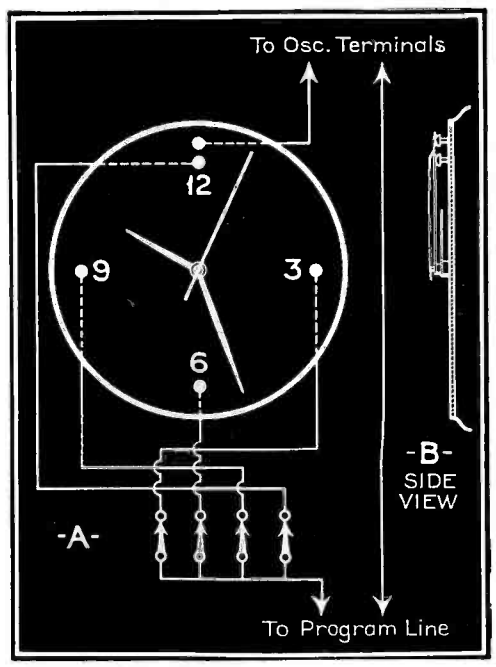
A simple method for placing automatic time tones or signals on the air. The accuracy will depend upon the stability of the power-line frequency as well as the accuracy of the clock.—Editor.

HAVING on hand the problem of putting automatic time signals on the air, the engineering staff of WSAZ, after considering some of the more complicated circuits and devices, evolved the unit described in the following paragraphs. Since simplicity was the main object, no split-second accuracy is claimed for the signals put out by this unit, the accuracy depending upon that of the clock and the reliability with which the local utility company maintains the proper power-line frequency.

Perhaps a brief description of methods used to ascertain and correct any frequency deviation would be of interest. The usual method is to use a clock with two second hands. One of the second hands is controlled by a frequency standard and the other is controlled by the power-line frequency, just as any other electric clock. As long as the two hands indicate the same time all is well and good, but any deviation between the two indicates a slight shift of the power-line frequency. At regular intervals the speed of the generators is shifted slightly so that after a short time the two second hands will again coincide and the power-line frequency is back to normal. This of course corrects all the clocks being operated from that particular power line. The latest method uses a clock very much similar to the one described above, but in addition gives a continuous, automatic regulation of the frequency, thus assuring the correct time at any and all times.

The clock we used is a Telechron (six-inch dial) and to the date of this writing has never been more than one second off, compared to Arlington's time signals. The error is usually a very small fraction of a second.

Perhaps, strictly speaking, this is not a time signal, since it does not indicate the time, but it does give an "on the nose" tone, which, preceded by a suitable announcement, serves the purpose quite well. At times this may even be considered more satisfactory than a time-indicating signal, since it lasts only a fraction of a second, thus rarely interfering with the regular program or station break, and it is easily understood by any listener. Also, it is readily worked into spot announcements using time signals, requiring only the cooperation of the announcer in timing the spot.

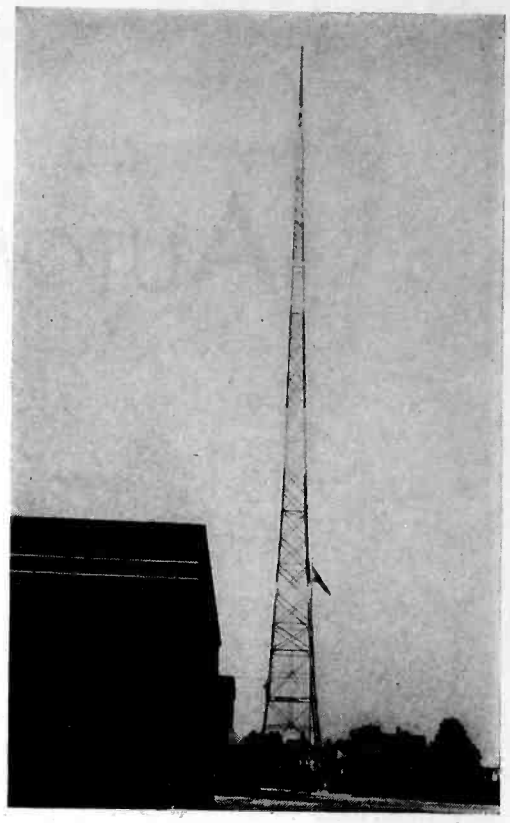


(A) Diagram showing connections to clock from oscillator terminals. (B) Side view showing contact points for the second and minute hands.

The constructional details are so few and simple that it seems hardly necessary to do more than refer to the diagrams. The contact points used were size six, round head machine screws, insulated from the metal clock face by fiber washers. The contact point for the second hand is farthest from the center and is so placed that the second hand touches it very lightly as it passes the sixty-second mark. It is quite important that this contact be light and the contact point very smooth, as any roughness will result in a harsh, scratchy tone. Also, if the contact is too heavy it may cause a drag on the second hand, and since this contact is made once every minute, it would soon have the clock running far behind the correct time. This detail is not so important for the minute hand. To prevent interference with the other hands of the clock, either this contact point must be slightly higher than the others, or the hand curved down a bit at the tip to meet the contact point, as shown in the diagram, (B). The other four points are placed one-fourth of an inch nearer the center, at the fifteen, thirty, forty-five and sixty-minute marks. It may be necessary to shorten the minute hand slightly, but this will in no way impair the value of the clock.

In operation, the circuit is completed through the hands of the clock. Although the second hand closes that part of the circuit once every minute, there can be no signal unless the minute hand is also making contact with one of the other four points. The four external switches were used in the circuit so that the signal could be omitted at one or more points without eliminating the others, as, for instance, during a thirty or sixty-minute program in which the time signal would be undesirable.

Any oscillator with a suitable tone may be used and it might be desirable to use a transformer or pad between this unit and the program line. We are using a 400 c-p-s oscillator adjusted to modulate about fifty-five percent. This modulation level seems to be the most satisfactory of several tried.



A 300-foot u-h-f tower installed by American Bridge Company at Cleveland, Ohio.

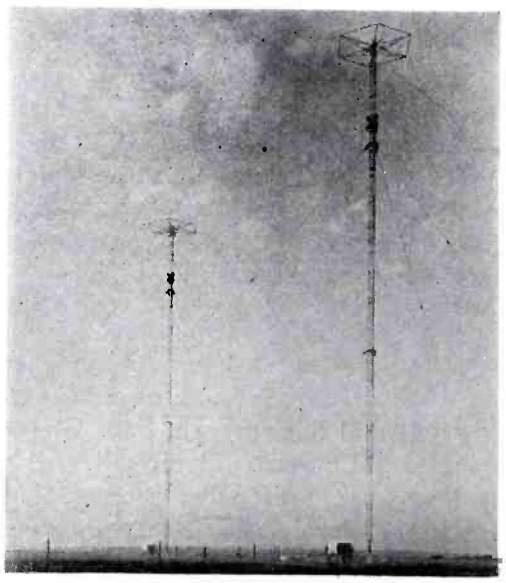
THE MARKET-PLACE

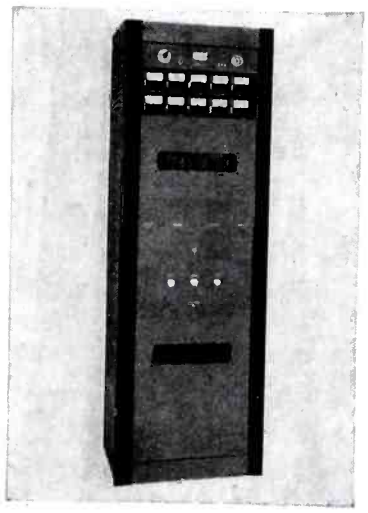
(*Continued from page* 24)

U-H-F STATION UNIT

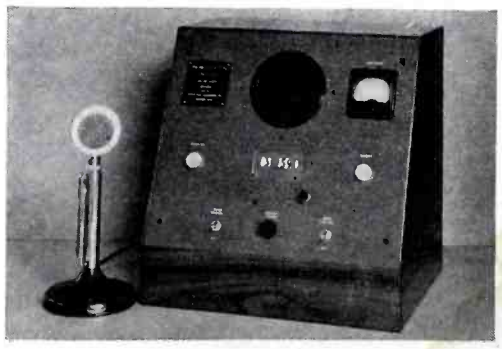
The Harvey PF-100C is an ultra-high-frequency communication unit designed for central station use by police, fire, public utility and emergency services. The frequency range is from 20-80 mc, while power output is 100-125 watts. It consists of a standard PF-100 transmitter and a type PFR-10 u-h-f superheterodyne receiver. The PF-100C is designed primarily for local control of the transmitter and receiver, but can be modified when desired for full remote-control operation. A modulation monitor is provided to show visually percentage modulation on both positive and negative peaks, to show carrier shift and to provide an aural monitor so that the operator may listen to transmitter carrier. An automatic volume compression circuit is also incorporated. A remote unit is supplied which contains a microphone preamplifier, audio output stage and necessary control circuits. Harvey Radio Labs., Inc., 25 Thorndike St., Cambridge, Mass.

Antenna towers of WWL, New Orleans, La. Photo from International Derrick & Equip. Co.





