Communication and Broadcast Engineering

OL. 4 NO. 1

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Radio Telegraphy

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Wire and Cable
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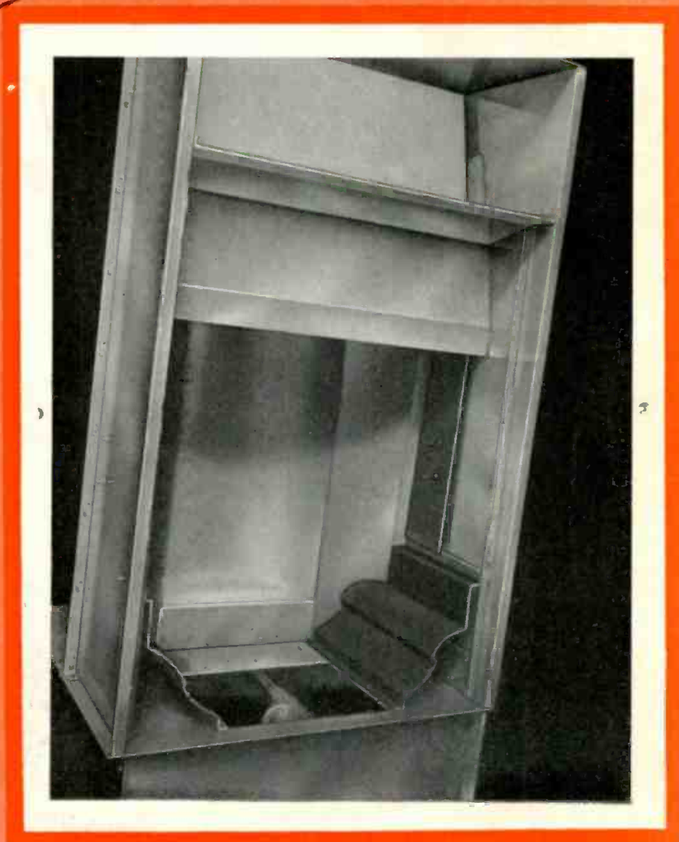
Wire and Cable
Telephony

JANUARY, 1937



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Editor

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VOLUME 4 JANUARY, 1937 NUMBER 1

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EDITORIAL

COAXIAL CABLE SYSTEM

THE NEW YORK-PHILADELPHIA coaxial cable system, which has been completed for several months, is now being subjected to performance tests. This system has presented many problems and a large number of engineers have been engaged on the project at various times. Undoubtedly some problems will require even further consideration before the final system is evolved and ready for general use.

The system has a number of interesting automatic features, not only at the terminals but also at the repeaters which are located at about 10-mile intervals. A number of these repeaters incorporate equipment for changing the amplification to compensate for changes and losses due to temperature variations along the line. At the terminal, a vacuum-tube oscillator generates a pilot frequency of 1024 kc, and at each regulating repeater this pilot frequency is selected and arranged to automatically change the amplification to the proper value.

The coaxial cable has been heralded as a transmitting medium for television signals. Due to its ability to handle a frequency range in the vicinity of one megacycle, it will probably be well suited for this purpose. To make such use of it, however, special terminal apparatus is required to transform the television signals into a frequency range which the system can handle. It is understood that such equipment is now being developed.

COOPERATION

IT IS EASY to recall the unfriendly attitudes that certain industries have had towards broadcasting. It is also easy to remember how later the cooperation of certain of these various groups with the broadcasters has worked to benefit all.

Television broadcasting, when it arrives, may face similar and perhaps even more trying situations. It would be well if all were to keep in mind the fact that little if anything is ever accomplished by a hostile or uncooperative attitude.

Particularly, we have in mind that the motion-picture field will have data and methods which will be useful in connection with television broadcasting. For example, similar problems exist in camera technique, recording on film, studio acoustics, and monitoring methods (in this connection Mr. Felstead's article on page 12 should be of interest). In turn, the television groups will be able to make available to the motion-picture industry various useful television equipments and methods.

In our opinion the motion-picture field has little to fear from television, provided the former industry adopts a logical and far-sighted attitude. Both can benefit by cooperation.

ANTENNA CURRENT VS. MODULATION

THE CURVE on page 17 depicts the relation between percent increase in antenna current and percent modulation. It has been plotted from the formula

$$I = \left(1 + \frac{K^2}{2}\right)^{1/2}.$$

Let us assume a current given by

$$i = A_0 \sin pt$$

so that the antenna current with a percentage modulation of K becomes

$$i = A_0 (1 + K \sin \omega t) \sin pt$$

where p is the frequency of the carrier. Assuming $A_0 = 1$ and expanding

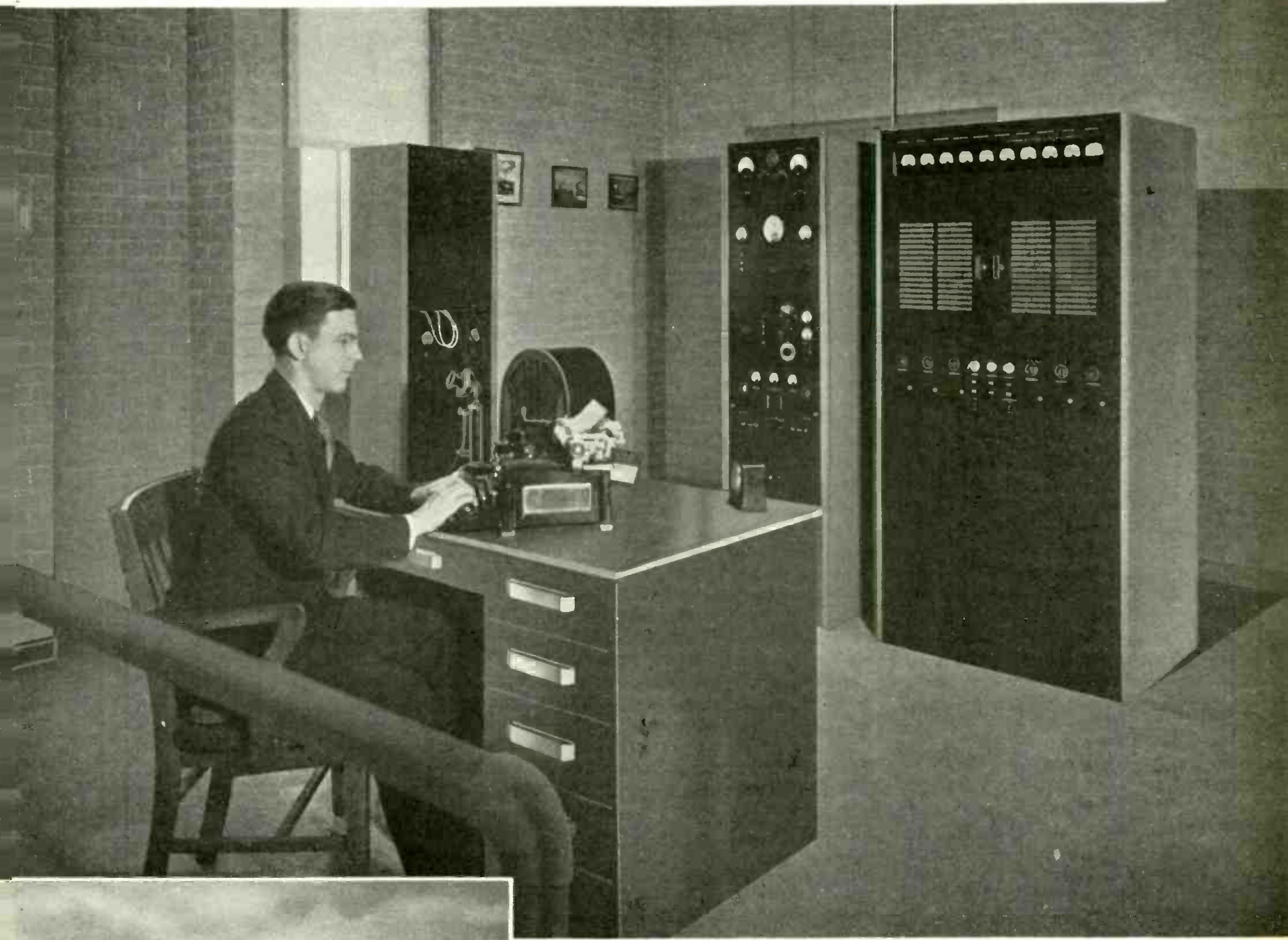
$$\begin{aligned} i &= \sin pt + K \sin \omega t \sin pt \\ &= \sin pt + \frac{K}{2} \cos (p - \omega) t \\ &\quad - \frac{K}{2} \cos (\omega + p) t \end{aligned}$$

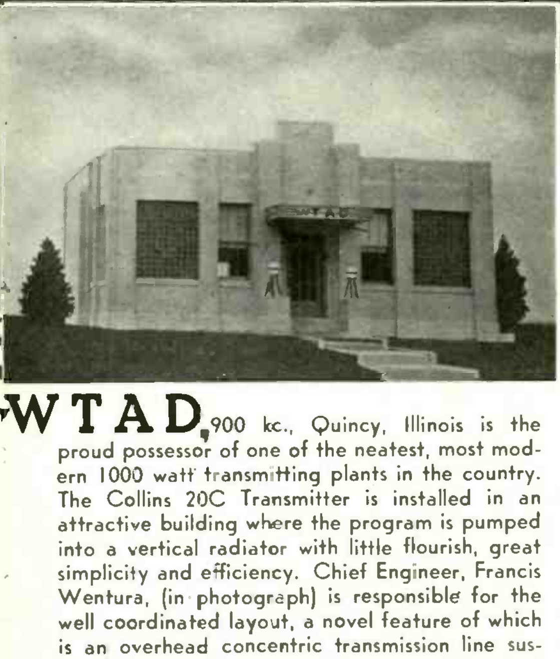
Hence the effective current becomes

$$\begin{aligned} I_{eff} &= \left(1 + \frac{K^2}{4} + \frac{K^2}{4}\right)^{1/2} \\ &= \left(1 + \frac{K^2}{2}\right)^{1/2} \end{aligned}$$

It is interesting to note from this curve that increasing the modulation from 80 percent to 100 percent results in an increase of 7.8 percent in antenna current.

Join the Swing to Collins





WTAD, 900 kc., Quincy, Illinois is the proud possessor of one of the neatest, most modern 1000 watt transmitting plants in the country. The Collins 20C Transmitter is installed in an attractive building where the program is pumped into a vertical radiator with little flourish, great simplicity and efficiency. Chief Engineer, Francis Wentura, (in photograph) is responsible for the well coordinated layout, a novel feature of which is an overhead concentric transmission line suspended by a messenger cable.

★

More and more stations are joining the swing to Collins. Broadcasters who spend their money for equipment carefully, who make certain they are getting the most modern design, the greatest eye-appeal, and most of all, the greatest built-in dependability and fine performance, are thinking more and more in terms of Collins Equipment. It is time for you too, to inform yourself as to the advantages of relying on Collins for your present and future needs.

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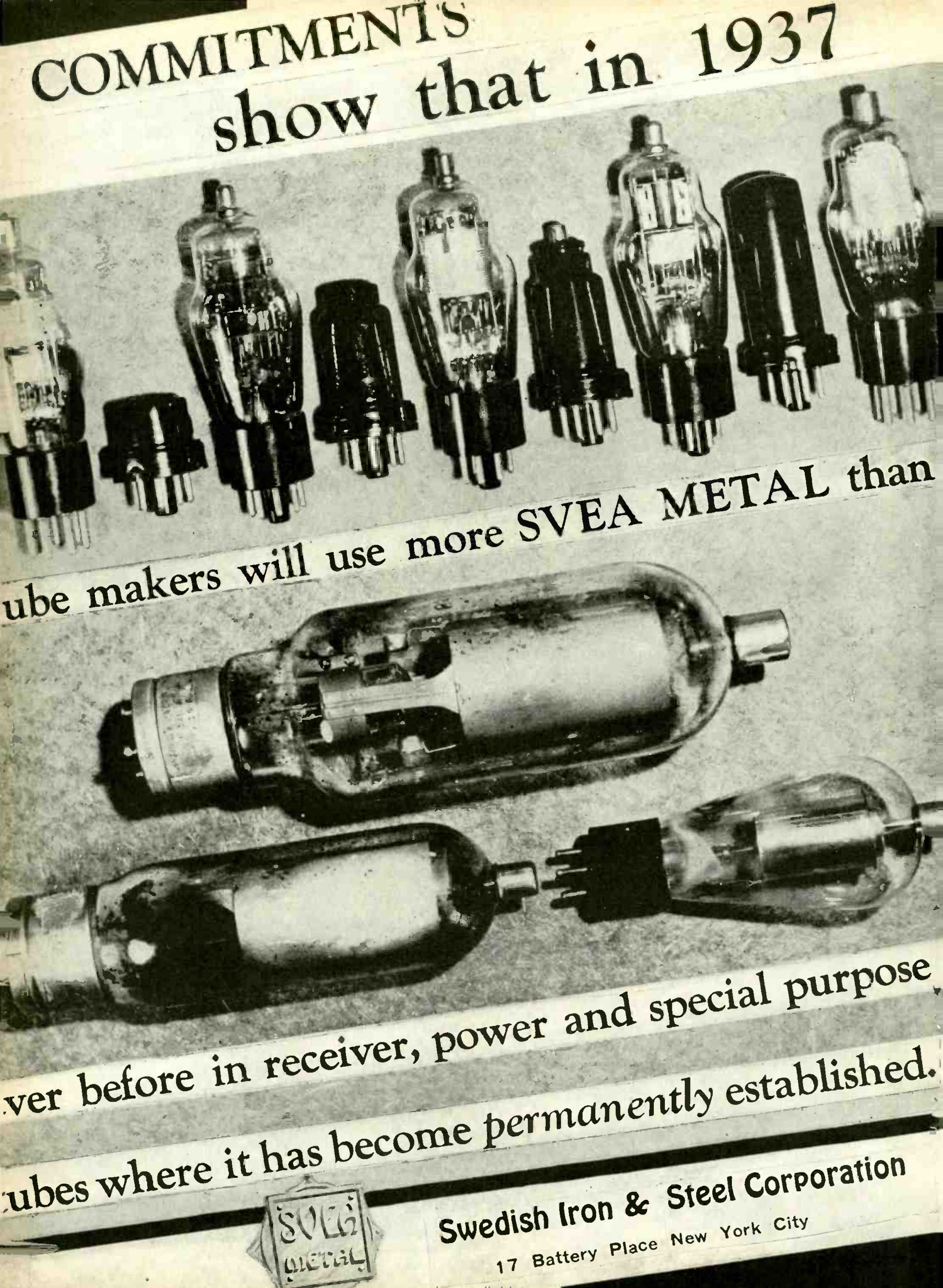
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COMMUNICATION & BROADCAST ENGINEERING

FOR JANUARY, 1937

RADIO STUDIO ACOUSTICS

By MICHAEL RETTINGER

IN PLANNING a radio studio used for the artistic production of speech and music we must fix beforehand the conditions which will influence the outcome. Unlike designing an ideal music room or ideal lecture hall, however, the criteria constituting an ideal radio studio are not so simply developed. Wide-range transmission, improved reproducer characteristics, newer microphones with flatter response curves, lower noise levels throughout the electro-acoustic system, conspire to call, one might say, for an entire new set of acoustics for such a room. Indeed, if one bears in mind that the microphone is equivalent to but one ear, and that at the same time architectural conditions should be produced which will enable the artist to instill harmony into the rapid succession of tone sequels that would sound flat without it, one might well say that such a studio represents an epitome of all that is known in architectural acoustics, theoretical and applied.

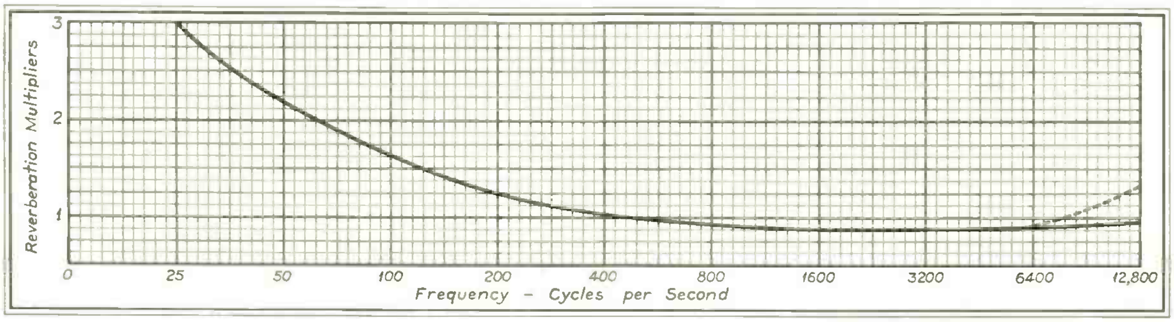
To gain a clearer view of the principles and methods underlying the planning of a radio studio, it may be advisable to develop a set of requirements from a general discussion of the acoustic phenomena pertinent to the production of a faithful facsimile of the sound-pattern to be broadcast. Again we must bear in mind that music is not one absolute tone after another, but a sequence of tone relationships modified at every point by the player and the room together. The all-but-imperceptible tone adjustments that constitute musical "color," "depth," "personality" are to a great extent predicated upon the acoustics of the rooms in which the musicians play so frequently. We, thus, want to transfer a portion of the power and brilliancy of the concert hall to the region about the band in the studio, without introducing that reverberation which, perhaps pleasing to two ears, is undesirable in the case of monaural hearing incapable of discounting all but initial sounds.