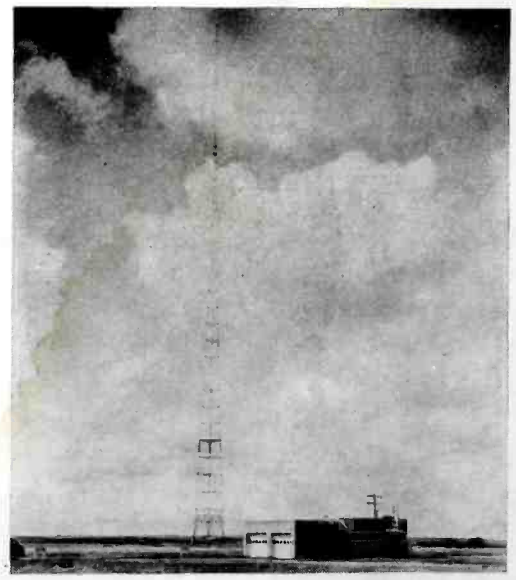
Showing Harvey Radio transmitter (above) and remote-control unit (below).



WESTINGHOUSE APPOINTMENT

Two new directors of the Westinghouse Electric & Manufacturing Company were elected at a recent Board meeting of the company. They are George A. Blackmore, President of the Westinghouse Air Brake Company of Pittsburgh and of the Union Switch and Signal Company of Swissvale, Pennsylvania, and Arthur W. Page, a Vice-President and Director of the American Telephone and Telegraph Company of New York, and a Director of the Continental Oil Company. The announcement was made by A. W. Robertson, Chairman, following a meeting of the Board of Directors at the Westinghouse New York offices, 150 Broadway.

The 700-foot Truscon tower at KFYR, Bismarck, N. D.

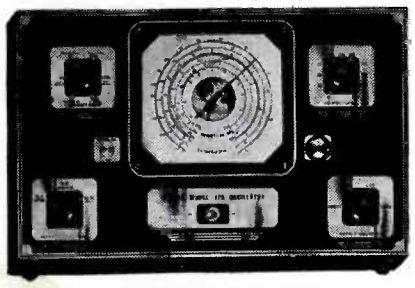


FOR NEW TEST REQUIREMENTS OF

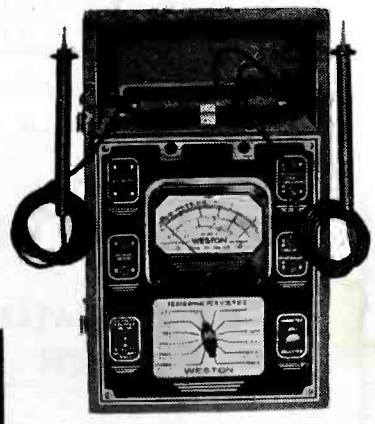
Frequency Modulation

1. F.M. assigned channels 40 to 44 mc. — band width 100-200 kc.
2. F.M. intermediate frequencies 2 to 5 mc. — each stage aligned at exactly the same point.
3. Checking limiter and discriminator circuits.

WESTON Model 787
U.H.F. Oscillator



WESTON Model 776
direct-reading Oscillator



WESTON Model 772
Super-Sensitive Analyzer

HERE ARE THE ANSWERS:

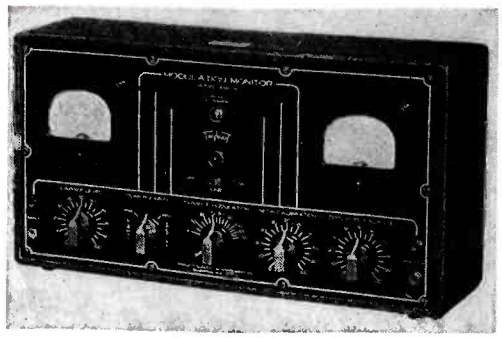
1. The WESTON Model 787 is the only service Oscillator which reads 40 kc. per division at 40 mc. This precise tuning is absolutely essential to test the band width of F.M. receivers. Each instrument is individually hand calibrated at 2 mc. intervals. (The broad frequency coverage of Model 787... from 22 to 150 mc. fundamental frequencies... safeguards against obsolescence in the event of changes in assigned channels.)

2. The WESTON Model 776 Oscillator supplies an absolutely stable signal source. Laboratory tests have shown that the frequency drift is less than .05% at 5 mc. for an operation period of several hours. This stability is the result of newly improved control circuits. With Model 776, too, an individually hand calibrated scale insures dependable accuracy over its entire frequency range of from 50 kc. to 33 mc., fundamental frequencies.

3. Because of frequency limitations of present visual aligning equipment, current measurements down to 1 microampere offer the only means of checking I.F. alignments, cut-off point on limiter tube, and adjustment of discriminators. WESTON Model 772 Super-Sensitive Analyzer offers all ranges necessary to make these sensitive measurements; *plus* additional ranges for all customary voltage, current and resistance measurement needs.

Full particulars on the above instruments are available in bulletin form, and will gladly be sent on request. Weston Electrical Instrument Corporation, 612 Frelinghuysen Avenue, Newark, New Jersey.

WESTON *Instruments*

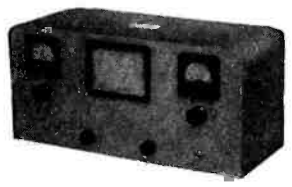


MODULATION MONITOR

A recent bulletin issued by the Triplett Electrical Instrument Co., Bluffton, Ohio, describes the 1696-A modulation monitor. Designed primarily for amateur use, the instrument operates from 100 to 130 volts, 50 to 60 cycle line. Copies of the bulletin may be secured from the above organization.

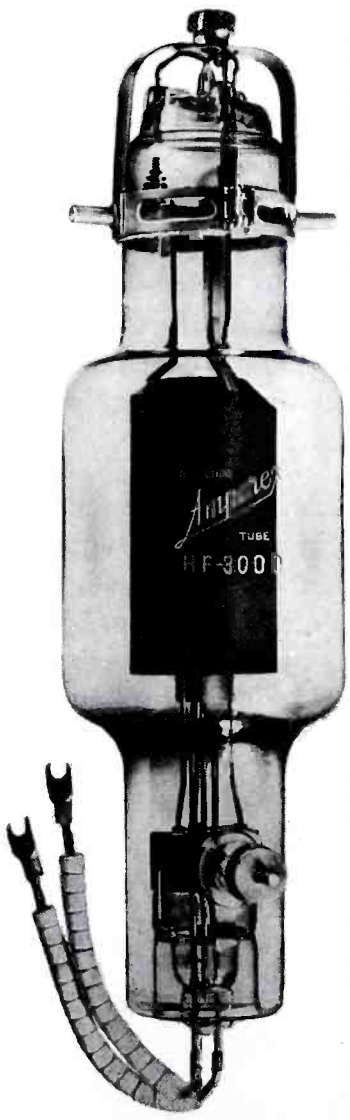
U-H-F TRANSMITTER-RECEIVER

A complete six-tube transmitter and receiver mounted in a small cabinet has been announced by Radio Transceiver Laboratories of Richmond Hill, N. Y. This 112-mc



unit has been designed along the lines of previous 56 mc units. The parts have been arranged for easy conversion to 224 mc by substitution of smaller inductors.

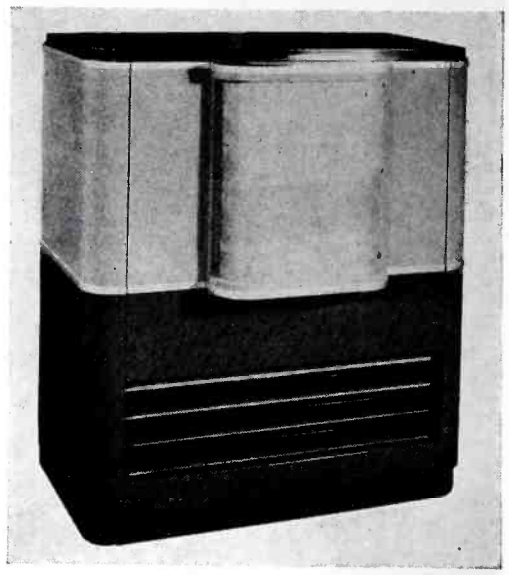
AMPEREX TUBES



Amperex Electronic Products, Inc., 79 Washington St., Brooklyn, N. Y., have recently made available a series of high-power air-cooled transmitting tubes which are capable of operation at high frequencies. These tubes are designated as the HF3000, HF3100 and ZB3200. The HF3000, shown in the accompanying illustration, is an all-glass radiation air cooled triode suitable for use as Class C plate modulated r-f power amplifier (frequency limit 45 mc), Class C unmodulated or negatively modulated r-f power amplifier (frequency limit 60 mc) and as a Class C telegraphy r-f power amplifier (25 mc). The ZB3200 is also an all-glass radiation plus forced air-cooled high-power triode especially suitable for use as a zero-bias Class B modulator, Class B r-f power amplifier, and Class C telegraphy r-f power amplifier.

MONITOR SPEAKER

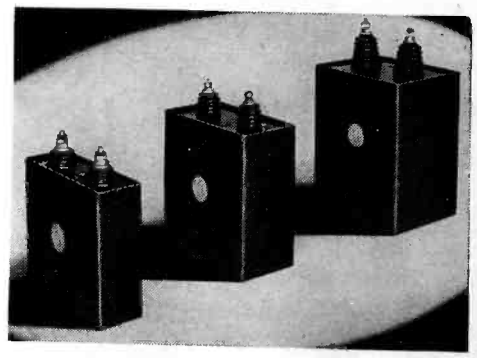
A new monitoring loudspeaker employing a newly-designed permanent magnet mechanism and housed in a cabinet which is said to permit a wide angle of sound distribution has been announced by the RCA Manufacturing Co., Camden, N. J. The loudspeaker (Model 64-B) is designed pri-



marily for broadcast control room monitoring, but its reproducing qualities make it suited for many other applications.

TRANSMITTER CAPACITORS

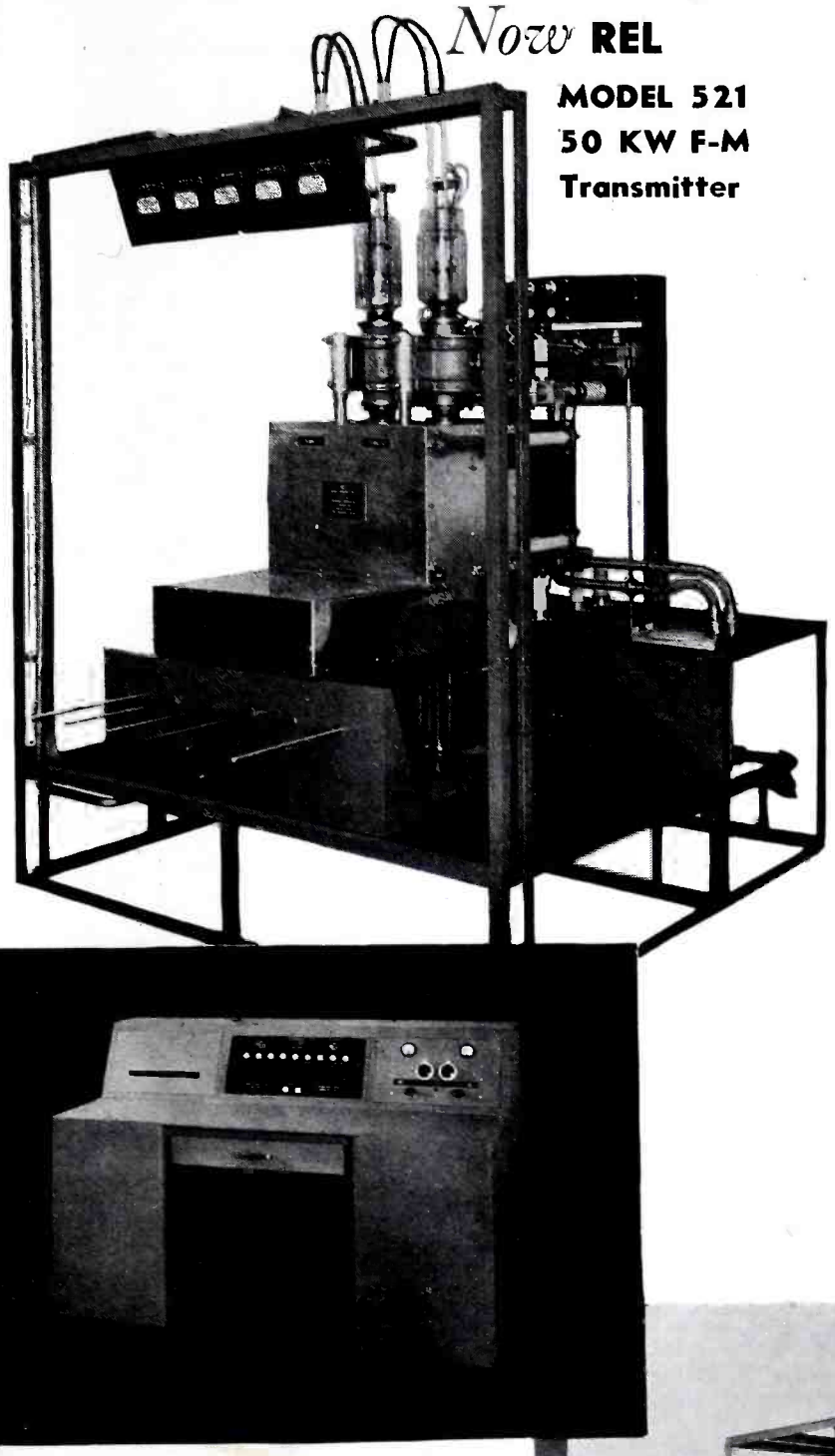
The Cornell-Dubilier Type TK Dykanol capacitors provide characteristics suited to high-voltage transmitter applications. The d-c working voltages range from 6000 to 25,000 in a wide range of capacity values.



Aluminum foil is employed in the construction, contributing to low r-f resistance. Multi-laminated kraft tissue provides high insulation resistance and high voltage breakdown. Dykanol "A" is used to immerse, seal and impregnate the foil-tissue assembly. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

FREQUENCY MODULATION

(ARMSTRONG SYSTEM)



First to Develop

Original equipment at W2AG (Yonkers, N. Y.) and at W2XMN (Alpine, N. J.) was developed at REL in collaboration with the inventor, Major E. H. Armstrong.

First to Produce

F-M Equipment for the following:

15-W. Portable Mobile Transmitter	1000-W. High Fidelity Broadcast Transmitter
50-W. Portable Broadcast Relay	2000-W. High Fidelity Broadcast Transmitter
50-W. High Fidelity Studio-Station Relay	5000-W. High Fidelity Broadcast Transmitter
200-W. High Fidelity Studio-Station Relay	50000-W. High Fidelity Broadcast Transmitter

Now in Daily Service

REL F-M Transmitters are no longer in the experimental stage, as proved by the following list of stations which are now servicing the public daily:

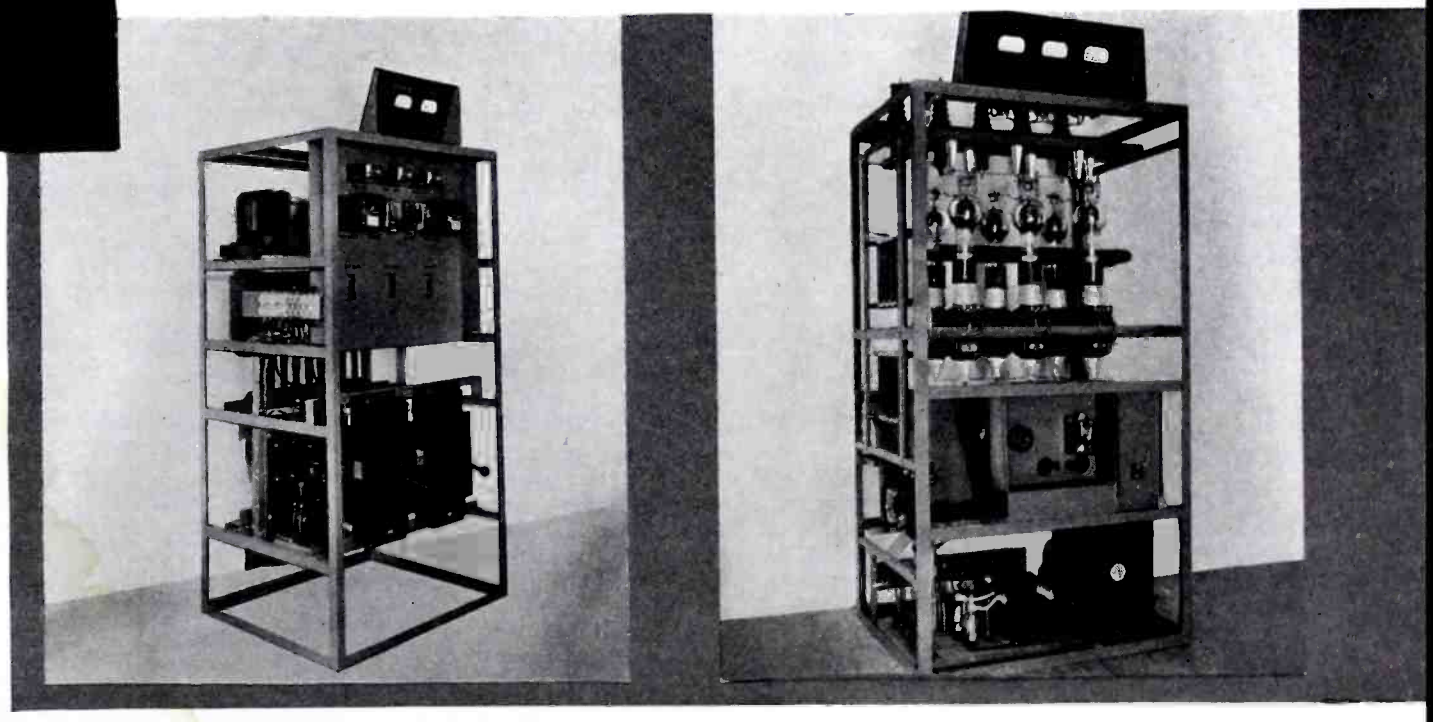
STATION	LOCATION	OWNED BY
W2XMN	Alpine, N. J.	Maj. E. H. Armstrong
W2XAG	Yonkers, N. Y.	C. R. Runyon, Jr.
W1XOJ	Paxton, Mass.	Yankee Network
WEOD	Boston, Mass.	Yankee Network
W3XO	Washington, D. C.	Jansky & Bailey
W8XVB	Rochester, N. Y.	Stromberg-Carlson
W2XQR	Long Island City, N. Y.	J. V. C. Hogan
W9XAO	Milwaukee, Wisc.	The Journal Company
W8XAD	Rochester, N. Y.	WHEC, Inc
W2XOR	Newark, N. J.	Bamberger Broadcast Service

and the following are now being built by REL:

STATION	LOCATION	OWNED BY
WGAN	Portland, Me.	The Portland Broadcast. System, Inc.
WWJ	Detroit, Mich.	The Evening News Association

A large percentage of the construction permits now on file with the FCC calling for F-M equipment specify REL Transmitters.