The problem, therefore, resolves itself into the introduction of a moderate amount of localized liveliness about the region of the orchestra, and into a minimization of multiply-reflected sound striking the microphone. An added requirement consists in obtaining sufficient diffusion of sound in the room, and particularly about the orchestra, so as to avoid interference patterns at sustained passages and to gain a steady rate of decay of sound level—particularly important for the higher frequencies which are more directive in character.

Too much reverberation at the lower frequencies lends to music an unnatural. booming effect; too much reverberation at the higher frequencies causes the music to sound harsh and hard—"glassy," to use a mixer's term. In a radio studio, therefore, careful precautions must be taken not to overemphasize the extreme registers, and to aim for a reverberation characteristic of such slopes as to retain a true and natural balance between bass and treble, without requiring an undue effort on the part of the artist to determine precisely the true pitch of the following note while perceiving the present one.

A criterion making for a very suitable reverberation characteristic in radio

FIG. 1. REVERBERATION CHARACTERISTIC FOR RADIO STUDIOS.



studios is that due to W. A. MacNair[1], which states that the loudness of all pure tones shall decay at the same time for all frequencies. Since the publication of MacNair's paper, a new table of loudness-level contours has appeared in print[2], and Fig. 1 shows the reverberation characteristic based on MacNair's criterion when using the new loudness curves. It is seen that the new reverberation characteristic is practically flat from 500 cycles per second on up, while the old curve (dotted) shows an increase of the reverberation for frequencies above 4000 cycles per second. It is questionable whether the new curve represents an improvement over the old one. Frequencies as well as frequency- and intensity-variations for frequencies above 4000 cycles per second are less easily detected by the ear than when they lie between 500 and 4000 cycles per second, so that these higher registers should be somewhat prolonged by reverberation in order to increase their recognition.

As regards the variation of reverberation time with volume of studio for the standard frequency of 1000 cycles per second, the general opinion is to have two-thirds of the optimum value that would be required by the room were it used for binaural hearing. In calculating reverberation times for such dampened rooms as radio studios, the writer has obtained very accurate results with the aid of Carl F. Eyring's equation[3]

$$T = .05V - \log_e (1 - a)$$

where T represents the reverberation time for the conventional 60-db decay of the sound; V, the volume expressed in cubic feet, and where a stands for the average absorption coefficient of the room. The lesser known equations of G. Millington and J. W. Sette both fail when any one area in the room is completely absorbent, while the equation of W. C. Sabine gives erroneous results when the average absorption coefficient is high—above .5.

Next to reverberation, the problem of diffusion of sound in the room merits its closer examination. It must at once be stated, however, that it is practically impossible to obtain thorough diffusion in any room, that is, to have at any point in the room the same sound-energy flux as at any other point. Experiments show that even in acoustic laboratories, with rotating loudspeakers, rotating microphones, large rotating paddles, with "warble" frequencies and

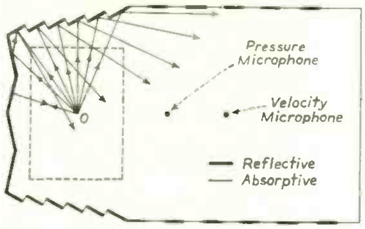


FIG. 2. A LARGE RADIO STUDIO. NOTE THE REFLECTIVE AND ABSORPTIVE PANELS.

non-parallel walls, the sound-energy flux is not exactly the same at every point in the chamber. Nevertheless, even a well mixed or ordered state of sound is highly desirable in a radio studio, since interference of sound must be kept to a minimum and the reverberation must not be allowed either to be longer in a certain direction or to deviate from the exponential law. Diffusion of sound, or an approach to it, can be secured by the following means:

(1) Dispersion.

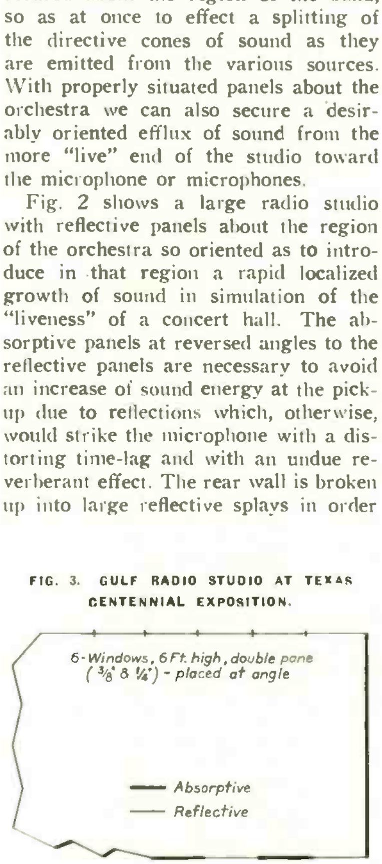
(2) Change of circular waves into plane waves by vibrating panels.

(3) Alternate reflective and absorbent surfaces.

Dispersion of sound, the most effective way to obtain "diffusion," is best secured about the region of the band, so as at once to effect a splitting of the directive cones of sound as they are emitted from the various sources. With properly situated panels about the orchestra we can also secure a desirably oriented efflux of sound from the more "live" end of the studio toward the microphone or microphones.

Fig. 2 shows a large radio studio with reflective panels about the region of the orchestra so oriented as to introduce in that region a rapid localized growth of sound in simulation of the "liveness" of a concert hall. The absorptive panels at reversed angles to the reflective panels are necessary to avoid an increase of sound energy at the pick-up due to reflections which, otherwise, would strike the microphone with a distorting time-lag and with an undue reverberant effect. The rear wall is broken up into large reflective splays in order to prevent flutter echoes in the longitudinal direction of the studio, which should be done even in small studios. While theoretically it necessitates 37.5-foot separation between walls to produce an echo, the writer has observed echoes even when parallel walls were only 25 feet apart, which certainly is not an uncommon dimension in any studio.

FIG. 3. GULF RADIO STUDIO AT TEXAS CENTENNIAL EXPOSITION.



The region about the microphone is no less important, from the acoustical standpoint, than the region about the orchestra. Whenever reflected sound is so much delayed that a compression of it meets with a rarefaction of the direct sound, or a rarefaction of it meets with a compression of the direct sound, a neutralizing effect is produced, and a region of comparative silence occurs; while when compression meets with compression an additive effect is produced and a region of exaggerated loudness results. This phenomenon is known as interference, and can be minimized only by diffusing the sound in the room—so as to produce many such, but unpronounced, regions of comparative silence and exaggerated loudness—and by diminishing the ratio of the reflected to the direct sound pressure at the microphone.

Fig. 2 also shows the third means of producing diffusion in a room, that of using alternate vertical layers of hard and soft surfaces about the region of the microphone. These layers, even as the oriented absorptive and reflective panels about the region of the band, must not be made too small, but must be commensurate with the lower wavelengths. Such a construction also prevents an abrupt change in the reverberation time between the live and dead end of the studio, while at the same time it has a tendency to increase the absorption coefficient of the absorptive layers. The latter phenomenon, experiments indicate, is due to diffraction effects of the sound. Sound energy flows in toward the absorptive material from all around it, striking it in larger quantities than would normally reach the material if it affected its own area of wave front and no more. According to John S. Parkinson[4], this attraction of energy may happen in at least two ways. First, in the pores of the sample and in the immediate neighborhood of its surface it is reasonable to suppose that friction and interference have robbed the molecules of their directional vibration and have substituted the random vibration of heat. In consequence the directional vibration which exists in the surrounding elements of air would have a tendency to flow into this area of ran-

(*Continued on page* 25)

[1]MacNair, W. A.: "Optimum Reverberation Time for Auditoriums," *Jl. Acoust. Soc. of America*, I, (January, 1930), No. 2, p. 242.

[2]Fletcher, H., and Munson, W. A.: "Loudness, its Definition, Measurement, and Calculation," *Jl. Acoust. Soc. of America*, V, (October, 1933), No. 2, p. 91.

[3]Eyring, Carl F.: "Reverberation Time in Dead Rooms," *Jl. Acoust. Soc. of America*, I, (January, 1930), No. 2, p. 217.

[4]Parkinson, John S.: "Area and Pattern Effects in the Measurement of Sound Absorption," *Jl. Acoust. Soc. of America*, 2 (July, 1930), No. 1, p. 112.

Measurement of the Plate Resistance of

HIGH-FREQUENCY CLASS B & C AMPLIFIERS

By DR. VICTOR A. BABITS, A.M.I.E.E., M.I.R.E.

Assistant Professor

UNIVERSITY OF TECHNICAL SCIENCES

BUDAPEST

W. L. EVERITT[1] has published a paper dealing with computations in high-frequency Class B and C amplifiers. Although the results set forth in this paper proved to be satisfactory in practice, the computations may also be made by a graphical method[2]. As is generally the case when dealing with technical radio problems, however, it is desirable to check the results of theoretical analyses by actual measurements.

According to Everitt, the plate resistance of high-frequency Class B and C amplifier tubes apparently increases to β times its original value R_p which is a function of the operating angle θ, 2θ being the angle while current is flowing. By means of the measurement outlined here the apparent plate resistance βR_p is determined.

Now the apparent plate resistance is practically independent of the frequency. Hence the measurements may be carried out at either high or audio frequencies.

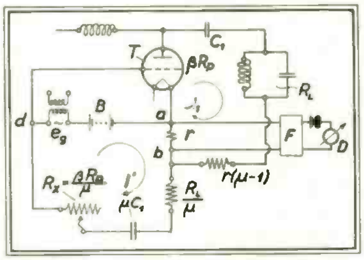
In the accompanying circuit diagram T is the tube subjected to the measurement. Its plate resistance is βR_p. In its plate circuit the condenser C_1 is connected. If $LC\omega^2 = 1$, then the impedance of the tank circuit, which is a pure resistance, is

$$R_L = \frac{L}{CR}$$

There is still the pure resistance μr, which is very small compared with R_L. B is the battery for grid bias, and e_g the alternating grid voltage. Following Everitt the amplitude of the fundamental alternating-current component of the plate current is

$$I_1 = \frac{\mu E_g}{R_L + \beta R_p + \mu r} \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

μ being the tube's amplification factor, E_g the maximum value of varying component of grid voltage, μr a resistance



connected for measuring purposes. Consequently, if the resistance applied between a and b is r, the fundamental alternating-voltage drop between these points is

$$e_{ab} = I_1 r \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Between the points ad we form a separate circuit for e_g. The parts of this circuit are arranged in such a way that the intensity I' of the current caused by the voltage e_g should equal I_1, its phase displacement being 180°. For this purpose we connect the pure resistances

$$\frac{R_L}{\mu},\ R_x = \frac{\beta R_p}{\mu},\ r$$

and the capacity μC_1 in the circuit ad.

Practically μC_1 may be neglected in the same way as the C_1 which has been joined in the plate circuit of the tube subjected to measurement. Therefore

$$I' = \frac{E_g}{\dfrac{R_L}{\mu} + \dfrac{\beta R_p}{\mu} + r}$$

$$= \frac{\mu E_g}{R_L + \beta R_p + \mu r} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

However, because of the 180° phase displacement there is no potential difference between points a and b.

If therefore in the plate circuit only the fundamental alternating-current component of the plate current is flowing, then the voltage indicator connected between points a and b would show no deflection. Now in the plate circuit harmonic frequencies occur, and to remove the perturbations due to these, a filter circuit F is joined between points ab and the voltage indicator D. Consequently, if the mentioned resistances are connected in the plate circuit and the auxiliary circuit, then $I' = I_1$, and the indicator shows no deflection.

The measurement of the apparent plate resistance βR_p of the tube T is effected by varying R_x (which at the beginning of the procedure by no means equals $\dfrac{\beta R_p}{\mu}$) until the voltage indicator D shows no deflection.

When the balancing is completed, then

$$R_x = \frac{\beta R_p}{\mu} \quad \text{and} \quad \mu R_x = \beta R_p \qquad \ldots\ldots\ldots (4)$$

In order to avoid a possible phase error which might be caused by the filter circuit F, it is advisable to apply a one-tube amplifier before the latter.

*Manuscript received on November 2, 1936.

[1]W. L. Everitt, "Optimum Operating Conditions for Class C Amplifiers," *Proceedings of the Institute of Radio Engineers*, Vol. 22, pp. 152-176, February, 1934.

[2]V. A. Babits, "Class B and C Amplifier Computations." COMMUNICATION AND BROADCAST ENGINEERING, Vol. 2, pp. 7-9, July, 1935.

Balanced Amplifiers

PART VII

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA INSTITUTES, INC.

XXV. DRIVER INPUT TRANSFORMER

THE INTERNAL DRIVER RESISTANCE R_D must be pro-rated between the winding resistances of the driver input transformer and the plate resistance of the driver tube itself. Moreover, a driver tube of adequate size must now be chosen. In actual practice, the nearest standard size tube manufactured is selected. Suppose the one chosen requires a certain B supply voltage; also a certain bias E_c, and that it has a certain mu and a certain plate resistance r_p. Assume it is to be a Class A driver. Then, the equivalent voltage in the plate circuit is of magnitude μE_c. Assuming that the open-circuit inductance of the primary of the driver input transformer is very high, then during that period of the grid cycle when no grid current flows, the circuit μ of the driver stage will be practically equal to the tube μ and the voltage across the primary therefore equal to μE_c in magnitude. From Fig. 26 we see that the generated voltage required in the grid circuit is of value OD. For average tubes of moderately high r_p, μE_c should be greater than OD. The turns ratio of the driver input transformer is then

$$a = \frac{\mu E_c}{OD} \qquad \text{.......... (57)}$$

Usually a comes out between two and four in value. The plate resistance r_p therefore appears as viewed from the grid terminals as

$$r_p' = r_p a^2 \qquad \text{.......... (58)}$$

As is indicated above, a is a fraction meaning a step down in voltage, so that r_p' will be less than r_p. The difference between R_D determined in Fig. 26 and r_p' gives the resistance available for the primary and secondary windings of the driver input transformer. If we assume that these two resistances are equally divided in effect between the two windings (as is usually the case for a good design) then the secondary winding resistance is

$$R_{SW} = \frac{R_D - r_p'}{2} \qquad \text{.......... (59)}$$

and the primary winding resistance is

$$R_{PW} = \frac{R_D - r_p'}{2a^2} \qquad \text{.......... (60)}$$

The designer of the driver input transformer can then determine whether these are practical values for a transformer whose open-circuit reactance is sufficiently high compared to the r_p of the driver tube. If R_{PW} and R_{SW} come out too small then a larger driver tube must be used, or else the permissible distortion percentage must be increased.

The method indicated above will be illustrated by an example, but before presenting the latter, it may be well to note some further conclusions regarding this analysis.

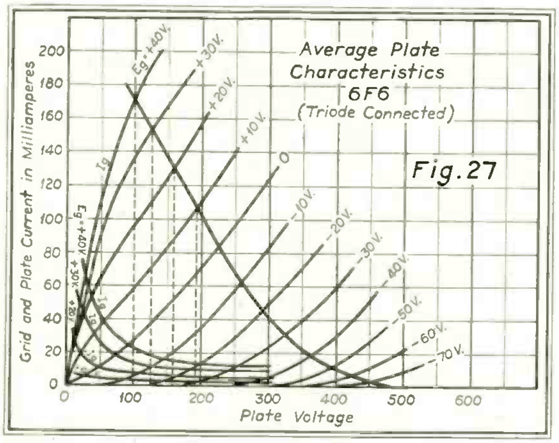


Fig. 27

XXVI. FURTHER CONCLUSIONS

(1) This analysis is based upon the assumption that the open-circuit reactance and the leakage reactance are very high and negligibly small, respectively. This condition is probably approached by a good driver input transformer at frequencies in the neighborhood of 1,000 cycles.

(2) At low frequencies the open-circuit reactance becomes lower and comparable to the r_p of the driver tube, whereupon, the generated voltage available in the grid circuit is less, so that the power output obtained will not be as high as desired. In other words, the frequency response droops off at lower frequencies. On the other hand, by Thevenin's theorem, the impedance which the grid circuit of the tube sees looking back into the source is less than its value at higher frequencies by the shunting effect of open-circuit reactance. Hence, we might expect that the effect of the open-circuit reactance is to reduce not only the power output but the amount of distortion because the grid swing is less and the equivalent internal driver impedance is less, so that the grid-terminal voltage wave is not flattened as much.

(3) At higher frequencies, say around four and five thousand cycles, we may expect the leakage reactance to have an appreciable effect upon the output and distor-

tion products. Since it is a series reactance it makes the internal driver impedance appear higher and therefore causes more flattening of the grid-voltage wave, hence, more of an equivalent undershoot in the plate circuit and consequently less fundamental output and more distortion. Therefore unless it is kept down to a very low figure at those frequencies it causes the calculations given above to be considerably in error. As a consequence we may regard these calculations for the driver and winding resistances as giving a maximum or upper figure, or else we may choose for our computation a lower value of n in order to be on the safe side at the higher frequencies.