We invite engineers and executives to profit from our experience as the pioneer builders of successful F-M Transmitters.



Various components of the REL 50 KW F-M Transmitter are here illustrated.

Above—top—shows the power amplifier unit before it is mounted in its shielded room. Immediately beneath is the central control desk. which contains all monitoring equipment.

To the right—
1st—Power control.
Next—Rectifier Unit.

These units are only part of the complete station. All units are assembled in a building particularly designed for the purpose.

REL

RADIO ENGINEERING LABORATORIES, INC.

35-54 36th STREET — **Phone RAvenswood 8-2340** — **Cable "RADENGLABS"** — **LONG ISLAND CITY, N. Y.**

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Tribute

OUR Association paid tribute to the broadcasting industry of the country as the "Finest in the World" by the presentation of awards to the leaders of the industry on the occasion of our Fifteenth Anniversary-Cruise on February 21, 1940, at the Hotel Astor, New York City. The Marconi Memorial Service Award, a beautiful bronze plaque—an enlargement of our medal design—was presented to Neville Miller, President of the National Association of Broadcasters for the industry. Honorary memberships were tendered Mr. Miller; Lenox R. Lohr, President of the National Broadcasting Company; Alfred J. McCosker, Chairman of the Board of the Mutual Broadcasting System; William S. Paley, President of the Columbia Broadcasting System. Marconi Memorial Medals of Achievement were presented to the engineering heads of the three major networks of the country: O. B. Hanson, Vice-President and Chief Engineer of the National Broadcasting Company; J. R. Poppele, Chief Engineer of WOR-Mutual; and E. K. Cohan, Vice-President in charge of Technical Operations of the Columbia Broadcasting System.

A Marconi Memorial Medal of Merit was awarded to Admiral Stanford C. Hooper for his outstanding contributions in developing the radio communications service of the U. S. Navy to its present high standard. Admiral Hooper was aboard the *S. S. Brazil* enroute to New York from the Inter-American Radio Conference at Santiago, Chile, and was notified of the award by a message tapped out by David Sarnoff, President of RCA and transmitted over the facilities of the Radiomarine Corporation and RCA Communications after which Admiral Hooper handled the key in the wireless cabin of the *Brazil* in acknowledgment. Both messages were heard over the public address system in the banquet hall. The exceptionally fine code work of Mr. Sarnoff and Admiral Hooper was applauded by those present.

A portion of the presentation program was broadcast over NBC-Blue and the Mutual Broadcasting System. Our President, William J. McGonigle, made the presentations and the program was concluded by Dr. Lee de Forest, our Honorary President, who delivered his annual message to the Cruise from the NBC studios in Hollywood.

World's Fairs

The West Coast Chapters of our Association will sponsor a "De Forest Day" at the San Francisco Exposition of the Pacific during the first week in August. All interested in this tribute to the "Father of Radio" should communicate with Gilson Willets, San Francisco Chapter Chairman at 1434 Twenty-sixth Avenue, San Francisco, Calif.

A "Wireless Pioneer's Day" at the New York World's Fair 1940 will be sponsored by our Association sometime in August or September of this year. Further details will be included in this page. All interested should communicate with us at Radio City, N. Y.

Membership

Our hard working Secretary, George H. Clark, will appreciate your cooperation in sending in your 1940 dues. If you are not sure of your status just send along a year's dues and he will send the appropriate dues card. There are innumerable details in connection with our Association's activities and we earnestly request your wholehearted cooperation and indulgence.

Honolulu

A very interesting communication from our energetic Honolulu Chapter Chairman, George Street, Superintendent of R. C. A. Communications in the Territory of Hawaii. George writes:

"The Honolulu Chapter will hold a meeting on the evening of April 6th, 1940, to do honor to John Adian Balch, who is to be retired from the Presidency of the Mutual Telephone Company (of Hawaii) at the end of March.

"All of the old timers in this part of the world have a great deal of respect and admiration for Mr. Balch, who is in his own right a pioneer in wireless communication. We should like to nominate Mr. Balch for an award to recognize his pioneer wireless work in the Territory of Hawaii and the linking of these islands together in what is one of the oldest continuous service wireless telegraph and telephone companies in the world.

"Mr. Balch was born in San Francisco on August 6, 1876, and educated in the public schools of that city. Son of a prominent mining engineer he began work with his father in California mining companies. Later he was a chemist and superintendent of smelting for the Mountain Copper Company in California.

"His attention was turned definitely from mining to communications upon his arrival in Hawaii on March 15, 1907. In June of the same year, with others interested, he purchased the Wireless Telegraph Company operating between the Hawaiian Islands and became its Vice-President and Manager. Mr. Balch devoted all his interest to improving this system and erected at Kahuku, Oahu, the first Hawaiian ship-to-shore station which was completed in 1908. In 1909 he assisted in effecting the amalgamation of the Wireless Telegraph Company and the Mutual Telephone Company, becoming Vice-President of the combined companies. Later he was elected to other offices and to the board of directors. The past fourteen years Mr. Balch has held the office of President of the Mutual Telephone Company.

"During his regime not only have the islands of the Territory been brought together by communication facilities undreamed of by early residents, but the whole world has been linked to Hawaii by wireless telephone. In the first days of ultra-high-frequency experiments Mr. Balch undertook the construction of an inter-island radio telephone system and by extensive experimentation definitely established that such a service was possible. This system which has been successfully operating for more than a decade employs high-frequency transmitting and receiving links situated on mountain tops offering unobstructed vision of the islands of the group. He has realized a life-time ambition in fulfilling his intense interest in communications whereby telephone stations on any part of the local island system is successfully linked to practically the entire world.

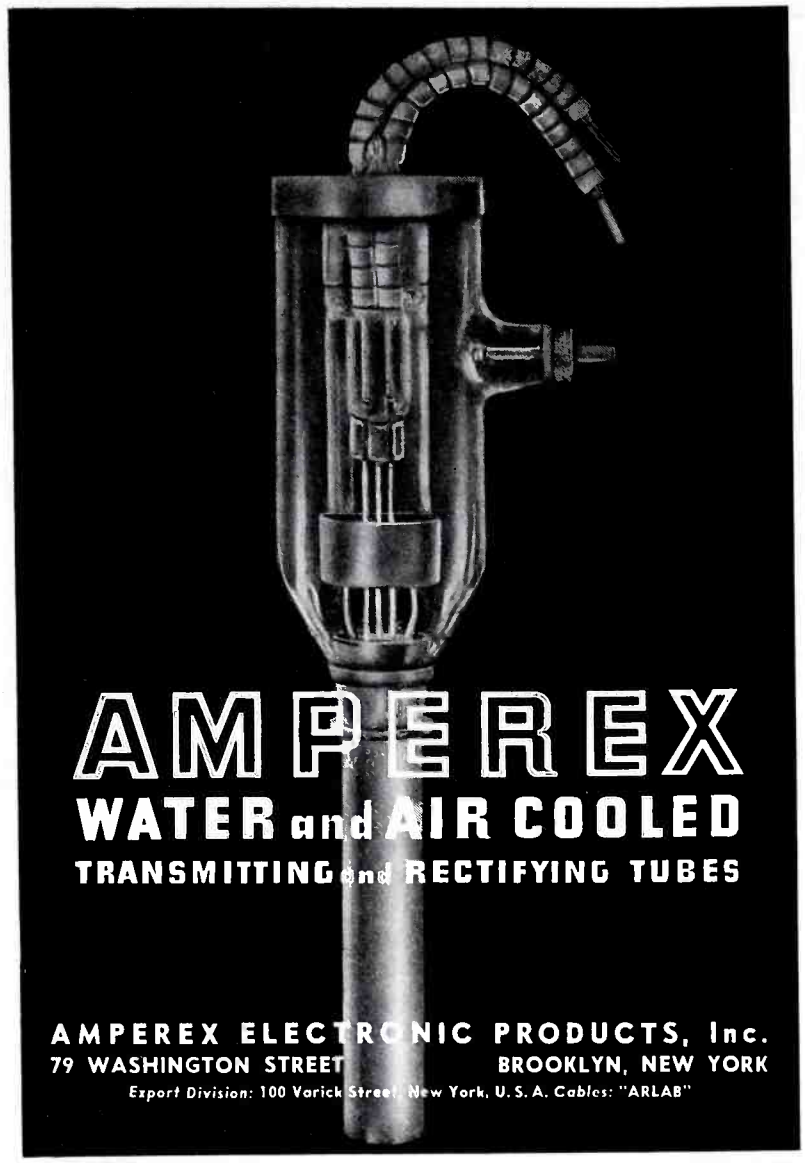
"During the World War Mr. Balch was Chairman of the Draft Board for the Territory. He also accepted a commission of Lieutenant in the Naval Reserve and served as district radio superintendent of the 14th Naval District. He is a member of the Engineering Association of Hawaii, the Institute of Radio Engineers and of VWOA."

On behalf of the entire membership of our Association we salute a true "Wireless Pioneer," John Adrian Balch. It was a genuine pleasure to dispatch a Wireless Pioneer Medal to Chairman Street for presentation at the dinner honoring Mr. Balch.

Los Angeles

The Los Angeles-Hollywood Chapter was inaugurated in February of this year under the guidance of Messrs. de Forest, Chapple, Styles, Bremmer and Stoddard. In the month of March further impetus was lent to VWOA activities in that area by a meeting of the leading lights in the various fields in which veteran wirelessmen of Southern California have engaged. Among those present at the March meeting —and then elected to their "Board of Strategy"—were: L. H. Bowman of the Columbia Broadcasting System; A. H. Saxton of the National Broadcasting Company; C. O. Slyfield of the Walt Disney Studios; Ed Hansen of the 20th Century Fox Studios; H. Duke Hancock of Broadcast Station KGFJ; W. H. Beltz of RCA Manufacturing Company; J. F. Dunn of Mackay Radio; James Chapple of the Federal Communications; T. M. Gardner of Radiomarine Corporation of America; Roger Bunce of Globe Wireless, Ltd.; A. E. Jackson of RCA Manufacturing Company; Frederic H. Stevens of the Civil Aeronautics Authority; Harrison Holliway of Broadcast Stations KFI-KECA; M. J. Schaefer of Lyon and Lyon; H. E. Austin of RCA Communications. The meeting was held in the studios of KFI-KECA and a fine picture of the assembled veterans was taken and reproduced in a Bulletin issued by their Secretary Leroy Bremmer. Those interested in mem-

(*Continued on page* 36)



AMPEREX

WATER and AIR COOLED

TRANSMITTING and RECTIFYING TUBES

AMPEREX ELECTRONIC PRODUCTS, Inc.
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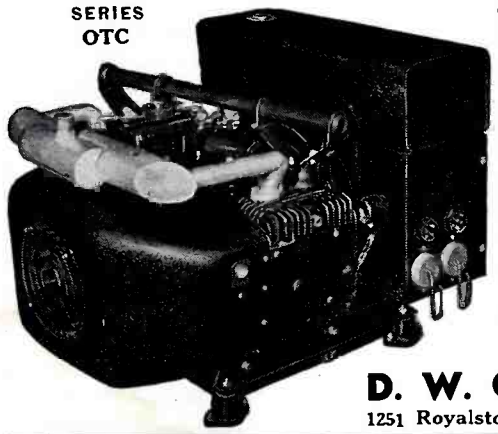
ONAN ELECTRIC PLANTS

SERIES OTC



ONAN A.C. ELECTRIC PLANTS are used by Radio Operators all over the world for primary or Emergency power supply.

40 DEPENDABLE MODELS 350 to 10,000 watts, ready for immediate shipment and operation.

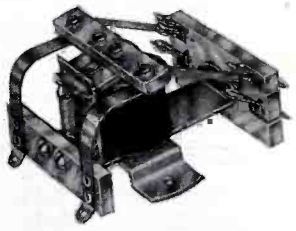
LIGHTWEIGHT, COMPACT PLANTS for Mobile, Pickup, Transmitter Trucks. 1500 watt OTC, weight 120#; 4000 watt OTA, weight 200#.

Built by specialists in Electric Plant manufacturing for 14 years. 15,000 in operation on land, on sea, and in the air.

WRITE FOR DETAILS

D. W. ONAN & SONS
1251 Royalston Ave., Minneapolis, Minn.

ALLIED HIGH FREQUENCY RELAYS



TYPE H

The maximum air space insulation is used throughout.

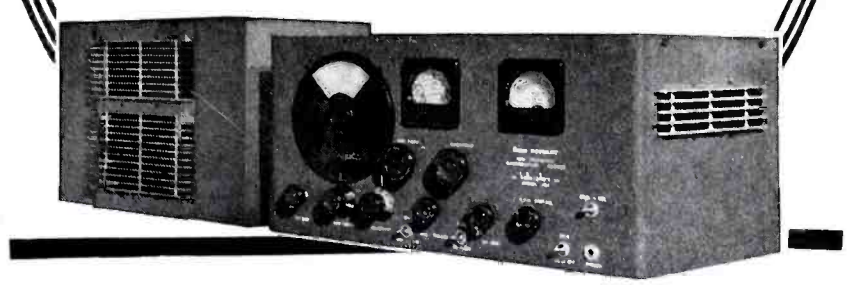
Designed for antenna change-over, switching of band, crystal or tank circuits. All parts are plated. The insulating material on the standard relay is "Lucite." Layer wound, impregnated coils are standard. The contacts are fine silver. Relay dimensions are 3"x2½"x1½".

Stock items are double pole double throw in 6, 12, and 125V AC 60 Cycle, or DC.

Jobber stocks throughout the country.

ALLIED CONTROL COMPANY, Inc. 227 FULTON ST. NEW YORK

from COAST TO COAST a Sweeping Demand for the SUPER DEFIANT SX-25



Amateurs from coast to coast acclaim this new, de luxe model, amateur receiver as the finest ever developed for anywhere near this price. And orders have been pouring in far beyond our expectations.

The SUPER DEFIANT, at $50 less, offers even better performance than that of the famed SX-17. Its general circuit is based on the proved efficiency of America's BEST selling receiver, the Skyrider DEFIANT, and, in addition, it has important improvements and refinements of its own that definitely step up all former standards of value.

You wanted more preselection. Now you can have it. You wanted more and better audio. The SUPER DEFIANT gives it to you. You wanted less noise, less distortion, easier tuning. All this, and more, you get in this new Hallicrafters triumph.

Your Distributor is now ready to supply you with the new SUPER DEFIANT on time payments if you wish. See him and learn for yourself why there is such a demand for this exceptional amateur receiver.

Note These Outstanding Features

- Two Stages Pre-Selection.
- 540 kc to 42 mc in 4 bands.
- Calibrated bandspread dial for 10 to 80 meter amateur bands provides frequency meter tuning.
- Compensation in Oscillator Circuit for Frequency Stability.
- Better Signal-to-Noise Ratio.
- Improved Crystal action.
- Automatic Noise Limiter.
- 12 Tubes.
- 6-Step Variable Selectivity.
- S Meter calibrated in "S" and "DB" Units.
- Push-Pull output.
- All functions controlled from front panel.
- 115 volt 50-60 cycle AC operation.
- Battery or Vibrapack socket for DC operation.
- Dimensions: 19½ x 11⅛" x 9½" high.

COMPLETE with Speaker Crystal and Tubes $99.50

the hallicrafters inc.
CHICAGO, U.S.A.

WORLD'S LARGEST BUILDERS OF AMATEUR COMMUNICATIONS EQUIPMENT

VWOA NEWS

(*Continued from page* 34)

bership or the activities of the Los Angeles-Hollywood Chapter should contact the secretary at Suite 212 Hollywood Studio Building, 6560 Hollywood Boulevard, Hollywood, Calif. Dr. Lee de Forest, our Honorary President, is Chairman of the Advisory Council.

• • •

"SOUND" IDEAS

(*Continued from page* 18)

Seven amplifiers are used in all, four of them power amplifiers to provide the driving power for different speaker groups.

Another system at this airport on the occasion of its dedication is of interest as representing an application of standard equipment to the specialized requirements of a vast crowd of well over 100,000 visitors, a small portion of which is shown in Fig. 6. The installation was made by the New York City sound engineers, who have the happy knack of doing big jobs in a simple way. The setup consisted of three 100-watt standard amplifiers (one of which was for reserve use) and eight heavy-duty dynamic units in horn baffles raised above the crowd on telescoping stands. Four speakers were operated from each amplifier and the speakers alternated in position so that should anything go wrong with one amplifier complete coverage would still be obtained, although at decreased level.

The pick-up of speakers' voices was obtained through the microphone of WNYC, the city's own broadcast station, which was one of the battery of several surrounding the speaker's table.

• • •

TELEVISION FUNDAMENTALS

(*Continued from page* 21)

limiting factor in bringing to reality the proposed Birmingham provincial station outside of London in a relatively highly populated area.

At the present time there seem to be two general methods of approach to the interconnection problem. One is the use of transmission lines. Over relatively short distances a selected pair in an ordinary telephone cable has been used with correction for remote television program pickups. The coaxial cable is well adapted to the transmission of video signals because the attenuation is fairly low and quite uniform over a wide frequency range. Unattended amplifying units located in manholes at proper intervals have been used successfully in a 100-mile trial section between New York and Philadelphia. A lead sheathed co-

axial cable suitable for such purposes is shown in Fig. 10.

The second approach to the problem is that of ultra-high-frequency radio link transmitters. At high frequencies very efficient and highly directional antenna structures can be cheaply constructed. By the use of such antennas for both the receiving and transmitting functions, low transmitter power acquirements and a minimum of interference may be attained. It is conceivable that an extensive network could be built up of many such units located on strategic geographical points at distances depending upon the line-of-sight range obtained. It is also possible that sufficient reliability could be realized in an unattended station or at least by remote control.

Fig. 11 shows an experimental link transmitter operating on a frequency of 177 mc. It is located on the 10th floor of the RCA building and serves as an alternate to a coaxial transmission line between the NBC television studios in the RCA building and the television transmitter located in the Empire State Building, a distance of somewhat less than a mile. It will be noted that such transmitters can be made compactly.

(*To be continued*)

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(3) "Television Station W2XAX"—Part 2—Goldmark, COMMUNICATIONS, February 1939, page 27.
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BROADCAST AMPLIFIER

(*Continued from page* 16)

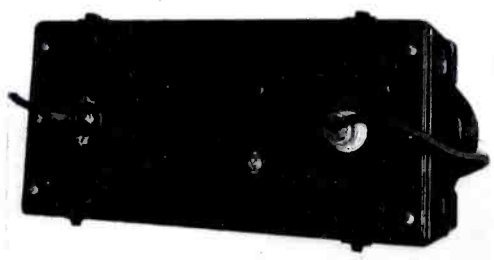
transformer. The two sides, therefore, behave exactly as if they were two separate single-sided amplifiers as far as plate-load impedances are concerned. Nevertheless, if the push-pull tubes in the resistance-coupled circuit are matched, cancellation of the even-order harmonics is obtained, and for this reason all push-pull tubes should be carefully selected so that their characteristics are identical, if full advantage is to be had from this amplifier. It will be noted in the circuit diagram, Fig. 2, that all coupling and filter condensers are of sufficient size for the amplification of low frequencies as well as high.