(4) The method, as has been cautioned throughout this article, is based on the assumption that all the distortion for a sinusoidal input is third harmonic. Actually, the load line for I_L requires a more complicated power series, which means that higher harmonics are really present. However, their amplitudes are usually very small so that if a conservative value for n is taken, say 5 percent or less, the effects of these higher harmonics need not be feared. In some types of tubes, such as the 59, the electrodes are so connected as to cause the tube to cut off with a very small negative grid bias. These tubes may therefore be operated with zero grid bias, and yet, when in push-pull, will exhibit extreme Class AB characteristics (plate-current cut-off occurring almost immediately in the cycle of grid swing) so that they may be regarded as practically Class B operation. Such tubes draw grid current almost over the entire period of the grid-signal cycle. However, they are suitably designed so that the peak grid current is not too high, so that a practicable value for R_D can be had. A possible advantage of a tube whose grid current flows over practically the entire cycle (besides the elimination of a bias source) is that there are no sharp corners in the grid-current curve, hence in the grid signal-voltage wave, so that the higher harmonics are less in amplitude. Nevertheless, satisfactory performance can be obtained with ordinary tubes whose grids are negatively biased so that grid current does not flow except for a portion of the grid cycle.

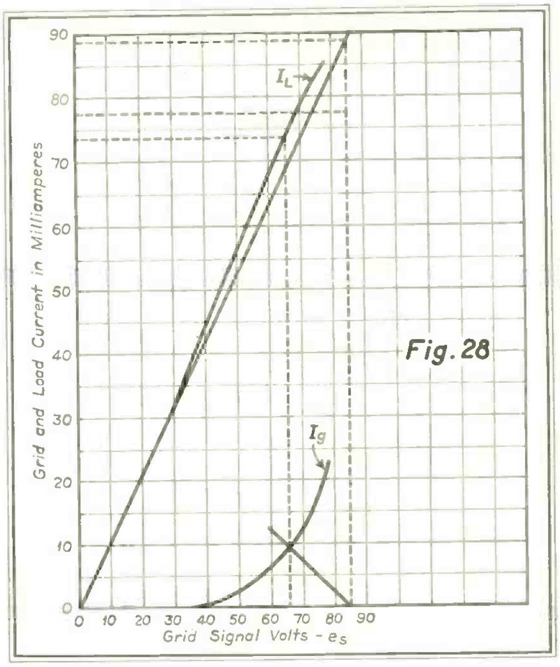


Fig. 28

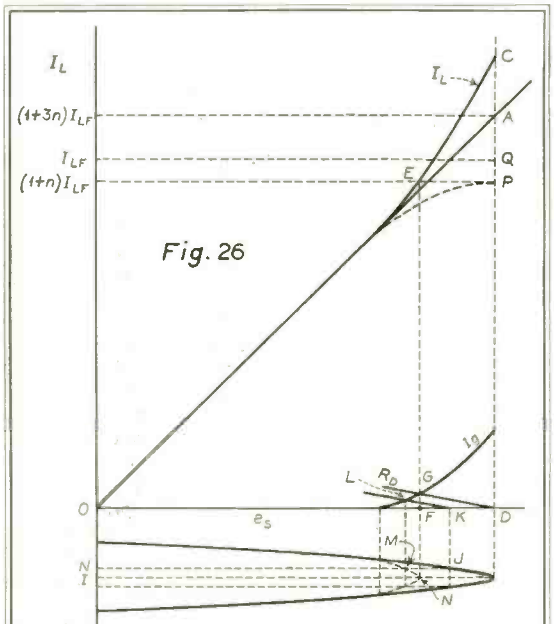


Fig. 26

(5) The driver tube should preferably be of a type which is not critical as to the value of load impedance. This means that it is preferably operated Class A, and even then that it be preferably a triode rather than a pentode. A pentode is very critical as to load resistance and will give rise to high distortion products in its plate circuit if the load impedance presented to it is very variable, such as a grid-to-cathode resistance.

(6) The difficulty in obtaining a driver input transformer design whose winding resistances will fall within the required limits given by equations (59) and (60) depends upon the initial load line for I_L. If this has an overshoot, then, as is evident from Fig. 26 the allowable driver resistance will be greater—or what amounts to the same thing, more internal voltage drop in the driver can be allowed before this overshoot is converted into the permissible undershoot.

(7) No mention has been made of the C bias source for the balanced-amplifier stage. If the internal resistance of the latter were the same both to the a-c and d-c components of the grid-current wave then it could be subtracted from the value of R_D before proceeding to calculate R_{PW} and R_{SW}. Usually, however, the impedance of this source to a-c is negligibly small because a large by-pass condenser is placed across its terminals. Hence, its only effect is to experience a voltage drop due to the d-c component of the grid current. This, in effect, means a change in the steady bias value. To calculate this effect and consequent effects upon the grid-current wave is quite difficult. The d-c component of the grid-current wave would have to be determined by a Fourier analysis, then the voltage drop in the C bias found and then the grid-current curves shifted in a negative direction by the amount of this voltage drop. Then a recalculation of the voltage drop in the grid circuit would have to be made as well as calculation of the position of the load line for R_L which would be shifted too. Then

(*Continued on page 16*)

THE AUTOMATIC RADIOCOMPASS

and its Applications to Aerial Navigation*

By H. BUSIGNIES

Les Laboratories Le Materiel Telephonique, Paris

TEN YEARS ago initial efforts were made to develop a radiocompass system, then called "Hertzian compass," in which the angles indicating the position of a radio transmitter appeared automatically on a graduated scale, similar to the scale of an ordinary magnetic compass. Two years later, more complete studies were undertaken and rough models and testing apparatus were constructed. A first working model was then made and the essential principles established. The apparatus described in this article is, therefore, the outcome of an old idea that had been developed over a period of several years.

Le Materiel Telephonique, Paris, has constructed a radiocompass indicating the direction of a transmitter on a dial graduated in degrees completely around the circle. This radiocompass is, in fact, an automatic radio goniometer: it indicates the direction of chosen transmitters which may be situated all around the plane. More varied applications are thus possible than in the case of an instrument showing only the direction to the left or to the right of the axis of the airplane.

*Condensed from *Electrical Communication*.

The apparatus is based on the following principle: a receiving loop aerial turning regularly around a vertical axis permits maximum reception every time that the plane of the loop passes in the direction of the transmitter. If the loop turns regularly at a certain speed, a certain number of maxima and minima of receptions per second can therefore be observed in a receiver tuned on a transmitter.

A rotating speed of five revolutions per second has been chosen. Maxima and minima of receptions, therefore, take place at the rate of ten a second.

The phase of these maxima and minima, i.e., the moment at which they occur in connection with a given origin, depends on the direction of the transmitter in relation to the axis taken as origin. If the loop turns regularly, these maxima always appear when the plane of the loop points in the direction of the transmitter. If the location of the transmitter changes in relation to the radiocompass, the minima and maxima phases also change. This changing of phases is utilized in the apparatus to obtain the automatic indication.

The high-frequency waves received in the loop pass through amplifier, detector, and low-frequency amplifier stages in the receiver. In the output stage a variable current, representing the maxima and minima of reception, with phases identical to the phases of the wave received, is thus obtained. To obtain the measurement of phase in the indicating instrument, it is necessary to adopt a predetermined origin. This origin is obtained by placing on the rotating axis of the loop a diphased current generator, the phase of which is constant in relation to the revolutions of the rotating loop.

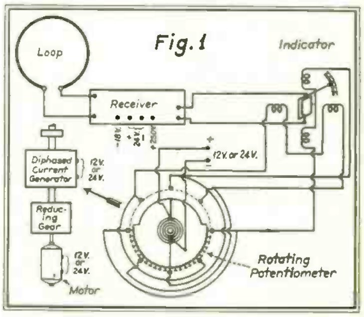
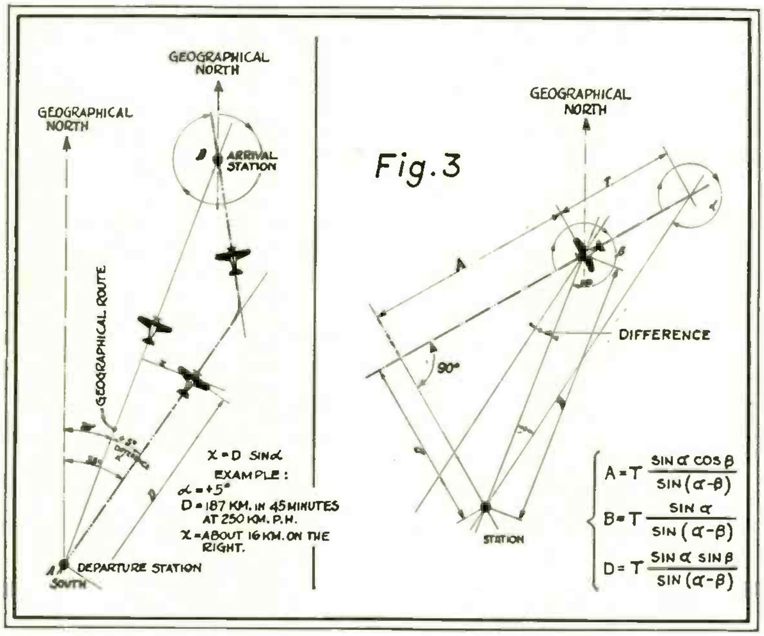


FIG. 1. SCHEMATIC LAYOUT OF EQUIPMENT.

The variable current obtained at the output stage of the receiver, representing the maxima and minima of reception caused by the rotation of the loop, and the diphased currents from the generator are fed into a special phasemeter. The diphased current creates a rotating field in a magnetic stator, comparable to the stator of a synchronous motor. This field rotates at a speed double the speed of the loop. The variable current from the receiver actuates an armature carrying a pointer associated with a dial. In this armature, therefore, an alternating current is produced by the rotation of the receiving loop and, in the stator, a fixed-phase rotating field by the diphased current generator. Thus the magnetic reactions of one flux on the other give a definite position to the armature, which sets itself perpendicu-

FIG. 3. ILLUSTRATING METHODS OF CORRECTING FOR DRIFT.



larly to the flux when the current going through it is maximum, thereby indicating the phase looked for and the direction of the transmitter.

Fig. 1 shows a schematic layout of the equipment. As indicated, the receiving loop is connected to a detector-amplifier receiver. The variable direct current, proportional to the signal, passes through the armature of the indicator. To simplify the diagram, the entire indicator dial has not been reproduced but merely the needle and a portion of the dial. In reality the needle is fixed and the entire scale rotates. The diphased current generator, reduction gear, and the motor for driving the loop at constant speed also are shown.

The diphased current generator consists of a revolving potentiometer, fed by d-c, rotating regularly between fixed brushes. These brushes represent alternately opposite points of maximum positive or negative potential, and pass through all intermediate values in such a way that the result is the production

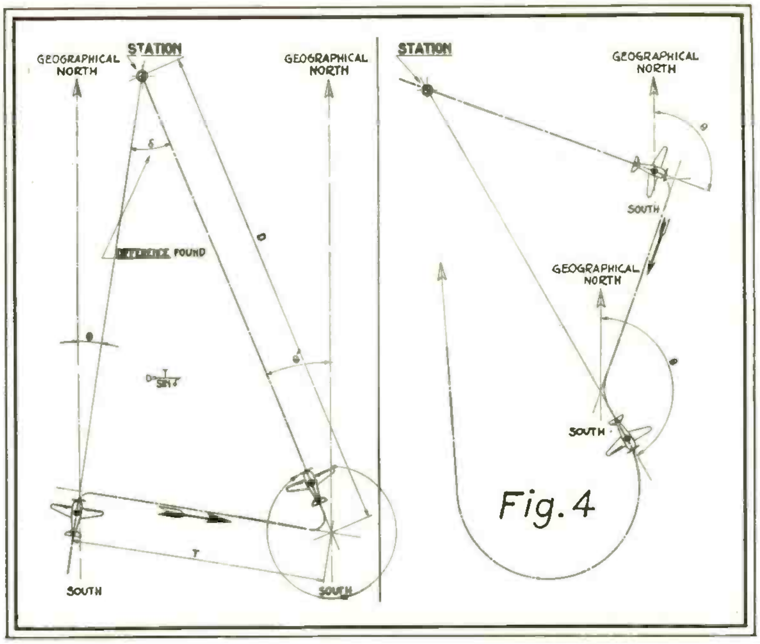


FIG. 4. ILLUSTRATING METHODS OF CORRECTING FOR 180° AMBIGUITY.

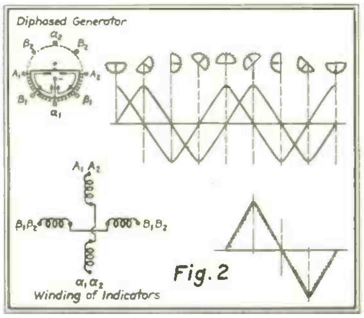


FIG. 2. ILLUSTRATING POTENTIAL RELATIONS.

on these brushes of an angular potential waveform which is rendered sinusoidal by the inductance of the stator of the indicating apparatus. Accordingly, an indication can be obtained at any distance, as only one simple electric link between the indicator and the other parts of the equipment is employed.

The potentiometer is neither continuous nor circular, but consists only of half a circumference since there are two maxima and two minima for each revolution of the receiving aerial, i.e., two periods of the variable current at the output stage of the receiver for each one revolution of the loop. In order to synchronize the diphased currents with the variable current at the output stage of the receiver, it is necessary that they should have the same frequency as the variable current. It is, therefore, necessary to double the rotation speed of the rotating magnetic field by doubling the frequency of the diphased currents relative to the rotating frequency of the loop. When the loop rotates five times per second, the frequency of the output current of the receiver is ten periods per second. The diphased current generator rotating at five revolutions per second also produces a current of ten periods per second, because its current is collected on a half circumference, and because the number of brushes is eight, the brushes being fitted at 180° and commoned in pairs. The current reversals are twice as great as would be the case with four brushes and one complete circular potentiometer.

The brushes, bearing on brass segments, are connected to a resistance. There is thus formed on the segments a potential which may be represented by the lower curve of Fig. 2. This curve is simply due to the passing of the brushes from one segment to the other. The continuous line represents the nearly sinusoidal current obtained when applying to a large inductance a tension of the above form and, in this case, to the stator of the indicator.

The upper part of Fig. 2 shows the diagrams of the diphased currents in the successive positions of the resistances.

In the indicators, the magnetic reaction of one flux on the other causes the armature and dial to take up a steady position and thus to indicate the direction of the transmitter in connection with a predetermined origin. This origin is simply the setting which exists between the diphased generator and the receiving loop: by modifying this setting by mechanical means, the origin can be modified as desired and the indicators can be made to show the zero angle when the airplane is heading towards the transmitter.

The indicator not only utilizes the current maxima to show the direction, but it also entirely integrates the variable current due to the signal. Therefore, the sensitivity is very high and the stabilizing of the indicator is proportional to sin α (α being the angle through which the armature might be artificially pulled out of position).

This integration of the effects of the variable current is due to inertia of the armature. However, the inertia has been so limited that the armature vibrates at 10 periods per second on about ¼ of a degree, which considerably lowers the initial friction of the pivots and has the added advantage of allowing the observer immediately to detect a possible "dead" receiver or any other fault.

Two indicators can be utilized. One is called "navigator's indicator" and the other, "pilot's indicator." In the first, the indication is read on a movable dial graduated in 360° and moving in connection with a fixed pointer. In the second, the indication is limited to plus or minus 15°. The first is called "navigator's indicator" because it allows any of the crew of the airplane taking bearings to determine the position of the plane in relation to any given transmitter located around the plane. The second is specially limited and designed for flying toward any given transmitter, and especially concerns the pilot.

By means of the indicator the pilot can modify the reference axis by ±15° in such a way that by altering his pointer the same amount of degrees as the angle of the drift he can still steer

(*Continued on page* 21)

CLOSE-MIKE vs. REVERBERATORY MONITORING

By CHARLES FELSTEAD

Instructor

FRANK WIGGINS TRADE EVENING SCHOOL

STUDIO MONITOR MEN have separated more or less into two distinct parties in their methods of recording sound for motion pictures.* The members of one party adhere to the practice of monitoring with a "close mike," in order to record mostly the direct voice of the speaker, and they depend to a very small extent on the effect of the reverberated voice in placing the microphone. Monitor men of the other group rely principally on reverberated sound for recording, and locate the microphone to emphasize the direct voice only when a closeup scene is being "shot." It is time these two styles of monitoring be compared and their relative merits considered.

MONAURAL AND BINAURAL HEARING

The microphone is necessarily a monaural (single-eared) hearing device. This is an unfortunate condition, because human beings are endowed with a binaural (two-eared) hearing organism. By long training, the human being has learned to determine the direction and distance of the source of a sound wave rather accurately through the functioning of his binaural hearing. This operates on a principle similar to that which permits an individual to estimate with great accuracy the direction and distance of an object viewed by the eyes. When a normal person hears a sound, he is able to determine its origin by a mental process which takes into consideration the relative amounts of sound received by each ear and the interval in time elapsing between one ear hearing the sound and the other one hearing it.