A simple tone control is connected across the input of the power stage to be used mainly for public-address work, but it has been found very convenient for recording. Fig. 8 shows the attenuation curve of the tone control.

The power stage of the amplifier consists of two 6N6-G tubes in push-pull. The 6N6-G tubes were chosen because of their characteristics. The 6N6-G tube comprises two triode units mounted in a single ST-14 bulb. The smaller, or input section, acts as a driver tube for the larger output units and is directly coupled to it, therefore, eliminating coupling condensers and resistors. Fig. 6 and Fig. 7 show the frequency response curves of the amplifier in conjunction with the individual input and output channels.

Fig. 10 shows the arrangement of parts in the amplifier with the front panel removed.

The output circuit of the amplifier is also universal in that two headphone jacks, a 500-ohm remote broadcast line,



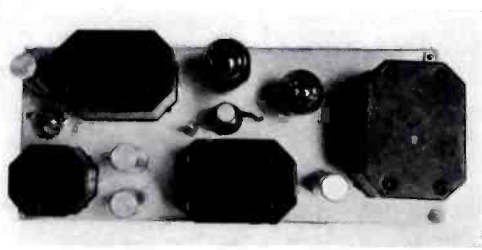


Fig. 12. (Above) Showing physical layout of power pack.

Fig. 13. (Left) The power pack.

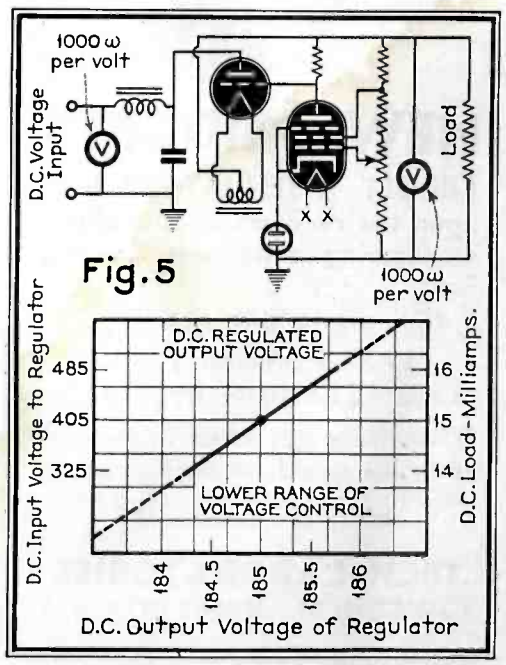


Fig. 5. (Right) The voltage-regulator circuit and voltage regulation curve.

and two 500-ohm output impedances are provided.

Either one of the two high-level 500-ohm outputs may be used individually or simultaneously as selected by the output selector switch S.W. (Fig. 9). When the switch is in No. 3 position the two circuits are paralleled, giving 250 ohms as well as connecting the output circuits

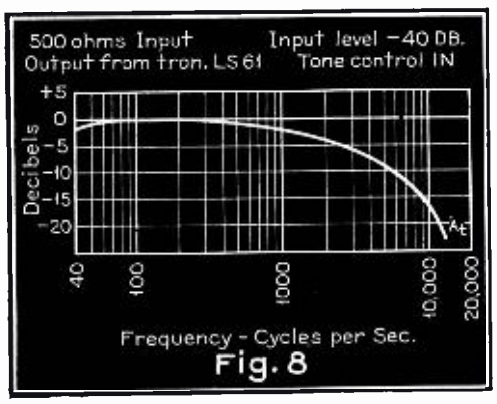
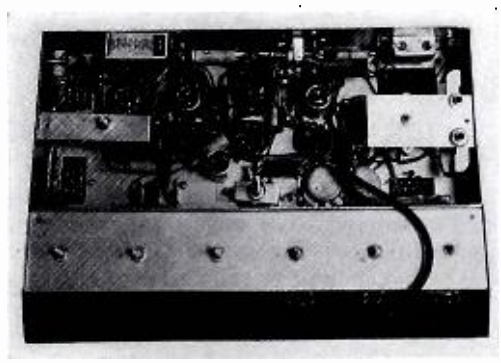


Fig. 8. Attenuation curve of tone control.

of the transformer to match the load. This has the following advantages: When the switch is in position No. 1 it may be feeding a monitor speaker, and when switched to position No. 2 may be feeding a recording cutting head or monitor speaker, but this is not recommended for high-fidelity recording unless the reflected impedance of both the speaker

Fig. 11. (Above) Back view of amplifier showing physical layout.

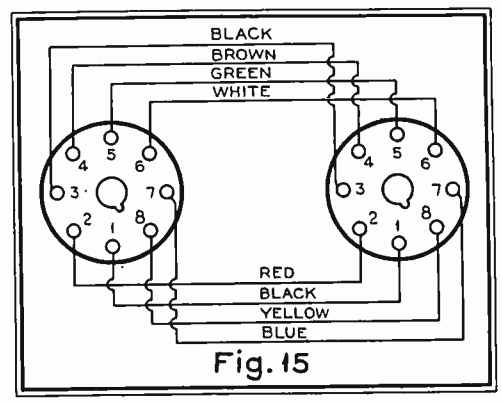
Fig. 10. (Below) Showing layout of parts.

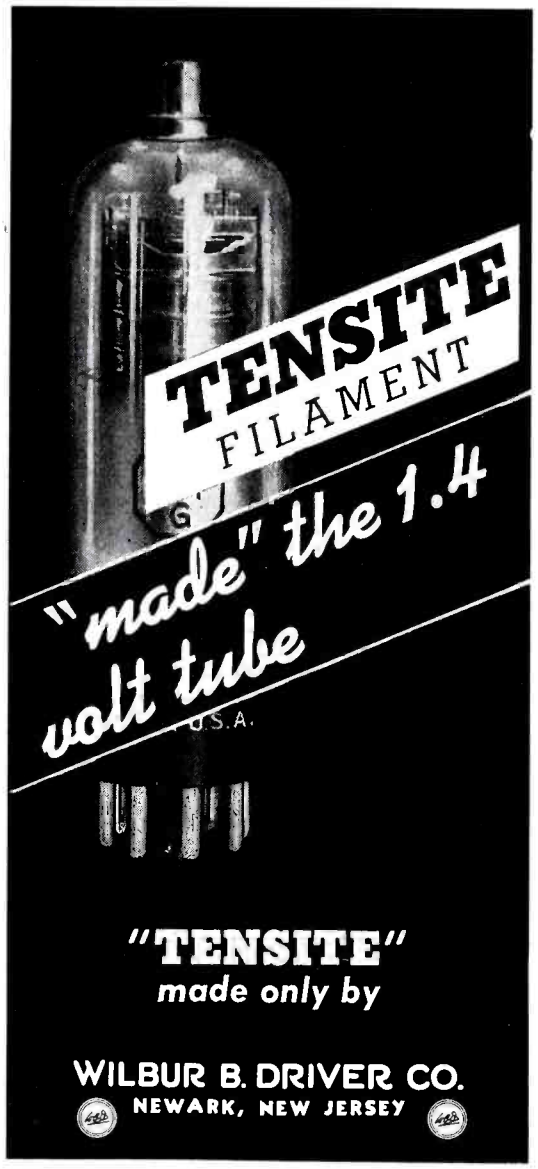


and recorder head is known.

Bridged across the output circuits of the output transformer are headphone jacks and radio remote line (Fig. 3). The resistance of bridging circuits is so high that it does not affect the output circuit and allows a means of varying the input to both headphone jacks and radio remote line. These controls are mounted on the chassis because once set there is no need for readjustment under normal operating conditions.

The V.I. decibel meter that indicates the power in the radio remote line is also used for indicating recording levels. When the meter reads +2 db it is peak level for both the broadcasting line and recorder head. This level holds true whether the output selector switch is in position No 1, No. 2 or No. 3. The meter reads +6 db for full undistorted power output of the amplifier, and if it is necessary to use the amplifier for public-address work where more than 12 watts are required and over 5% dis-





tortion may be tolerated, it will be necessary to readjust the potentiometer so that the meter will not be damaged.

It is also necessary to have a 500-ohm resistor connected across the output circuit of the radio remote line when not feeding the 500-ohm line so that the V.I decibel meter will read correctly.

Power Supply

The power supply is constructed separately from the main amplifier so as to eliminate any possible hum that might have been introduced in the input transformer of the amplifier. The power-supply circuit is a conventional circuit with the exception of the voltage regulator circuit (Fig. 4). This is shown separately on Fig. 5. Fig. 5 also shows the voltage regulation curve.

The principle upon which the voltage regulator circuit of the power supply operates is fairly simple and can be explained by referring to Fig. 5. A high-gain voltage amplifying tube (such as the 6J7, 57, and 6SJ7) is connected in such a way that a small change in the input voltage to the voltage-regulator circuit causes a change in the grid bias and thereby a corresponding change in plate current.