The same accurate judging of distance and direction is not possible with a single ear or a single eye, although experience helps the individual in cases where one of either pair of these organs has been destroyed to overcome the handicap by developing a mental ability to "guess" direction and distance with a fair degree of certainty. In the case of hearing, this is due in a considerable measure to the mind subconsciously balancing the relative amounts of direct and indirect sound reaching the single ear from the source of the sound. It is an identical condition which is encountered in sound recording, for, although the individual who hears the reproduced sound in the theatre has binaural hearing, the microphone that was employed for receiving the original sound is a monaural hearing device.

The physical difficulties that would be encountered in overcoming this condition, by devising a binaural recording system, represent too great an obstacle to make the binaural reproduction of sound practicable, as two complete recording and reproducing systems would have to be provided . . . one for each ear of the auditor. Consideration of the manner in which this deficiency in the sound-recording equipment is surmounted brings the discussion back to the two schools of monitoring, each of which attempts by a different method to compensate for the monaural hearing of the microphone by creating the illusion of binaural hearing on the part of the listeners.

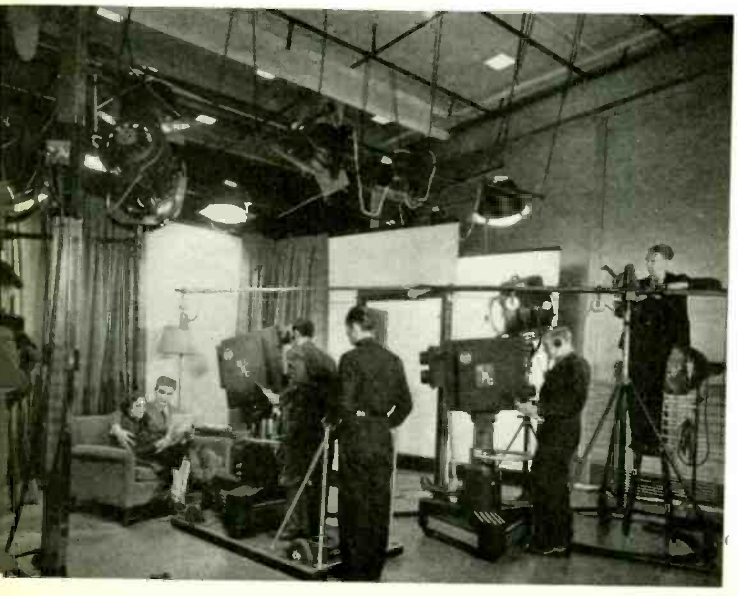
*It is anticipated that television studio engineers may profit from the experience of motion picture engineers. See editorial.

RELATIONSHIP OF MICROPHONE AND CAMERA

The motion-picture camera serves as the eye of the theatre patron, and the microphone as his ear. To produce the necessary illusion of reality in the finished product, the proper relationship must be maintained between the camera and the microphone. This relationship corresponds to the physical relationship of the eyes and ears of the spectator. In other words, the voice of the image on the screen should seem to originate from the same position back of the screen that the eye of the spectator informs him the speaker is located.

During a closeup shot with the camera, the microphone should be placed close to the actor, so that more of the direct voice is received by it than the reverberated voice. During a long shot with the camera, the microphone should be back some distance from the actor, so that less of the direct voice and more of the reverberated voice is received by it. The type of lens employed on the camera should also be checked by the monitor man before each shot.

The proper employment of reverberated sound in recording simulates actual conditions, for under normal conditions the farther a person is from a source of sound, particularly in a place surrounded by walls or other hard surfaces, the less the amount of direct sound and the greater the amount of reverberated sound that will reach his ears. The direct sound, which is the sound that passes straight from the source to the diaphragm of a microphone (or the human ear), reaches the microphone much more quickly than the reverberated sound, which must be reverberated from some nearby surface before it encounters the microphone. As this is one of the means by which a person with normal binaural hearing determines the distance of a sound, it is



IN THE NBC TELEVISION STUDIO. NOTICE THAT THE MICROPHONE IS SUSPENDED ABOVE THE PERFORMERS' HEADS.

evident that the proper placing of the microphone in recording to collect the correct proportion of direct and reverberated sound for each shot tends to heighten the effect of depth in the picture.

Attempt is made in photographing a picture to create a similar impression of visual depth by careful lighting of the set and actors. Producing a correct illusion of depth is one of the important factors in making a pleasing picture—it is the lack of this third dimension that is the greatest drawback to the motion picture. Thus, it is evident that expert sound monitoring can serve to add measurably to the artistry of a production.

IN THE PHILCO TELEVISION STUDIO. NOTICE THE PLACEMENT OF THE MICROPHONE HERE.

REVERBERATORY MONITORING

In reverberatory monitoring, full advantage is taken of the effect of reverberation in so far as it will add to the quality of the recorded sound. The microphone is usually hung with the diaphragm forming an angle of about sixty degrees with the floor. It is not always faced exactly toward the speaker, but often it is turned so that it receives a considerable portion of its acoustic energy from some adjacent hard surface. This is true particularly when a long camera shot is being made.

No definite rules can be laid down for this type of monitoring, since experience is the best and only real teacher. It must always be remembered, however, that the longer the camera shot the greater the amount of reverberated sound and the less the amount of direct sound that should reach the microphone. Placing the microphone at a distance from the source of sound will accomplish this automatically, but it is usually desirable to heighten the effect by turning the microphone to receive from some hard surface a greater than normal amount of reverberated sound. Generally, the correct position for the microphone for any particular scene can be determined after listening with it in several likely positions.

The type of wall construction employed in the motion-picture set in which the recording is done considerably influences the placing of the microphone. If the walls are of a hard material, such as wood, and thin enough to be resonant at certain frequencies within the audible range, the amount of reverberation will be high. For that reason, a set of this type is said to be "hard." The microphone should be located in such a set so that it receives more direct than reverberated sound, because sound that is reverberated from resonant surfaces will be greatly emphasized at the resonant frequencies and is likely to be unpleasant in quality.

In other sets in which walls of canvas are painted to resemble wood, there is almost no reverberation present; the canvas walls do not offer a sufficiently hard surface to the sound waves to reflect them to a material extent. In such cases, the microphone should be placed to take full advantage of all reverberation present in the set, except on picture shots which show such large closeups of the speakers that it would be incongruous to record other than the direct sound of their voices.

CLOSE-MIKE MONITORING

Those monitor men who still insist on "playing a close mike" have little to worry about concerning the reverberatory characteristics of the walls of the set in which they are working, for reverberation has small effect with their style of monitoring. Monitor men of this school usually suspend the microphone three or four feet in front of the speaker and just high enough to be out of range of the camera lens. The head of the microphone is turned so that the diaphragm is parallel to the floor or tilted slightly to face the speaker. Only the slight amount of sound that is reverberated from the floor reaches the microphone in addition to the direct voice, and it is doubtful if that reverberated sound would be distinguishable in the overwhelming volume of direct sound. A certain amount of resonance is obtained from the voice of the speaker without recourse to reverberation. It must be said for this type of monitoring that the recorded voice is clearer and more distinct than that secured by reverberatory monitoring, chiefly because only the direct voice of the speaker is present in the sound record.

The effect of depth in recording with a close microphone is improvised to a great extent by varying the electrical level at which the sound is recorded. This means that the mixer dials are turned down so that only a low amount of electrical energy enters the recording device when a long shot is being made with the camera; the dials are turned up to permit considerably more energy to reach the recorder when a closeup is being photographed. Often, in addition, the microphone is moved a short distance toward or away from the speaker to permit the illusion of a close or distant speaker to be more easily created. Regardless of the position of the microphone with respect to the speaker, however, the microphone is nearly always faced almost directly toward the floor. This has a tendency to create standing waves of sound between the microphone diaphragm and the floor, which is an unsatisfactory condition and is one of the chief technical objections to this form of monitoring.

When an attempt is made with a close microphone to create the impression of sound depth by varying the level at which the sound is recorded, the effect of the distance of the speaker back of the screen in the reproduction of the scene is obtained satisfactorily; but the theatre audience invariably notices that something of naturalness is lacking in the sound. What they actually miss is the absence of normal reverberation.

On the other hand, it is as easy to use the effect of reverberation wrongly as it is to use it correctly. Examples of this incorrect use of reverberation may be seen frequently in the recording of sound in a small cellar, or other place with hard resonant walls, without there being any reverberated sound evident in the recording, and in the recording of sound in a set supposedly out in the open with so much reverberated sound present that the recording is "tubby." These examples of poor acoustic control are due usually to carelessness on the part of both the monitor man and the man who designed the set with such incorrect acoustic qualities.

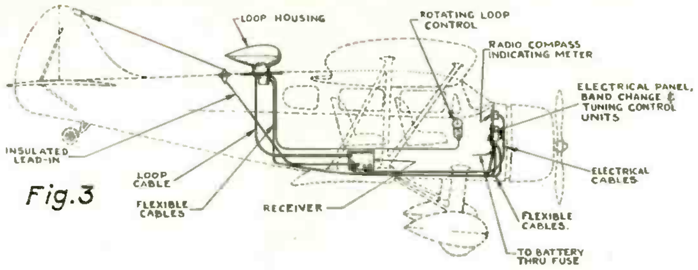


Fig. 3

AN AIRCRAFT RADIOCOMPASS

By

E. D. BLODGETT and E. T. DICKEY

RCA MANUFACTURING CO., INC.

THE MODEL *AVR*-8 Radiocompass is a combination of a navigating instrument and a high-grade radio receiver. It may be used as a conventional receiver of aural output for the reception of weather broadcasts or for flying conventional radio-range courses; for the reception of standard radio-broadcast signals for entertainment and also for the reception of high-frequency aviation communication. The flick of a switch and the adjustment of a visual-indicator control secures operation as a radiocompass for navigational purposes, providing visual output. The use of the AVR-8 as a radiocompass is confined to the 200- to 410-kc radio-beacon-weather band and the 550- to 1500-kc standard entertainment band.

The principal specifications for this radiocompass may be briefly outlined as follows:

Circuit—Superheterodyne with automatic volume control and direction-finder loop with controls.

Tuning ranges—200-410 kc, 550-1500 kc and 2200-6700 kc.

Tubes used—Ten tubes consisting of: two 6C6s, three 6D6s, two 6F7s, one 6B7, one 37 and one 84.

Power supply—Airplane 12-volt storage battery with vibrator (of synchronous rectifier type), transformer and filter system to provide plate and grid bias voltages.

Power output—0.7 watt maximum.

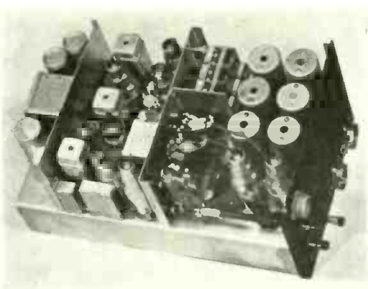
Current consumption—Radiocompass—2.8 amperes; receiver (compass "off") 2.5 amperes.

This radiocompass has been designed with several arrangements of control boxes and panels so that it may be accommodated to various types of installations in the ship. The Model AVR-8 is supplied with a fixed loop designed for operation in the radiocompass circuit and also serving as a receiving antenna. The control boxes and electrical control panel are separate units. Reference to Fig. 1 shows the various possible arrangements of mechanical and electrical control mountings which are available for the various types of this instrument.

In addition to the loop, a fixed antenna is also used in conjunction with the loop as described later. Either the standard aircraft vertical pole or any of the other conventional types of aircraft antennas may be used with due consideration to location away from the engine, reliability of support and adequate effective height.

The receiver unit itself is usually located toward the rear of the plane, under the back seat or in the luggage compartment. The receiver unit is held in place by shock-mounting straps and should have its base in a horizontal position for best operation. The top or lid and front panel are removable for inspection or simple servicing and the unit should be so mounted as to provide for this. The compact construction and shielding provisions are shown in Fig. 2.

FIG. 2. THE AIRCRAFT RECEIVER USED WITH THE AVR-8 RADIOCOMPASS.



Flexible shafts are provided to run between the "band-change," "loop-rotating" and "tuning" unit control boxes and the loop and receiver cases. The maximum dimensions of these flexible shafts are shown in Fig. 1. These lengths may be shortened in the usual manner in case the lengths provided are greater than necessary. The maximum lengths of the other interconnecting cables are also shown in Fig. 1. The band-change control has flexible shafts leading both to the loop housing and to the receiver unit since it is necessary to shift connections in both of these units in switching from one band to another.

The control heads or boxes, electrical control panel and indicating meter should be in easily accessible locations near the pilot, preferably on or near the instrument panel (see Fig. 3). The indicating meter is mounted in such a location as to be easy to read in accordance with standard practice. Its position is usually among the flight instruments. This meter is specially constructed and its movement is damped to withstand the shocks and vibrations encountered in aircraft.

The loop is usually mounted on the outside surface of the ship, although occasionally it is mounted inside, just below the skin. When used inside, the loop housing is removed. This housing is of streamline design to reduce air friction or "drag" when mounted outside. The loop should be as far as conveniently possible from the engine, metal frame of the ship or from closed loops formed by tubing or guy wires. The loop should always be mounted along the lubber line in such a position as to have a vertical plane of axis in order to properly intercept the direction wave.

Plate and grid voltages are provided by a vibrator, transformer and filter system. The vibrator unit bears "plus" and "minus" marks on its top. The unit may be placed in its socket in two ways so that either of these signs comes opposite to an arrow mark on the chassis. This provides a very simple and easy way of accommodating the receiver to variations of battery ground terminal polarity.

The operation of the AVR-8 equipment covers:

(A) Radio reception on all bands covered by the instrument.

(B) Radiocompass on beacon "X" and broadcast "A" bands.

(C) Loop-coupled aural receiver on beacon "X" and broadcast "A" bands.

The loop-coupled receiver provides operating conditions, through electrostatic shielding of the loop, which give a materially reduced effect of "rain static." This is accomplished by throwing the right-hand toggle switch on the electrical control panel down to the "receiver static limiter" position (see Fig. 1). In this condition the antenna is disconnected and reception is by means of the loop which then acts like the conventional direction-finder loop with aural indication, on "X" and "A" bands. The reception on "B" band is then through the vertical antenna only. In the "X" and "A" bands under this condition, if the ship is headed towards the station, either the ship or loop must then be turned from 5 to 15 degrees "off course" in order to equal the pickup obtained with the vertical antenna.

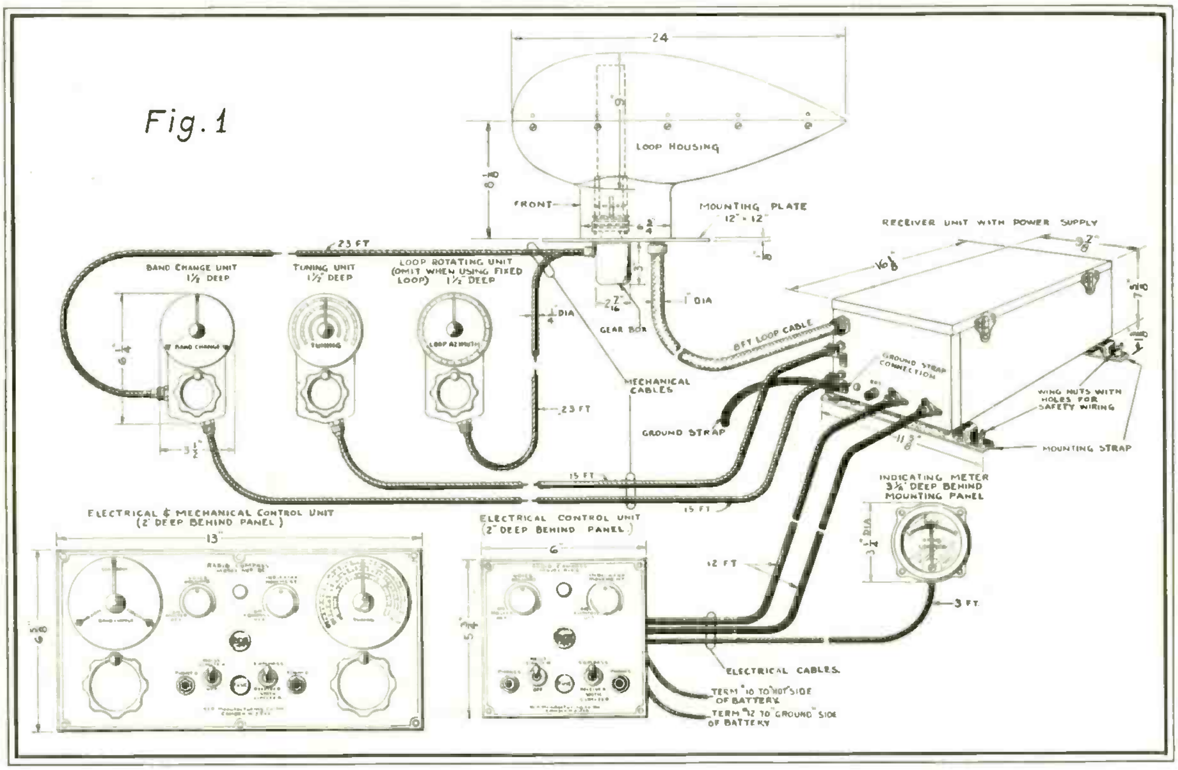
With the right-hand toggle switch on "compass" and the compass "indicator-movement" control at "off" the equipment then operates as an ordinary radio receiver with the conventional antenna on all three bands. The volume in the headphones is then adjusted by means of the "voice-volume" knob, and minimum position of this knob operates the master "on-off" switch. By throwing the right-hand toggle switch to "receiver static limiter," reception by means of the loop is then available for "X" and "A" bands, but the antenna alone is always used for the "B" band.

Throwing the left-hand toggle switch to "noise limiter" assists in reducing the peak intensity of high atmospheric disturbances in the headphones. Readjustment of the "voice-volume" control is usually necessary under this condition.

Turning the "indicator-movement" knob "on" and throwing the right-hand toggle switch to "compass" places the equipment in operation as a radiocompass on "X" and "A" bands. By use of the indicating meter, the receiver may then be used as a radiocompass for determining the direction of any receivable station. That is, signals emanating from a radio-broadcast station may be used with an AVR-8 and thus the pilot may fly to points that would otherwise be impossible due to lack of other radio-navigational aids at such points.

With the fixed loop, when the ship is "off course," the indicating meter will show by its indication the direction in which the ship should be turned in order to fly "on course" toward the station. The installation is always made so that when the ship is pointed toward the station the meter indicator reads zero. When the nose is turned to the left of the station the indicator moves toward "L." This arrangement is similar to the "bank and turn" indicator. If, however, the ship has flown over and beyond the station the indicator movements will be reversed. That is, by turning the ship slightly "off course" to the left the indicator will move toward "R." This provides an additional check of position. When flying on one side of a beacon path, on either side of the "A" or "N" course it is helpful to listen to the keyed signal in order to interpret the indicator movements. The indicator meter operates only at the time of signal reception and the pointer movement may, therefore, be confusing unless interpreted by simultaneous listening. The deflection amplitude or sensitivity of the indicating meter is controllable by ad-

Fig. 1



justment of the "indicator-movement" control. This control is independent of the "voice-volume" control and therefore does not affect the headphone signal intensity.

When operating with a rotating loop the operation is the same as with the fixed loop if the loop azimuth control is set at zero. In this case, however, it is not necessary to turn the ship to locate the direction of the signal transmitter. By turning the loop azimuth control until the indicating meter points to the center of its scale and then adding the reading on the dial of the loop azimuth control to that of the magnetic compass, a true

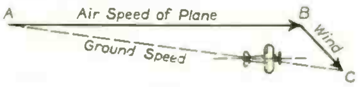


FIG. 4.

reading of the geographical course may be obtained. The loop azimuth control is calibrated for this purpose, and its reading alone gives the difference in degrees between the ship's heading and the direction of the source of signal. The rotating loop may also be used by taking readings from two or more different stations, to determine the exact location of the ship by triangulation.

The value of the radiocompass in actual navigation of an aircraft can be well illustrated by a brief consideration of the methods used for air navigation

FIG. 5.

by so-called dead reckoning as compared with radio navigation. Fig. 4 is taken from the U. S. Department of Commerce publication No. 197 on "Practical Air Navigation." It shows the result of piloting a plane on a certain predetermined course without respect to, or knowledge of, the wind velocity or direction. The result, of course, is to drive the plane off course unless the direction of the wind is exactly along the course.

Fig. 5 from the same publication shows the method used to plot the necessary wind correction angle so that the plane may be flown in the proper angle to the plotted course so as to arrive at the desired destination. This requires an accurate knowledge of the plane speed, the wind direction and speed, and depends on the wind remaining as plotted for the duration of the flight. If the wind changes, the plane may again be off course unless the course is recalculated from revised wind data. In bad flying weather this becomes a very complicated process and much time is apt to be lost as a result of this system of navigation in such weather.

In radio navigation, on the other hand, the pilot needs only to select a radio-transmitting station near to his destination and then by keeping the pointer of the indicating meter at zero, he will arrive over this station regardless of the wind conditions or changes therein. Flying in this manner with a steady cross wind the plane would fly a course similar to that shown by the dotted line of Fig. 6. Actual calculation shows that even with high wind velocities this course requires little more time to traverse than the dead-reckoning course of Fig. 5. Whereas, the latter may fail to bring the pilot to his desired destination due to changes of the wind after the start of the flight, the plane

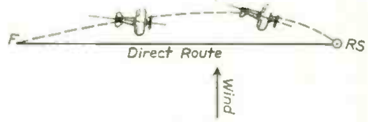


FIG. 6.

flown by radiocompass cannot fail to arrive at the desired destination regardless of wind changes. Thus, in the majority of cases, piloting by radiocompass will bring the plane to its destination as soon as, if not before, the plane piloted by dead reckoning. Also, of course, in fog flying all methods except radio navigation fail or become very uncertain.

In closing the authors wish to acknowledge the assistance received from Messrs. S. G. Flack and J. Kaul in the development work on this device.

BALANCED AMPLIFIERS

(*Continued from page 9*)

the correct grid-current wave would be determined, its value of d-c component found and another correction made to the bias. In this manner, by a method of approximations, a final state of equilibrium could be found.

(8) However, the methods outlined previously will serve at least to determine feasible values of winding resistance, and at least one conclusion can be drawn, namely, that the bias source should have as low a d-c resistance as possible and should be adequately by-passed so as to have a negligible a-c impedance in the working range of frequencies.

XXVII. TYPICAL CALCULATIONS

We now proceed with the illustrative example.

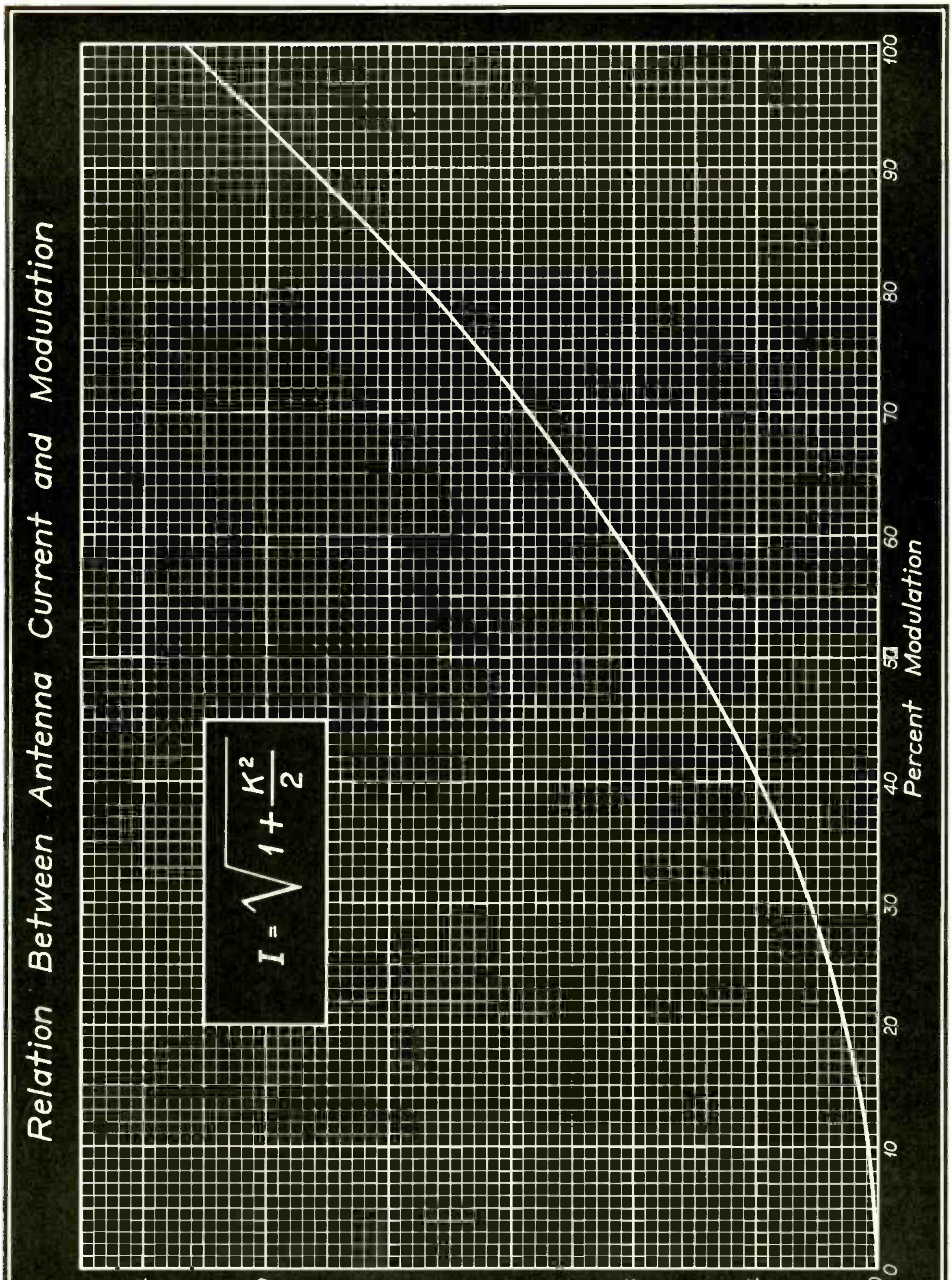
Using the 6F6 tube, we draw the push-pull load-line as shown in Fig. 27. This intersects the + 10, + 20, + 30, and + 40 grid-volt curves at points which are projected downward to the corresponding grid-current curves, as shown by the broken lines. The corresponding grid currents are indicated by the circles. The load current, I_L, obtained from the push-pull load line, and the grid current I_g are now plotted against grid signal voltage e_s — Fig. 28. A straight line is now drawn as nearly coincident with the lower part of the I_L–e_s line as possible. It is to be noted that the I_L–e_s graph represents an overshoot compared to the linear line, although it shows signs of an ultimate undershoot for a sufficiently large grid swing.

Suppose an output power, P_o, of 18 watts is desired with a third-harmonic distortion of 5 percent (= n). The fundamental load current will therefore be

$$I_{LF} = \left(\frac{2 \times 18}{6000}\right)^{1/2} 1000 = 77.5 \text{ ma.}$$

Lines are drawn through current values of 15 percent greater and 5 percent less than 77.5 ma, or through 89.2

(*Continued on page 24*)


Relation Between Antenna Current and Modulation
$I = \sqrt{1+\frac{K^2}{2}}$
Percent Modulation
0
10
20
30
40
50
60
70
80
90
100
Percent Increase in Antenna Current
0
4
8
12
16
20
24

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

TWO-WAY RADIO FOR FIREBOATS

NEW YORK'S nine fireboats will soon be linked by radio to the Manhattan Fire Alarm Central Office when a new two-way radiotelephone system, being furnished by the General Electric Company, is installed early next spring.

The new system will provide duplex communication identical to an ordinary telephone conversation, with no switching operations necessary to change from talking to listening and vice versa. Briefly, the equipment will include a remote-control 500-watt medium-high-frequency central transmitter for direct radio communication to all fireboats. The return part of the conversation from the boats will be transmitted by ultra-high-frequency radio to pickup receivers located at strategic points in the area to be covered and from each of the pickup locations via wire lines to the Manhattan Fire Alarm Central. Each boat equipment will include a 50-watt ultra-high-frequency transmitter, medium-high-frequency receiver, antenna and power supply. The site selected for the central transmitter is the Fire College Building in Queens.

The two-way radio system will only be in use when the boats have left their docks, at all other times direct wire-line calls can be made from the central office to the men in the dockhouses. The new radio installation, however, will enable the headquarters control point to be in direct and immediate communication with all boats at all times, whether they are at the docks or in the harbor waters. The pickup receiver locations have been selected so that at least one receiver will be within the communication radius of a fire boat at any point in the harbor waters.

A PRECISION RECEIVER

MANY UNUSUAL features have been incorporated in a new model of the Hammarlund "Super Pro" receiver.

One of the important features of this model is a five range, directly calibrated "Band Width" panel control. With the aid of this tuning device it is now possible to accurately select the actual band widths required. That is, if the operator wishes to tune a band width of 3, 4, 6, 10, or 16 kc, he can actually turn the knob to either one of these calibra-

FRONT VIEW OF THE NEW HAMMARLUND RECEIVER.

tions on the panel; in this manner, not only is a high technical precision achieved, but also the most effective results.

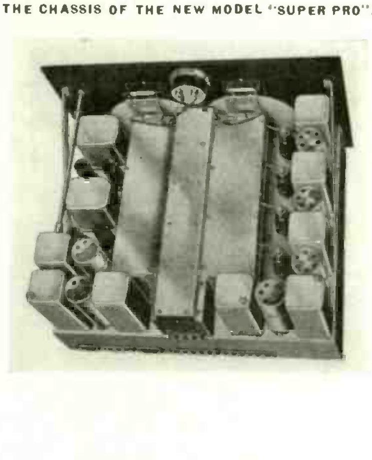
Graduated sensitivity and audio gain controls represent two more features. The calibrations of both these controls appear directly on the panel and enable the operator to select the proportionate sensitivity or audio gain required for each signal. Thus, an actual graph can be made for signals from any particular broadcasting station.

For cw code, a calibrated beat oscillator control has been included. With this unit it is now possible to select a beat note of somewhere between 0 and 2500 cycles on either side of zero beat.

By adjusting the bandwidth control, a tone control effect is also available, since the high or low notes can be cut off or heard at will, depending upon the band selected.

An additional feature is the special cam-operated knife switch; in this switch are five shielded sections with five silver-plated bakelite knives in each unit. Each knife glides into four silver-

THE CHASSIS OF THE NEW MODEL "SUPER PRO".



plated phosphor bronze spring clips and each spring clip is broken into two sections. Thus, a positive 6-point contact is made every time a knife is moved.

Another feature is the band spread system, with a 12-gang condenser, which spreads each amateur band over practically the entire dial. High-frequency broadcast channels are similarly spread for easy tuning. Within the precision tuning unit, are twenty tuning coils on Isolantite bases, a four-gang main tuning condenser, and a 12 to 1 ratio direct-reading dial, calibrated in megacycles and kilocycles accurate to within ½%.

With the bandwidth control at the minimum setting, or with the primary and secondary of the i-f transformer most widely separated, the selectivity of a signal 10 times the input is only 5.5 kc, and at 1000 times the input only 11.5 kc. With the bandwidth control at maximum width or actually at minimum selectivity, at 10 times the input, a 25-kc band is available.

The signal-to-noise ratio on 14 megacycles is said to be only 8 db at 0.7 microvolt input with 30% modulation at 400 cycles.

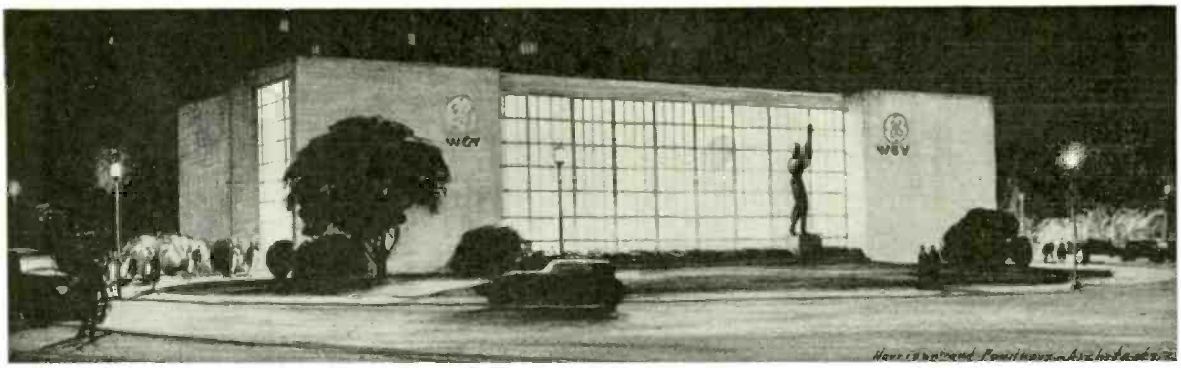
The image ratio at 14 megacycles is 1600 to 1, and at 1000 kilocycles, it is 316,000 to 1.

The receiver is powered with a separate power supply in its own metal housing. Individual grid and plate voltages are supplied to eliminate hum and insure voltage constancy.

NEW STUDIOS FOR WGY

A NEW HOME for WGY of the modernistic type, with the latest of studio and control-room equipment, will be built by the General Electric Company early next spring in Schenectady. The new structure, two stories in height, will be of gray stone finish with glass blocks on the front and two ends.