The plate current of the 6J7 flows through a resistor, the voltage drop across which is used to bias a second tube — the "regulator" tube — whose plate-cathode circuit is connected in series with the d-c line. The regulator tube, therefore, functions as an automatically variable series resistor in the power supply. If the output voltage increases slightly, the bias on the control tube becomes more positive, causing the control tube's plate current to increase correspondingly. The bias on the regulator tube, therefore, becomes more negative and the effective resistance of the regulator tube increases, causing the terminal voltage to drop. A decrease in the output voltage causes the reverse action. This principle is the familiar a-v-c action.[1]

[1]Q.S.T., August, 1937, p. 14.

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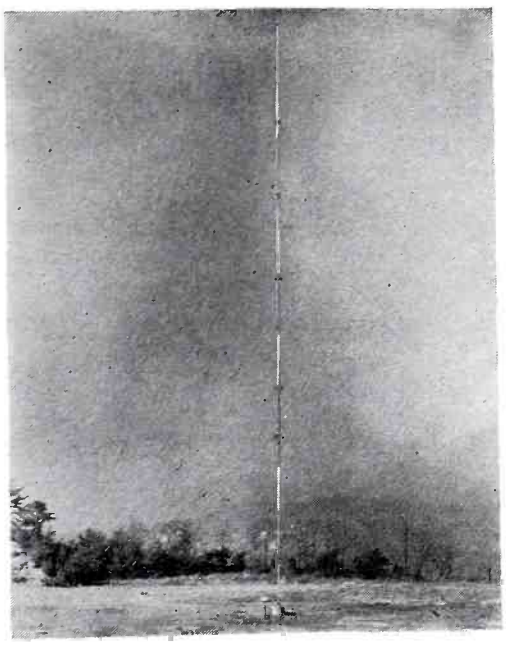
OVER THE TAPE

CLAYTON APPOINTED IRE COMMITTEE CHAIRMAN

John M. Clayton, General Radio Co., has been appointed Chairman of the Publicity Committee for the National IRE Convention. This gathering is to be held at the Hotel Statler, Boston, Mass., on June 27, 28 and 29.

C. A. WHITE DIES

Charles Arthur White, Secretary-Treasurer of the Leeds & Northrup Co., died on March 2 at the Germantown Hospital in Philadelphia, after two weeks illness. Mr. White was fifty-eight years old. He joined the Leeds & Northup Co., in 1920.



The 160-foot Lingo radiator of WGKV, Charleston, W. Va.

ARMOUR'S SUMMER INSTITUTE

Armour Institute of Technology, Chicago, according to the announcement made by Dr. L. E. Grinter, vice-president and dean of the graduate division, will conduct a three-term Summer Graduate Institute for engineers, professional men, industrialists, and educators in engineering and science beginning with the summer of 1940. It is planned, according to Dr. Grinter, who is in charge of the Summer Institute beginning with this year, to invite scientists of distinction to lecture each summer on modern developments in engineering and science.

This Summer Institute is divided into seven separate and distinct divisions and the program of specialized classes has been arranged to provide an opportunity for graduate work on the highest possible plane. These divisions include Advanced Mechanics, Chemical Engineering and Chemistry, Civil and Sanitary Engineering, Electrical Engineering and Physics, Mechanical Engineering, Industrial Engineering and Applied Mathematics. The first term of the Summer Institute will extend from June 17th to July 13th; the second term from July 15th to August 10th, and the third term from August 12th to September 7th.

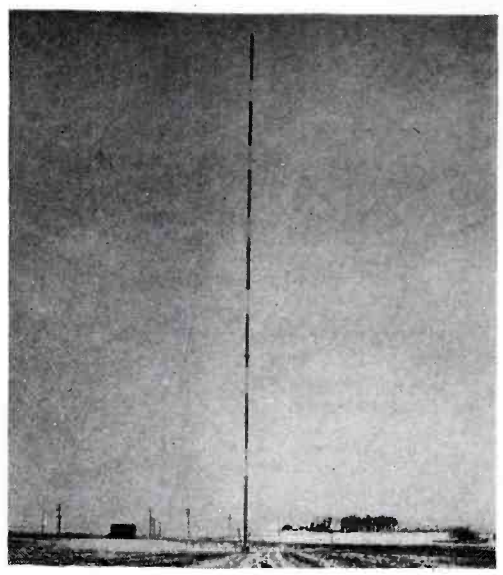
It was also announced that the Summer Institute will be conducted in future years under the direction of Armour College of Engineering of Illinois Institute of Technology. This will result from the merger of Armour and Lewis Institute, expected to become effective as of September, 1940, and the subsequent changing of the name of the new combined colleges to Illinois Institute of Technology.

RCA BULLETINS

Two interesting bulletins have recently been made available by the RCA Manufacturing Co., Inc., Camden, N. J. One bulletin covers the Type 311-A broadcast frequency monitor—circuit and technical data are given. The second bulletin is devoted to a description of the Type MI-7823-A ultra-high-frequency antenna. Both bulletins may be secured by writing to the above organization.

NEW OFFICES FOR RADIO DEVELOPMENT

Radio Development & Research Corp. announces the removal of their offices, laboratory and factory to 136 West 52nd Street, New York, N. Y. The new telephone number will be CIrcle 5-7971.



The 313-foot Wincharger tower installation at KVFD, Ft. Dodge, Iowa.

NEELY HOST TO ENGINEERS

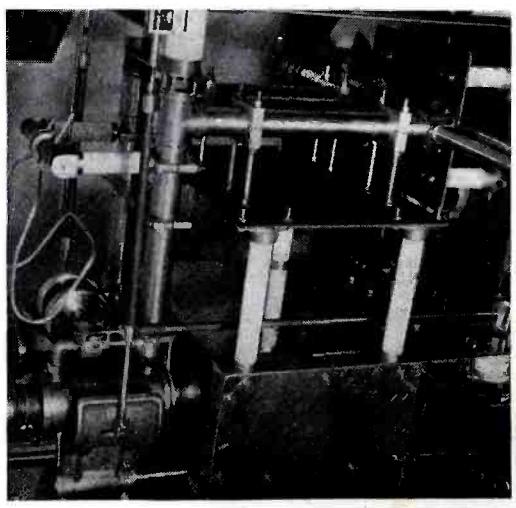
Over one hundred engineers attended a technical meeting held by Norman B. Neely in Hollywood on Thursday, March 21st. A paper entitled, "Square Waves and Their Application," was delivered by Bill Hewlett of the Hewlett-Packard Company of Palo Alto, California. The paper was demonstrated by photographic slides of oscilloscope patterns and demonstrations showing square-wave phenomena as applied to audio equipment.

After the paper and demonstrations were completed the meeting was opened to questions and a half hour of very interesting discussion followed. Then the meeting was adjourned from the assembly hall to Mr. Neely's offices next door for a buffet supper. A display of radio, sound, and laboratory equipment had been arranged by Mr. Neely and his staff and the first copies of his new catalog were distributed. Specializing in technical representation, Mr. Neely's business is rather unique in the field of manufacturers' agencies.

CINEMA ENGINEERING BULLETIN

The Cinema Engineering Co. have recently published a bulletin on "Precision Sound Equipment." It covers wire-wound resistors, variable attenuators, fixed attenuators, gain sets, decibel meters, VI units, power supplies, relay racks, jacks, jack mounting and strips, etc. Write to the above organization at 1508 S. Verdugo Ave., Burbank, Calif.

Showing Isolantite insulators employed in power-amplifier of 50-kw f-m transmitter. Photo courtesy Radio Engineering Labs.



Transcription equipment in studios of WKBN, Youngstown, Ohio. Presto Recording Corp. photo.

SHURE LITERATURE

Shure Brothers, 225 W. Huron Street, Chicago, have recently made available two bulletins covering their "Uniplex" (Crystal) and "Unidyne" (Dynamic) uni-direccinal microphones. Rather complete information is given on both units. Write to the above organization.

CHANGE OF NAME

Microvolts, Inc., of Boonton, N. J., announces a change of name to Measurements Corporation. The personnel and policies remain unchanged, and new models, with emphasis of the high frequencies, will be added to the present line.

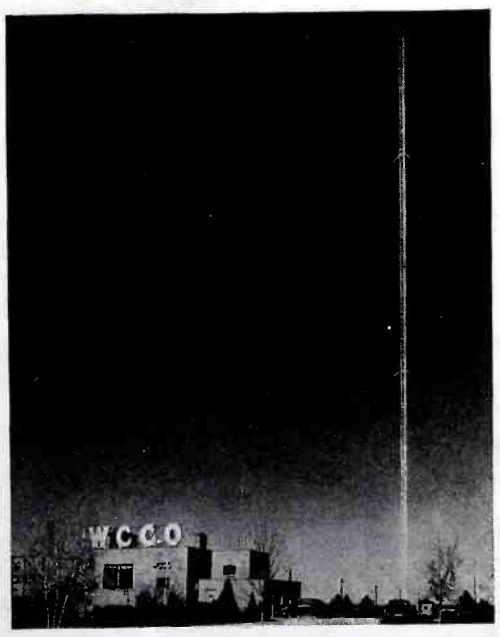
DRIVER TO EXHIBIT AT FAIR

The Wilbur B. Driver Co., of Newark, N. J., manufacturers of Tophet nickel-chromium resistance wire, again are exhibiting in the Hall of Industries at the New York World's Fair. A feature of the exhibit will be a complete display of the newest electrical appliances for the home.