The building will contain five studios including one which will be two stories in height and equipped with a balcony for spectators. This, with some additional seats on the first floor, will accommodate up to 150 persons who might wish to witness a broadcast. Another studio will also be unique in that it will be a modern electric kitchen. This studio will be used for those broadcasts which have to do with cooking and



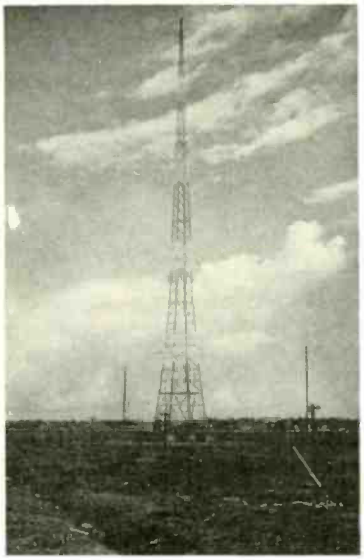
ARCHITECTS' DRAWING OF THE BUILDING WHICH WILL HOUSE WGY'S NEW STUDIOS.

other household duties. With glass panels facing the large hallway of the building, the interior of this studio will be visible at all times to spectators.

The other three studios will be of average size, and, in addition to broadcasts, will also be used for rehearsals and auditions. All studios will be air conditioned, assuring comfort to artists and spectators during any season of the year.

Adjoining each studio will be a control room from which the operator will have full view of the studio through a large window. On the corridor extending across the front of the building will be the master control room, from which programs are fed into the 50,000-watt WGY transmitter at South Schenectady or into the National Broadcasting Company network. Offices for the WGY personnel and a room for artists will be along the glass front on the second floor. WGY will continue to be operated by the National Broadcasting Company and will be an outlet for NBC red network programs.

The design and construction of the new building will be under the supervision of the engineering department of the General Electric Realty Corporation. The detailed plans were drawn by Harrison and Fouilhoux, New York architects who designed General Electric's "House of Magic."



THE 242-FOOT VERTICAL RADIATOR CONSTRUCTED FOR I. T. & T. AT SAN JUAN, PUERTO RICO. THE LEHIGH STRUCTURAL STEEL CO., DESIGNED THIS TOWER FOR A WIND VELOCITY OF 200 MILES PER HOUR.

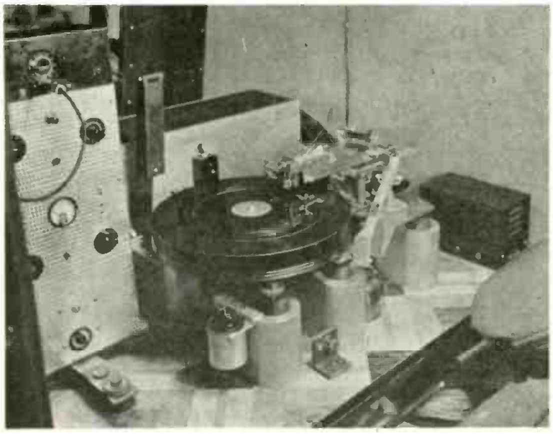
RECORDING TRUCK

THE PACIFIC DIVISION of the Starr Piano Co., Richmond, Ind., using the trade name of Gennett Records for sound-effects discs, has just equipped a Dodge truck at the Universal Microphone Co., Inglewood, Calif., with a professional recording machine specially mounted for mobile operation. The installation includes recording amplifier, velocity microphones and other attendant equipment to permit recording under all conditions.

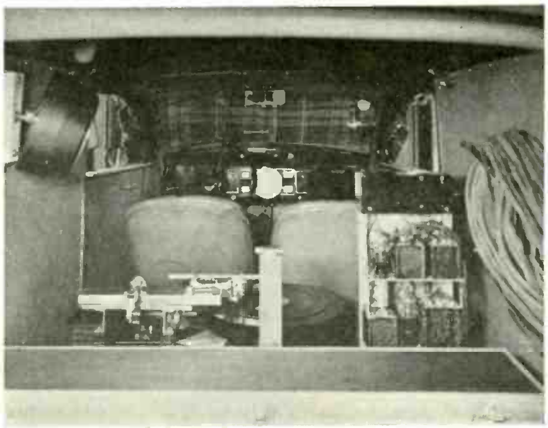
The Gennett truck will work up and down the coast recording sound for its transcribed sound-effects library, which is said to be the largest in the world. The uses of the discs are multiple and include usage in the films for dubbing in sound effects, for drama work on radio stations, for industrial sales programs to be sent to branch offices, travel talks on the lecture platform and in various other ways.

Because of the mobility and portability of the traveling recording outfit, it can go anywhere and record everyday sounds in city and country, or out-of-the-ordinary noises at the seashore, mountains or desert. It is the first installation of its kind to be installed for everyday use.

THE MOBILE RECORDING EQUIPMENT DESCRIBED IN THE ACCOMPANYING TEXT.



ANOTHER VIEW OF THE RECORDING TRUCK. SEE ILLUSTRATION AT LEFT.



BOOK REVIEWS

THE HANDBOOK OF CHEMISTRY AND PHYSICS, Chas. D. Hodgman, editor-in-chief, published by Chemical Rubber Publishing Company, Cleveland, Ohio, twenty-first edition, 2028 pages, price $6.00.

For twenty-three years *The Handbook of Chemistry and Physics* has been giving a unique service to those in need of accurate tables, formulas and scientific data in a single volume. The twenty-first edition of this book represents an increase over the last edition of about 175 pages of new composition entailed by complete revision of several important tables.

The mathematical section presents several new features. The numerical table now appears in two parts, the first of which gives the reciprocals and the circumference and area of circles. The second part is devoted wholly to squares, cubes and roots. all values being given to at least seven significant figures.

A table of haversines and considerable material on statistics have been added, and the order and arrangement altered so as to place the four- and five-place logarithm tables at the front of the volume. The collection of laboratory arts and recipes has been completely revised, while the photographic section now includes a large variety of new formulas and a revised table of plate and film speeds given in the Scheiner and in the Weston systems.

A 17-page table covering the properties of commercial plastics is appropriate in view of the increasing availability and utilization of this material. A revised table on isotopes brings up-to-date the information in this rapidly changing field. Convenience in the reduction of gas volume to standard conditions should result from the use of a special table giving both the factors and their logarithms for such reductions.

Several other small tables have also been added and a large number of minor changes and partial revisions have been made.

RESONANCE AND ALIGNMENT, published by John F. Rider, 1440 Broadway, New York City, 91 pages, price 60c.

This book is well described by its title, and like the other two Rider books reviewed on this page it has been written in a practical manner for the service man. It gives a general review of tuned circuits and discusses alignment procedure. Alignment and neutralization of t-r-f receivers, alignment of superheterodynes, and oscillator, r-f and detector alignment all receive their due space. This book is to be recommended.

THE "RADIO" ANTENNA HANDBOOK, prepared by the engineering staff of "Radio" under the direction of J. N. A. Hawkins, edited by Frank C. Jones and W. W. Smith, published by Radio, Ltd., 7460 Beverly Boulevard, Los Angeles, California, 80 pages, price 50c.

The editors of "Radio," feeling that antenna data has been incompletely presented in most common texts and that a need existed for a more complete presentation of the subject, have prepared *The "Radio" Antenna Handbook.* Their aim has been to present a comprehensive and practical outline of the whole antenna problem for the amateur and others using high frequencies.

As is usual in books of this nature, the first chapter has been devoted to fundamentals and discusses ground and sky wave, fading, antenna radiation, antenna length, radiation resistance and antenna impedance, non-resonant lines, etc. This is followed by a general discussion of the advantages and disadvantages of various antenna systems.

Considerable space has been devoted to the methods of feeding antennas as well as to coupling the antenna to the transmitter, harmonic operation, directive and receiving antennas. Data is also given on special antennas and methods of support. A number of miscellaneous tables have also been included.

This book has been written from a practical standpoint, and the various discussions are for the most part nonmathematical. This handbook is recommended.

RADIO RECEIVING AND TELEVISION TUBES, by James A. Moyer and John F. Wostrel, published by the McGraw-Hill Book Company, 330 West 42nd Street, New York City, third edition, 635 pages, price $4.00.

In the third edition of this already well-known book, a great deal of up-to-date material has been included, and information that is no longer of general interest to designers has been deleted. Emphasis has been placed on modern types of tubes and their applications in radio receiving and television equipment, and in other practical uses.

Besides chapters on the construction and fundamental electrical relations of vacuum tubes, there are sections on vacuum-tube action, radio measurements and meters, vacuum-tube testing and installation. Considerable space has been devoted to the use of tubes as detectors, rectifiers, amplifiers and as oscillation generators. Information has also been included on television tubes as well as on industrial applications of vacuum tubes.

Although this book is not altogether complete, it is to be recommended.

AUTOMATIC VOLUME CONTROL, published by John F. Rider, 1440 Broadway, New York City, 94 pages, price 60c.

This book is one of the "An Hour a Day With Rider" series for service men. It is written in a straight-forward, non-mathematical style and begins with a general discussion of avc as automatic control of sensitivity rather than a control of volume. Not only are simple avc systems discussed, but delayed avc and quiet avc systems also receive their due share of space. The book ends with a chapter on troubleshooting in the various types of avc systems. While this book has been written primarily for service men, it will also be of interest to amateurs, experimenters and engineers.

D-C VOLTAGE DISTRIBUTION IN RADIO RECEIVERS, published by John F. Rider, 1440 Broadway, New York City, 96 pages, price 60c.

This excellent little book is another of the "An Hour a Day With Rider" series. It begins with a general discussion of matter and molecules, atoms and electrons, and follows this with data on electric current. The series, parallel and series-parallel circuits are discussed in some detail and practical applications are given. This book, like Rider's *Automatic Volume Control,* has been written for the service man but will also be of interest to others. It is recommended.

AUTOMATIC RADIOCOMPASS

(*Continued from page* 11)

with his indicator on zero and thus fly a great circle course directly to the transmitting station.

The guaranteed accuracy of the apparatus is ±2° for a distance of about 500 km from a 300-watt transmitter. The receiver is extremely sensitive and, in most cases, this sensitivity is not fully employed. In fact, from the point of view of accuracy, it is difficult in an airplane to navigate within 1° to 2° and, therefore, this figure is fully satisfactory for aerial navigation.

Due to the well-known errors in magnetic compasses, such as the northern turning error, etc., it is difficult to keep an airplane on a steady course by means of a magnetic compass alone. The great stability of the R.C. 5 indicators, therefore, considerably facilitates the keeping of a correct course. In this connection it should be noted that the indicators allow for a plane, an inclination of about 30° without producing a fault greater than 1°.

Referring to the left portion of Fig. 3 assume that, from the point *A*, the pilot wishes to maintain a course 30° from the geographic north. He notes after a certain time that, with a 0° bearing of his radiocompass on transmitter *A*, his magnetic compass indicates a difference of 5°; then he no longer flies on a 30° course, but on a 35° course. This difference enables him to determine the approximate distance he is off his course. If the angular difference had been negative, the pilot would have known that he was on the left of his course. The same process can be utilized with station *B*, but in this case a positive difference indicates a deviation to the left, and vice versa.

The right portion of Fig. 3 represents a general case where there are no stations either at the point of departure or destination, but where there is a suitable station situated on the side. Formulae for determining the distance of the plane from this station are indicated in the illustration.

Obviously, neither the pilot nor the navigator would have the time for applying these formulae on board an airplane. Simple course and distance calculators which can be read very quickly have been made. Given, on the one hand, the distance already traveled from T_1 (the product of speed by time) in a direction known by the pilot between the two points T_1 and T_2; and, on the other hand, the difference between two bearings taken on the stations T_1 and T_2, the pilot can determine the distance from T_2. Information of

(*Continued on page* 25)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

MEETING

THE FEBRUARY MEETING of the Veteran Wireless Operators Association in New York will be at Bonat's Restaurant, 330 West 31st Street, at 6 p. m. on Monday, February 1, 1937. Final plans for the Dinner-Cruise on February 11 will be discussed. Please make every effort to attend.

ANNUAL MEETING

THE ANNUAL MEETING of the Veteran Wireless Operators Association was held at Bonat's Restaurant in New York City at 6 p. m., on January 4, 1937. In the absence of President Clark, Secretary McGonigle presided. A tellers' committee was appointed, consisting of E. A. Nicholas, chairman, Henry T. Hayden, R. S. Egolf and Fred Welsh. The ballots received up to that day from the membership were then tabulated by the committee. The results of the tabulation as announced by the chairman of the committee indicated the election of the following: William J. McGonigle, New York Telephone Company, president; Fred Muller, Collins Radio Company, vice-president; W. S. Fitzpatrick, RCA Institutes Technical Press, secretary; Wm. C. Simon, Tropical Radio Telegraph Company, treasurer. C. D. Guthrie, U. S. Maritime Commission, William J. McGonigle, New York Telephone Company, George Clark, Radio Corporation of America, Fred Muller, Collins Radio Company, W. S. Fitzpatrick, RCA Institutes Technical Press, Arthur A. Isbell, RCA Communications, Inc., A. F. Wallis, Mackay Radio and Telegraph Company, and A. J. Costigan, Radiomarine Corporation of America, were elected to the board of directors.

Among those present at the meeting were: Harvey Butt, commercial representative of Radiomarine in New York City; Arthur F. Van Dyck, engineer-in-charge of the RCA License Bureau; F. E. Meinholtz, director of communications for the New York Times; R. H. Frey, radio supervisor of the Bull Steamship Lines; S. W. Fenton of the Mackay staff in New York; A. F. Wallis, Mackay marine superintendent, who kindly acted as recording secretary; Joseph Appel, consulting radio engineer; R. S. Egolf of RCA Communications in New York; Henry T. Hayden, Ward Leonard Electric Company representative; Fred Welsh of Western Union; Paul K. Trautwein, president of Mariners Radio Service and our retiring treasurer, after several very efficient terms in that office; Fred McDermott, program transmission supervisor for the American Telephone and Telegraph Company in New York; C. A. Carney, cashier of the Radiomarine Corporation; Frank Orth, Columbia Broadcasting System; E. A. Nicholas of the Radio Corporation of America, and Fred Muller, Collins Radio Company.

TWELFTH ANNUAL

PLANS are progressing speedily for the simultaneous Dinner-Cruises of the various chapters of our Association to be held on the evening of Thursday, February 11, 1937, in leading hotels and restaurants in New York, Boston, Chicago, Honolulu, Miami, Omaha, Detroit, New Orleans, San Francisco, Los Angeles, Washington and other cities throughout the world. Suggestions and offers of assistance in the work of preparing for this big event should be communicated to your local officers. The affairs last year in the various cities were well attended and there is no reason why the number attending this year's affairs should not top that of last year by at least fifty percent. The tickets are in all cases moderately priced and judging from comments received one should not miss attending these affairs, for the unanimous sentiment is that a most enjoyable evening of entertainment and comradeship is the custom.

Numerous entertainment features are being arranged for the Dinner-Cruise at the Hotel Great Northern, New York City, on the 11th of February. We guarantee no long speeches, just a few short announcements. Tickets are $3.00 and are obtainable from the president at the above address.

PERSONALS

CARL O. PETERSON, who was a member of both Byrd Expeditions, was recently unanimously elected an honorary member of the New Zealand Antarctic Society with headquarters in Dunedin, New Zealand. At the same time he was appointed American correspondent to the Society. . . . Melvin P. Beckvold informs us that he has been on the *India Arrow* for almost five years' running. He tells us that she takes him all over the globe and has aboard all the most modern short- and intermediate-wave transmitting and receiving equipment. . . . Pleased to see Arthur F. Rehbein at the December meeting. Try to get to some of our other meetings AFR, especially the one on the 11th of February. . . . Arthur A. Isbell is one of the first to send in his 1937 dues and thanks, also, AAI for the good wishes. . . . Many thanks to Mr. Adelman and member H. A. Steinberg for a full page advertisement in our 1937 Year Book for the Cornell-Dubilier Company. . . . "Bill" McGonigle just before his election to the presidency of VWOA was unanimously elected for a third term as president of the Telcoli Radio Club. . . . On December 20, 1936, Gilson V. Willets, charter member, now residing in San Francisco, joined the ranks of us married folks by taking unto himself a bride—Miss Bernice Chandler Bowne of the "Golden Gate" city. GVW invites all veteran operators in his city to communicate with him at 1434 Twenty-sixth Avenue, S. F., Telephone—Overland 7361. . . . Sincere thanks and best wishes to Ray D. Rettenmeyer, editor of this magazine, for his wholehearted cooperation and support during the year just ended. . . . George Clark continues his interesting column in the *RCA Family Circle*. We note with pleasure George's election to the board of directors of our Association. Guess you just can't get away, George! . . . Congratulations to Ed Jones, formerly in charge of advertising and sales promotion of engineering products for RCA Manufacturing, at Camden, upon his appointment as manager of instrument promotion. . . . Best wishes to G. Harold Porter, manager of the Pacific Division of RCA Communications, Inc., upon his retirement after a long and fruitful career in radio. . . . We hope Harry Chetham is on the road to a speedy recovery. Let's hear from you soon again, Harry. . . . Thanks to Walter S. Rogers for his recent extremely interesting letter.

MIAMI

V. H. C. EBERLIN, chairman of the Miami Chapter, reports as follows: "Election of officers and plans for the coming February 11, 'Land-O-Sun' Chapter, Voyage will be settled at our coming meeting the first week in January, 1937."

Hope you get down this way as suggested early in 1937. Try and make it while the season is still on—C. J. and I will give you a few losers on the dogs—We're the local experts in that line.

●

RADIO INTERFERENCE

What causes a radio broadcast to turn suddenly from something intelligible into a blow-by-blow description of a feline battle royal is the object of a study of radio broadcasting and reception difficulties induced by electrical disturbances which is being undertaken in Newark and Essex County, New Jersey.

The project, financed jointly by the Federal Works Progress Administration and the City of Newark, is believed to be the first of its kind in the country. In the application for official approval of the project it was described as being designed "to detect electrical disturbances which interfere with police-radio reception in Newark and Essex County."

Field workers will be divided into ten parties of three men each.

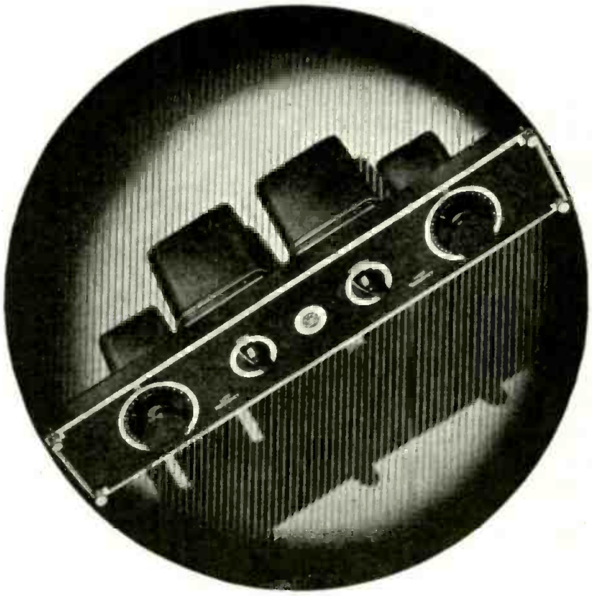
HARVEY RADIO CATALOG

Harvey Radio Laboratories, Incorporated, 12 Boylston Street, Brookline, Mass., now have available a catalog describing their line of amateur transmitting equipment. Complete descriptions and technical data is contained in this catalog.

COMMUNICATION EQUALIZER

• MODEL 3A—The UTC universal equalizer will equalize telephone lines, recording systems, pickups and cutters, microphones and all other broadcast equipment. It is accurately calibrated and quickly adjustable for both low and high frequency equalization. Low frequency controls permit maximum equalization at 25, 50 or 100 cycles with zero to 25 DB control. The high frequency end permits maximum equalization at 4000, 6000, 8000, or 10,000 cycles with zero to 25 DB control.

Net price to broadcast stations and recording studios **$85**

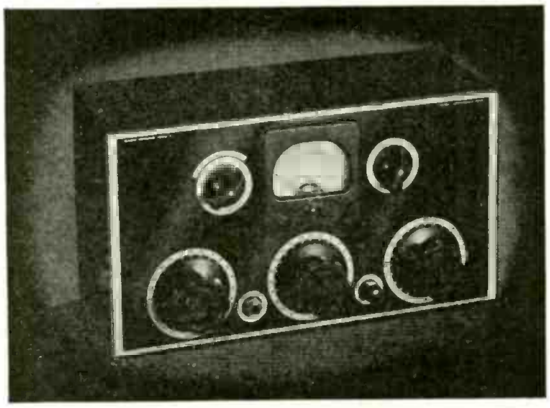


UTC BROADCAST RECTIFIER EQUIPMENT

A Typical Rectifier to replace motor generator sets for an average 1000 watt Broadcast Station. Technical Specifications (average)

1. Input: 3 phase, 200, 210, 220 volts, 60 cycles.
2. Output: (a) 300 to 500 volts, 800 MA to 1.2A, hum level —70 to —85 db as required.
   (b) 2000 volts, 550 MA, hum level —60 to —70 db as required.
   (c) 5000 volts, 1.5A, hum level —60 to —70 db as required.

Consult the UTC engineering staff on any of your rectifier problems.



JEWEL BOX REMOTE AMPLIFIER

MODEL 2A—The UTC remote amplifier is an ideal unit for all types of nemo service. This unit includes a three position mixer . . . isolated windings on the input transformer assure minimum cross talk . . . a four stage high gain amplifier . . . a single meter for checking all plate currents and volume indication. The frequency response is uniform from 30 to 14,000 cycles and the power output is plus 7 DB. The Jewel Box Remote Amplifier is housed in a leather finish lightweight case with removable latched cover. A case is also obtainable for the separate power supply.

Net price to broadcast stations and recording studios for Model 2A semi-wired remote amplifier kit, **less tubes and pads** **$70**

UNITED TRANSFORMER CORP.

72 SPRING STREET • NEW YORK, N. Y.

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

BALANCED AMPLIFIERS

(*Continued from page* 16)

ma and 73.6 ma, respectively. The line through 89.2 ma intersects the linear line at a value for e_s of 84.8 volts. The line through 73.6 ma intersects the actual load line at a value for e_s of 65.5 volts. This corresponds to a grid current of 9.5 ma. The permissible driver resistance is therefore

$$R_D = \frac{84.8 - 65.5}{.0095} = 2030 \text{ ohms.}$$

We must now choose a driver tube. If we select a 6F6, triode-connected, we can operate it Class A as follows. The B supply voltage is 250 volts; the bias, -20 volts; the plate resistance, r_p, equals 2,600 ohms, and the amplification factor, μ, $= 7$. The peak driver swing is 20 volts, which is equivalent to $7 \times 20 = 140$ volts across the primary of the driver transformer. From Fig. 28 we see that the generated voltage as it appears in the secondary winding must be 84.8 volts. Hence, the step-down ratio from the primary to one-half of the secondary must be

$$a = \frac{84.5}{140} = 1:1.65$$

The driver-tube resistance therefore appears on the secondary or grid side as

$$r_p' = \frac{2600}{(1.65)^2} = 956 \text{ ohms.}$$

This leaves $2030 - 956$ or 1074 ohms to be apportioned between the winding resistances. Half of this, or 537 ohms, is allotted to the secondary winding resistance, R_{SW}. The other half, when referred to the primary, appears as $537 \times (1.65)^2$ or 1460 ohms $(= R_{PW})$. These values are easily realizable in a practical driver input transformer. If desired, the primary-winding resistance can be decreased to take into account the additional voltage drop due to the d-c component of the 6F6 tube plate current, and the secondary-winding resistance proportionately increased.

It must be remembered that the leakage reactance of the driver input transformer will tend to increase the distortion products and reduce somewhat the fundamental power output. However, this should not be excessive in a carefully designed transformer. In addition, the distortion products of the driver tube will appear in the output of the balanced-amplifier stage, mainly as second harmonic. These, too, should not be excessive, since the r_p of the driver is fairly low, namely 2600 ohms.

CONCLUSION

This concludes this series of articles on the balanced amplifier. It was divided into three parts:

(1) A physical and graphical analysis of the output or plate-circuit end of the stage.

(2) An analytical study of the output end of the stage.

(3) A graphical analysis of the input or grid circuit, including calculation of the preceding driver-tube stage and driver input transformer.

AUTOMATIC RADIOCOMPASS

(Continued from page 21)

this character is, of course, highly useful and is readily obtainable by reference to a regular broadcasting station in cases where a transmitter is not available at the points of departure or arrival. If a low-power station is available at the point of destination, it can, of course, be used during the latter part of the journey.

The left-hand diagram in Fig. 3 shows the correct means of obtaining sense, i.e., of ascertaining whether the transmitter is ahead or astern. When flying a fair distance away from the transmitter the possibility of not knowing the location of the transmitter is small. However, near the transmitter, it might be difficult to locate the exact position (180° fault).

There are two main methods of coping with this situation: (1) there is the intensity variation of the received wave, which of course increases or decreases according to the direction of flight to or from the transmitter; (2) a 90° deviation from the course flown, and, after a few minutes, again turning the compass to 0°. A decrease of the magnetic reading indicates that he is flying towards the station, whereas an increase points to the fact that he is flying away (see Fig. 4). The larger the difference in these magnetic courses, the nearer the airplane is to the transmitter.

•

RADIO STUDIO ACOUSTICS

(Continued from page 6)

dom vibration. Second, the absorptive material is surrounded by reflecting surfaces so that a part of the sound energy which reaches the material is reflected at an acute angle from the surrounding hard areas and loses energy in passing over the absorbent layers. It is obvious that this could not have happened if the adjacent material had been highly absorbent—or at least could not have happened to such a noticeable extent.

To increase the effect of alternate hard and soft layers, these layers are staggered across the room, so that every absorptive layer faces a reflective one directly opposite, and vice versa. It is inadvisable to adopt this treatment on the ceiling and rear wall also, as these surfaces are facing large hard ones. The rear wall and ceiling should be made absorptive, with the rear wall perhaps more so than the ceiling, provided, of course, that thereby the aforementioned reverberation characteristic will not be shifted.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

VOLTAGE REGULATOR

An improved voltage regulator for alternating-current circuits has just been announced by American Transformer Company, Newark, N. J. This new device is

known as the Type TH Transtat and is available in various standard sizes for controlling voltage to loads up to 2.5 kva on either 115 or 230-volt lines.

A feature of the Transtat is that it not only permits smooth, continuous control of voltage from practically zero to normal line potential with maximum rated amperes

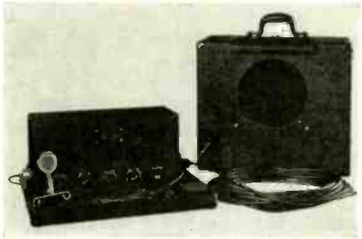
obtainable at any setting, but it is also capable of stepping up the output to values considerably higher than line voltage. The control throughout the entire range is at a uniform rate, increments being of the order of 0.5 volt each.

Fourteen diagrams illustrating different ways in which the regulators may be connected in electrical circuits are presented in the company's publication No. 1177 which describes this equipment. Copies of this bulletin are available on request.

PORTABLE P-A SYSTEM

The Model 115 portable public-address system, shown in the accompanying illustration, is a 15-watt Class A system suitable for orchestra and voice reinforcement.

This system permits mixing one or two low-level microphone inputs, such as crystal type and phonograph input. It has two



variable tone controls, one for high frequencies and one for low frequencies. It furnishes complete power supply for the Model 681 preamplifier which makes possible the use of high-impedance crystal microphones. The system is equipped with a 10-inch heavy-duty electrodynamic speaker. Provisions are made for additional speakers. Also included is a dual-diaphragm crystal microphone (suspension type) with 25 feet of cable.

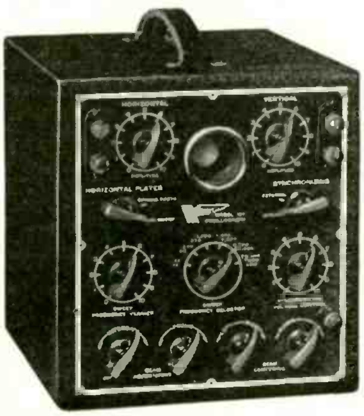
Specifications and further details may be had by writing the Operadio Manufacturing Company, St. Charles, Illinois.

MIDGET CATHODE-RAY OSCILLOGRAPH

The Clough-Brengle Company, 2815 West 19th Street, Chicago, Illinois, have announced their Model 105 cathode-ray oscillograph, using the new 913 cathode-ray tube. Except for physical size and screen area this instrument is identical to their large oscillograph, Model CRA. The unit features the following: built-in linear sweep, separate high-sensitivity amplifier for both horizontal and vertical inputs, and beam-centering controls on the front panel.

The entire unit is contained in a compact carrying case 8-7/8 inches high, 8-1/4 inches wide and 9-3/8 inches deep.

Complete descriptive literature may be obtained by writing to the manufacturer.



TURNER MICROPHONE

The Model VT-73 is a new crystal microphone being announced by The Turner Company, Cedar Rapids, Iowa.

This new microphone has been designed to have the most suitable response for

voice transmission. The output level is said to be higher than on any previous model.

Several new constructional features insure the microphone against adverse climatic conditions, it is stated.

CRYSTAL PICKUP

After months of research the Astatic Microphone Laboratory, Inc., of Youngstown, Ohio, has released a new crystal pickup. This new pickup is known as the

"Tru-Tan" Model B and is constructed with an off-set head which holds the needle, throughout the entire playing surface of a 12-inch record, practically true to tangent of the circle at all points—maximum error never exceeding 1.5° from true tangency, it is stated. Complete information may be obtained from the above organization.

ULTRA-HIGH-FREQUENCY CONDENSER

Bud Radio, Inc., Cleveland, Ohio, have announced a new ultra-high-frequency condenser. This condenser is for use in either a split or conventional tank circuit tuning above 56 megacycles. It also may be easily adapted for use in a parallel plate oscillator.

The condenser is constructed of aluminum plates with highly polished surfaces. The two round plates are 2-3/16 inches in diameter and 3/16 inch thick with rounded edges to minimize corona effect. Both plates are mounted on Isolantite pillars, and long threaded shafts attached to these plates make possible a wide range of capacity variation. The center plate is also mounted on Isolantite pillars, but is fixed in position.

MEGOHMMETER

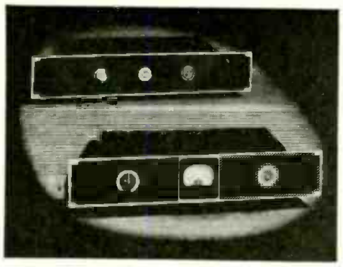
The General Radio Company's Type 487-A megohmmeter applies the simple principle of the ohmmeter to resistance measurements in the megohm range. The re-

quisite sensitivity is obtained by using a vacuum-tube voltmeter as the indicating means.

The range is from 20,000 ohms to 50,000 megohms in four overlapping ranges, so chosen that all values of resistance within the normal range of the instrument can be read on the open portion of the scale.

The accuracy is 5 percent between 200,000 ohms and 5,000 megohms, decreasing for higher and lower values. Power is obtained from a 115-volt, 42 to 60-cycle a-c line.

Applications include not only the rapid measurement of high resistance, but the measurement of many quantities resulting in resistance changes, such as moisture or adulterant content.



UTC PREAMPLIFIER

A new studio preamplifier in kit form has just been released from the United Transformer Corporation's audio laboratories, 72 Spring Street, New York, N. Y. This preamplifier incorporates the new UTC tri-alloy shielded input transformer, which when combined with other design features, is said to make possible a low hum level. The kit can be wired up for 2, 3, or 4-stage operation with corresponding gains of 55 db, 77 db or 100 db.

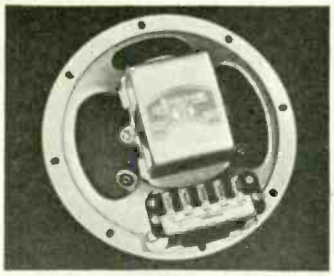
This unit is designed for broadcast service, being uniform in response from 30 to 14,000 cycles, and having a power output of plus 7 db. The construction is of the depressed chassis type with a removable etched overlay panel. The audio panel incorporates a switch and milliammeter to check plate currents of all tubes. The power-supply panel has a pilot light and a fuse which is readily removable from front of panel.

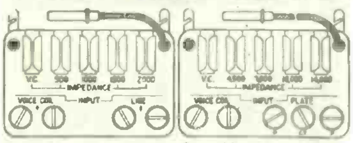
JENSEN SPEAKERS

The Jensen Radio Manufacturing Company, 6601 South Laramie Ave., Chicago, have announced a full line of speakers with adjustable-impedance transformers. These transformers have clearly marked terminal boards and impedance adjustments are made with flexible lead and pinjack, no soldering being required.

There are two types, one to match conventional plate-impedance values and the other to match conventional line-impedance values. Jensen speakers with these transformers are readily adaptable in public-address work.

The manufacturer will send a descriptive catalog free on request.



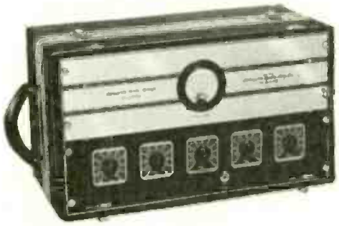


Terminal Board as used on "Y" Model Transformers

Terminal Board as used on "X" Model Transformers

P-A ON SHIPS

New outlets for public-address systems are being found each day by the engineering staff of Wholesale Radio Service Co., Inc., 100 Sixth Avenue, New York City. Recently, several interesting p-a shipboard installations have been made. Among them was the installation of a 20-watt portable system on a private yacht. The system is used for crew calls, broadcasting radio programs to all points of the vessel, and as a paging system. Included was a horn designed to be used in hailing passing ves-

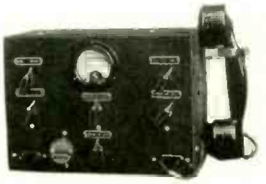


sels or in giving docking directions from the bridge.

U-H-F MOBILE TRANSMITTER

The compact transmitter illustrated is the laboratory model of a 10-watt carrier phone transmitter designed and manufactured by the Radio Transceiver Laboratories, 8627 115th St., Richmond Hill, N. Y. The new unit will be housed in an 8¼ x 12 x 6½-inch steel cabinet.