UNIVERSAL MICROPHONE BULLETINS

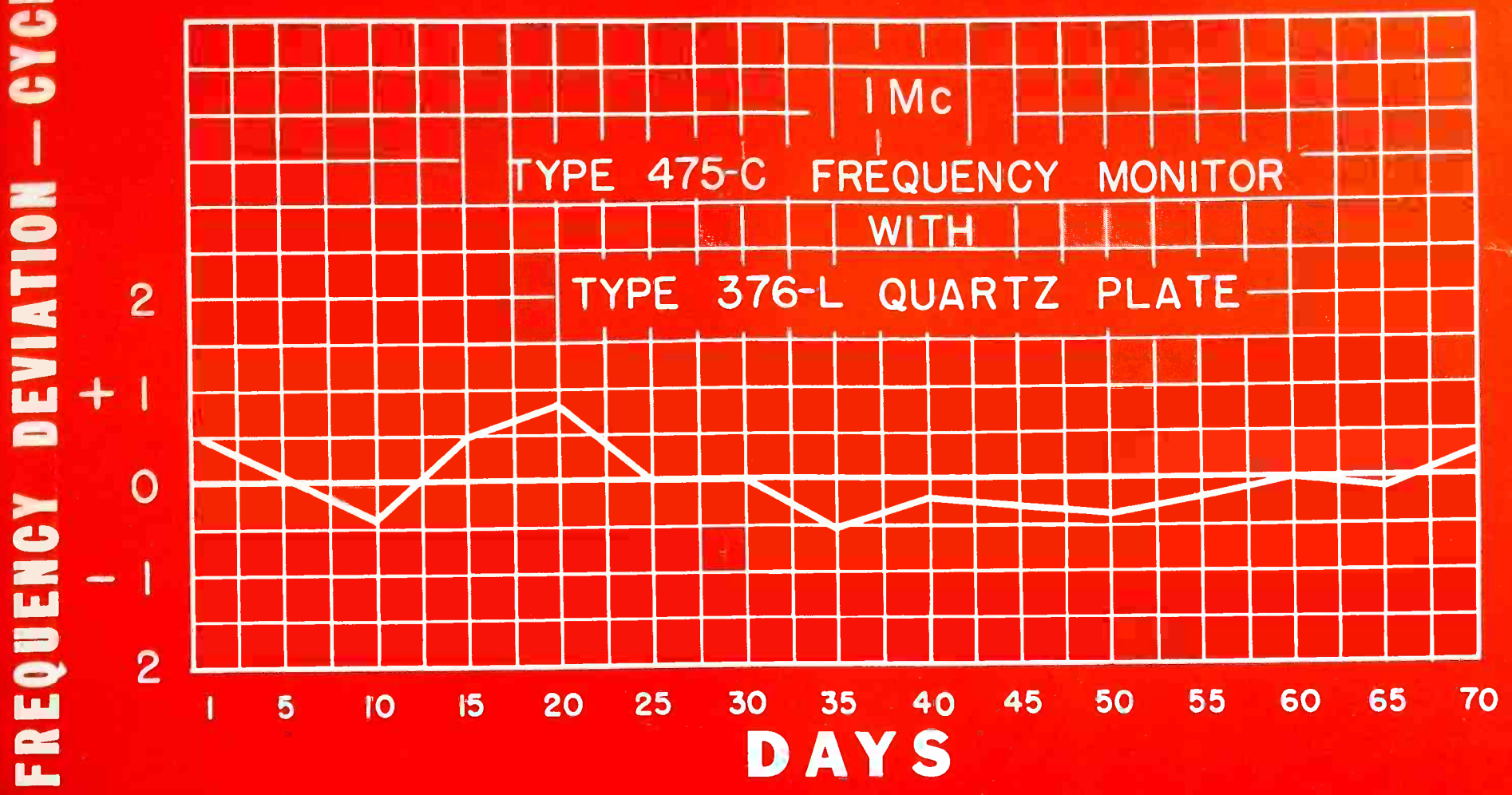
Universal Microphone Co., Inglewood, Calif., have issued 3 new leaflets. One is the annual issue of the microphone catalog and another a catalog on recording machines and accessories. Both are in loose-leaf form. The third, leaflet No. 165, is on recording and playback turntables. Copies may be secured from the above organization.

The 640-foot Lehigh vertical radiator at WCCO, Anoka, Minn.



Index to Advertisers

SPEAKING OF STABILITY



THE CURVE above shows the frequency deviation of a 1 megacycle G-R Broadcast Frequency Monitor, taken from stock and run continuously for *seventy days* from October 2, 1939 to December 12, 1939. The maximum deviation was *less than one cycle!* Remember, this was a STOCK model, not one especially tricked up, and is typical of the performance reported to us by many owners.

The G-R Broadcast Frequency Monitor assures your complying with Rule 3.59 of the F.C.C. at all times. The new deviation meter now reads to ±30 cycles and is direct reading to one cycle.

Many new electrical and mechanical features are incorporated in the G-R Monitor, which bears F.C.C. Approval No. 1461.

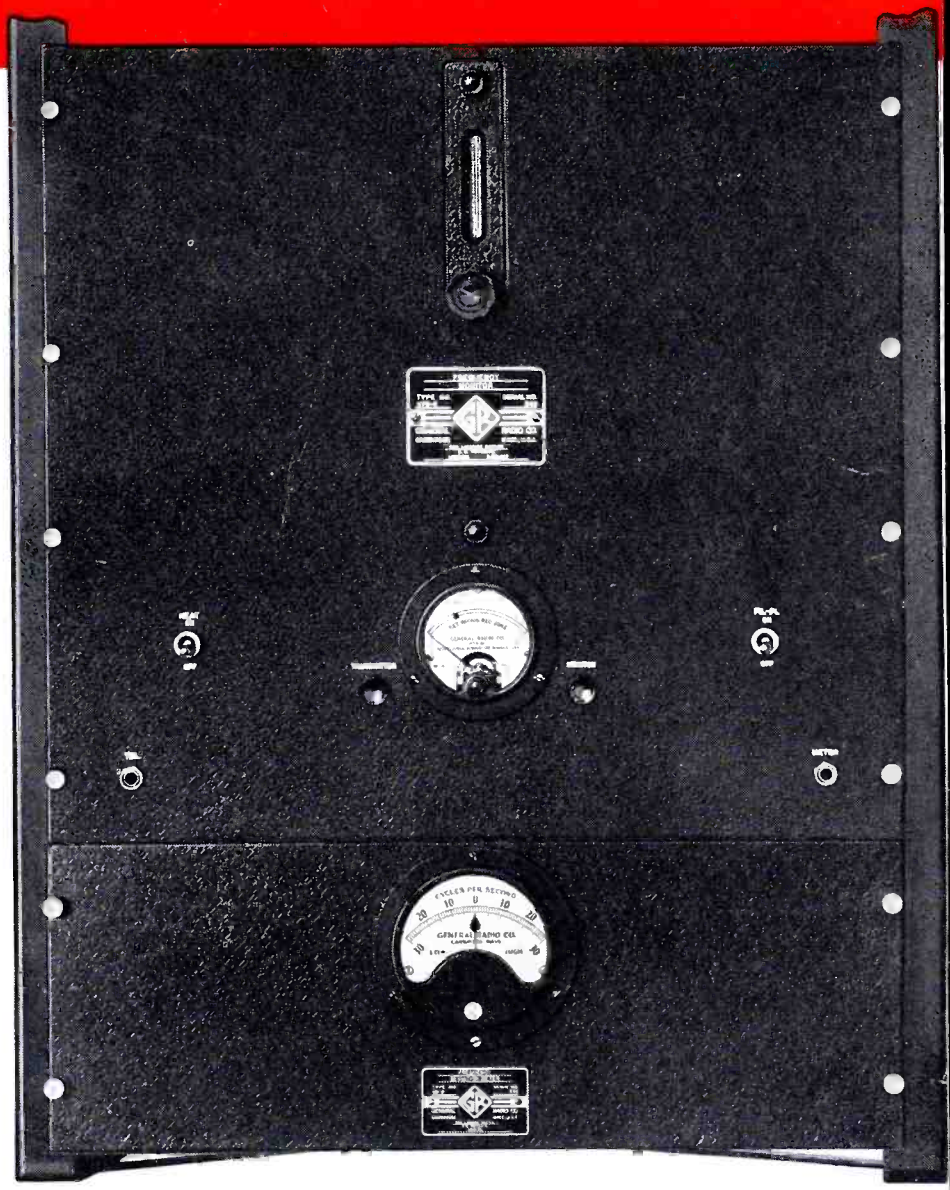
ELECTRICAL FEATURES

1—High-stability crystal oscillator circuit as used in primary standards
2—Amplifier to isolate crystal oscillator
3—Input amplifier to isolate transmitter
4—Diode voltmeter to adjust input level
5—New foolproof temperature-control system
6—Improved highly stable frequency-deviation-meter circuit
7—AVC circuit on deviation meter
8—Simplified operation
9—New inside layout for simplified replacements

G-R Monitors are now equipped with dress panels so that you can now secure a monitor to match any of five standard broadcast-equipment panel finishes from stock. Unfinished panels can be supplied for finishing by the user and subsequent assembly by us so that your monitor can have ANY panel finish desired.

You can't go wrong in selecting a G-R Monitor. G-R has pioneered in the broadcast frequency measuring field since broadcasting started. G-R Monitors are used by hundreds of the leading stations.

TYPE 475-C FREQUENCY MONITOR	$330.00
TYPE 681-B FREQUENCY DEVIATION METER	$145.00
TYPE 376-L QUARTZ PLATE	$ 85.00
BROADCAST FREQUENCY MONITOR	$560.00



• **Write for Bulletin 574**

GENERAL RADIO COMPANY CAMBRIDGE MASSACHUSETTS