The crystal oscillates in the region between 7.5 and 10.4 mc, depending upon the crystal employed. Four of the largest receiving-type tubes are used for oscillation for doubling and for modulation. The plate tank of the crystal oscillator tube is



tuned to double the frequency of the crystal and the frequency is again doubled in the output tube, the resultant frequency being in the 30-41 mc region.

Type HFM transmitter has been designed for communication work and is provided with connections to a high-grade single-button hand microphone or handset. The integral amplifier is designed to accommodate lower level microphones, however, for broadcast transmission.

TCA PORTABLE SOUND SYSTEM

The Transformer Corporation of America has made available to sound men a brochure descriptive of their Clarion Model C55 portable sound system. This system has a rated output of 25 watts, 35 watts peak, and may be used with modern high-fidelity microphones, including velocity, dynamic (moving-coil), diaphragm crystal and sound-cell crystal types. The output terminals provide impedances of .35, .61, 1.35,

2, 4, 6, 8, 15, 30, 50, 250 and 500 ohms, with provisions for connecting additional speakers.

For bulletin and technical data, address Transformer Corporation of America, 69 Wooster Street, New York, N. Y.

NEW PRODUCTS

The Gates Radio & Supply Company, Quincy, Ill., announce the release of three new products for the broadcasting industry.

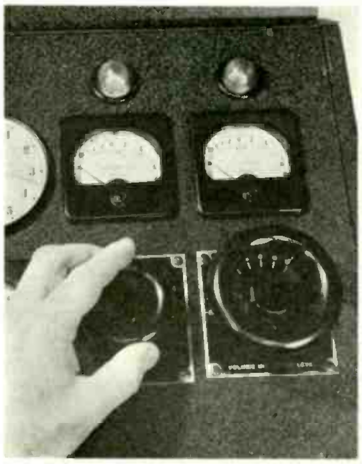
The first item, known as the "Trio-Pre," is a three-stage preamplifier, three-channel mixer and power supply for broadcast-station operation in connection with all prevailing types of low-level microphones. The equipment may be had either for rack mounting or in table type cabinet.

Another item, known as the "Announco-Mic," a new type of crystal microphone with self-contained amplifier built into a cabinet similar to that of inter-office communicating systems and to be used commonly for all studios or remote announcing purposes.

A new high-fidelity preamplifier having many outstanding features for humless full response reproduction, provision being made for variable input and output impedance for all existing types of microphones and mixers used today, has also been announced.

CONTROL WHEEL

Cotocoil Corp., 229 Chapman St., Providence, R. I., manufacturers of radio-broadcasting equipment, have announced a control wheel to replace unsymmetrical knobs. Entirely molded of black Durez, the wheels are self-insulating, and resistant to moisture and wear. They have a metal pointer fastened under the hub.



NEW!

Type "TH" TRANSTAT* Voltage Regulator

TRANSTAT Regulators provide the ideal method for controlling voltage in alternating-current circuits. The Transtat is a continuously variable auto-transformer which permits smooth, uninterrupted control of voltage. It also offers high efficiency, good regulation, and great flexibility. As it is moderate in cost, economical in use, and dependable in operation, it is well suited for a large number of radio and industrial applications.

*Patents 1,993,007 and 2,014,570. Other patents pending.

AMERICAN TRANSFORMER CO., NEWARK, N. J.

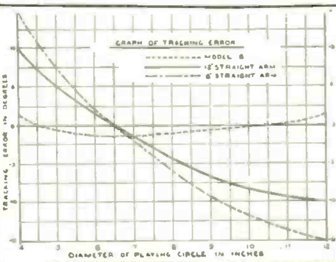
AMERTRAN

QUALITY TRANSFORMERS SINCE 1901

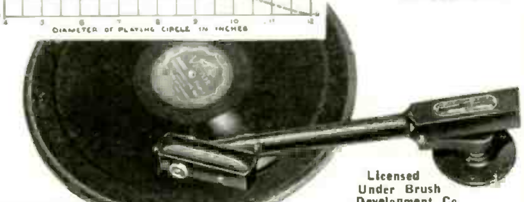
TRU-TAN

MODEL B-10

QUALITY CRYSTAL PICKUP



- **LONGER** RECORD LIFE
- **BETTER** REPRODUCTION
- **EASIER** NEEDLE LOADING



WRITE FOR BULLETIN 65

Licensed Under Brush Development Co. Patents
Astatic Pending

The new Astatic **TRU-TAN Pickup** obtains its remarkably better reproduction and longer record life with the unique, scientifically designed offset head that holds the needle so true to tangency throughout the playing surface of the record, that the tracking error never exceeds 1.5°—as compared to the conventional straight arm pickups now in use which often show 10° to 15° in tracking error (see chart above).
This same offset head can be reversed, allowing needle to be loaded from the top quickly and easily.

LIST PRICE $17.50

ASTATIC MICROPHONE LABORATORY, Inc. YOUNGSTOWN, O.
Pioneer Manufacturers of Quality Crystal Products

---

a NEW improved sound recording instrument

Designed to meet the most exacting professional requirements — sturdy construction — simple operation — priced within the range of every potential user.

FEATURES:

- Synchronous Motor
- Metal Panel
- Heavy aluminum turntable accurately machined — perfectly balanced
- 78 and 33⅓ R.P.M. speeds—instantly available
- Speed changed — move knurled knob on the panel
- Lead screw held at perfectly uniform pressure by self-adjusting thrust bearing
- Enclosed worm gear
- Cutting head carriage travels on ground stainless steel bar—perfect, long-life bearing
- Interchangeable lead screw

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE AND PRICE

Also manufacturers of the famous **CLEEN-CUT** blanks for instantaneous recording. Literature and price list sent upon request.

ALLIED RECORDING PRODUCTS CO.

126 West 46th Street New York, N. Y.

NEW 1937 REMLER

ATTENUATORS

New Features • Same LOW PRICE

Improvements provide unequalled ease of operation and long life. Attenuation variable in 27 steps of 1⅔ db. per step up to 45 db. fading in 3 additional increasing steps from 45 db. to infinity. Attenuation change halved as switch arm spans adjacent contacts resulting in attenuation of 5/6 db. per step. Impedance practically constant over entire range of the pad.

Standard impedances of 50, 200, 250 and 500 ohms. Special values to order.

LA-5 Ladder type—Net **10.80**

- Ball Bearing Rotor Shaft.
- Clock Spring Pigtail Connections.

REMLER COMPANY, Ltd.

2101 BRYANT STREET SAN FRANCISCO

REMLER — THE RADIO FIRM AS OLD AS RADIO

OVER THE TAPE...

NEWS OF THE RADIO, RECORDING AND SOUND INDUSTRIES

CRUSE TRANSFERS TO FCC

Andrew W. Cruse has resigned his position as chief of the Electrical Division, U. S. Bureau of Foreign and Domestic Commerce, to accept his appointment by the FCC as assistant chief engineer. Mr. Cruse will be in charge of engineering work for the Telephone Division.

MUTUAL GOES COAST-TO-COAST

On December 29, the Mutual Broadcasting System became a coast-to-coast chain of stations when nine stations of the Don Lee Broadcasting System and five stations located enroute from Chicago to the Pacific coast were linked to the Mutual chain. The present lineup of Mutual stations is as follows: WOR, New York; WGN, Chicago; WLW and WSAI, Cincinnati; CKLW, Detroit-Windsor; WAAB, Boston; WEAN, Providence; WICC, Bridgeport; WTHT, Hartford; WLBZ, Bangor; WFEA, Manchester; WSAR, Fall River; WSPR, Springfield; WNBH, New Bedford; WLLH, Lowell; W1XBS, Waterbury; WFIL, Philadelphia; WBAL, Baltimore; WRVA, Richmond; WCAE, Pittsburgh; WGAR, Cleveland; WSM, Nashville; WOL, Washington; KWK, St. Louis; WHB, Kansas City; KSO, Des Moines; WMT, Cedar Rapids; KOIL, Omaha; KFEL, Denver; KHJ, Los Angeles; KFRC, San Francisco; KGB, San Diego; KDB, Santa Barbara; KMPC, Bakersfield; KDON, Monterey-Del Monte; KFMX, San Bernardino; and KVOE, Santa Ana.

"SOUND ADVICE"

Vol. II. No. 8 of "Sound Advice" contains additional information on the phone potentiometer which can be furnished with the Neumann automatic high-speed level recorder. Requests for data are said to have motivated the issuance of this discussion of this phone potentiometer. Copies of "Sound Advice" may be secured from Sound Apparatus Company, 150 West 46th Street, New York City.

WBS CHICAGO STUDIOS

P. L. Deutsch, president of World Broadcasting System, has announced the perfection of plans for new WBS electrical transcription studios in Chicago. World is expected to move from its present location, 400 West Madison Street, to its own building at Erie Street and Fairbanks Court, in the Upper Michigan Avenue district, about February 15.

Three large studios of ultra-modern construction, a galvano plant for the manufacture of wide-range vertical and lateral transcriptions under Western Electric license, and complete office facilities are planned. The studios, of the "full-floating" type, will be fashioned after the WBS transcription headquarters in New York, and will embody the latest acoustical and recording developments of the Bell Telephone Laboratories.

RADIO SHOWS

Radio Parts Manufacturers National Trade Show, Inc., met in New York City on December 16 and named the dates of two industry shows to be held during this year. They will be sponsored by the RMA and the Sales Managers Club.

The spring show will be held at the Stevens Hotel in Chicago from June 10 through June 13. The fall show will be held in New York City, October 1-3 inclusive.

It is anticipated that the annual RMA Convention will be held in Chicago immediately preceding the National Trade Show. Other meetings scheduled for the period of the show are those of the Sales Managers Club, the IRSM, and "The Representatives."

S. N. SHURE, SHURE BROTHERS, PRESIDENT OF RADIO PARTS MANUFACTURERS NATIONAL TRADE SHOW, INC.

SYNTHANE FOLDER

The Synthane Corporation of Oaks, Penna., announce a new six-page general folder on the grades, physical, chemical, mechanical and electrical properties, shapes, characteristics and standards of quality of Synthane laminated bakelite tubing. Those unfamiliar with the application of laminated bakelite tubing to chemical, mechanical or electrical design or production problems will find this folder helpful.

HOWELL BULLETIN

The Howell Electric Motors Company, 1 Bond Street, Newark, N. J., have made available an 8-page bulletin describing their line of "red band" motors. Besides the rather complete description of the various types of motors, considerable data is also included on frame construction, windings and stator insulation, rotor construction, shafts, bearings, etc. This catalog is available on request.

FCC APPROVED TUBES

On page 10 of the August, 1936, issue of COMMUNICATION AND BROADCAST ENGINEERING appeared a table of transmitting tubes that had been approved by the FCC under Rule 127. Additions to this table appeared on page 24 of the December, 1936, issue. The following are further additions which should be made in order to again bring this table up to date:

TABLE A

Power Rating (Watts)	Heintz & Kaufman	RCA Mfg. Co.
75	154	...
40,000	...	898

TABLE B

Power Rating (Watts)	Heintz & Kaufman
25	154

ATLANTIC BROADCASTING CORP. EMPLOYEES' ELECTION

The Association of the Employees of the Engineering Department of the Atlantic Broadcasting Corporation, Inc., have announced the results of their recent election. Officers elected are as follows: Kendall E. Davis, president; John M. Tiffany, vice-president; Arthur B. Mundorff, treasurer; Charles H. Kleinman, secretary; Lester N. Hatfield, national representative; Charles Malmstedt and L. Farkas, executive committee.

UNIVERSAL MICROPHONE LEAFLET

The Universal Microphone Co., Inglewood, Cal., in December issued a four-page leaflet on its portable recording machine which it will follow, this month, with a complete catalog of its various models of professional recorders and, in February, with its 1937 microphone catalog.

TUBE DISTRIBUTORS

The Gates Radio & Supply Company, Quincy, Illinois, announce their appointment as midwestern distributors for all transmitting and industrial tubes as manufactured by the United Electronics Company of Newark, New Jersey.

A complete stock of both low- and high-powered transmitting tubes is carried at the Gates factory warehouse, Quincy, Illinois.

TRIUMPH APPOINTMENT

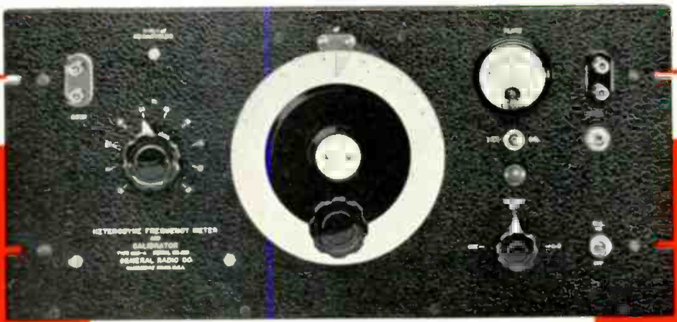
J. P. Kennedy, formerly an account executive for The Fensholt Company, was named sales and advertising manager of the Triumph Manufacturing Company, Chicago. In his new position, Mr. Kennedy expects to develop the direct-to-dealer sales policy of the Triumph Manufacturing Company and seek new markets for radio and electrical instruments.

RECORDING EQUIPMENT BROCHURE

"Quality Recording Equipment" is the title of a new 4-page brochure which may now be secured from Allied Recording Products Company, 126 West 46th Street, New York City. This brochure contains information on the Allied recorder and recording blanks.

INDEX OF ADVERTISERS

YOU DON'T HAVE TO BE A RADIO ENGINEER



300 KC to 300 Mc

DIRECT READING

COASTAL—435 KC

POLICE—1712 KC

AERONAUTICAL—4742.5 KC

DESIGNED for use by the operating staff . . . for routine hourly or daily frequency checks or for continuous monitoring . . . the new G-R Type 620-A Frequency Meter-Monitor and Calibrator has a number of features which will appeal to all operators.

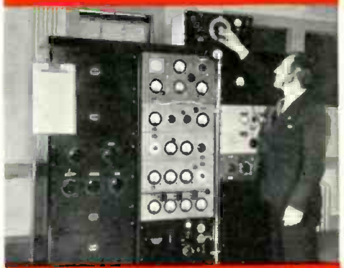
1. **DIRECT READING**—No calibration charts, curves or plug-in coils.
2. **EXCEPTIONALLY WIDE FREQUENCY RANGE**—Continuous from 300 kc to 300 Mc.
3. **SUITABLE ACCURACY**—0.01% or better; suitable for practically all classes of service throughout the range of the instrument.
4. **SELF-CALIBRATING**—Calibration can be checked quickly against the built-in low-temperature-coefficient quartz plate.
5. **PORTABLE**—The portable model weighs only 45 pounds; either model may be used on either d-c or a-c.
6. **RUGGED CONSTRUCTION**—Unique electrical and mechanical design insures trouble-free operation.

Designed for the man who has to use it, you don't have to be a radio engineer to operate this new G-R frequency meter.

Type 620-A Heterodyne Frequency Meter and Calibrator:

Relay Rack Model *$490.00*
Portable Model *$555.00*

MARINE—13245 KC



ULTRA HIGH B/C—61.5 Mc

LABORATORY—295 Mc

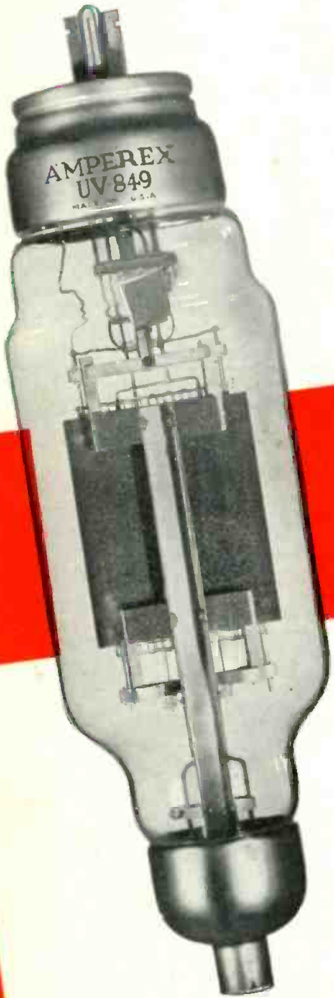
GENERAL RADIO manufactures a number of instruments and accessories of interest to the engineering and operating staff of all communication organizations. This apparatus includes standard-frequency assemblies, interpolation, and auxiliary equipment, secondard standards, piezo-electric oscillators, multivibrators, visual-type broadcast monitors, frequency deviation meters, heterodyne frequency meters, quartz plates and bars, temperature-control boxes, precision tuning forks, audio-frequency meters, precision and general-purpose wavemeters, beat-frequency oscillators, amplifiers, r-f, d-c, and a-c bridges, line voltage controls and an exceptionally complete line of standardized parts for experimental work.

WRITE FOR CATALOG 100-K FOR COMPLETE INFORMATION

GENERAL RADIO COMPANY • CAMBRIDGE, MASSACHUSETTS

After more than 16,000 hours of operating life ● *"your tubes have given us the best performance of any that we have ever used."*

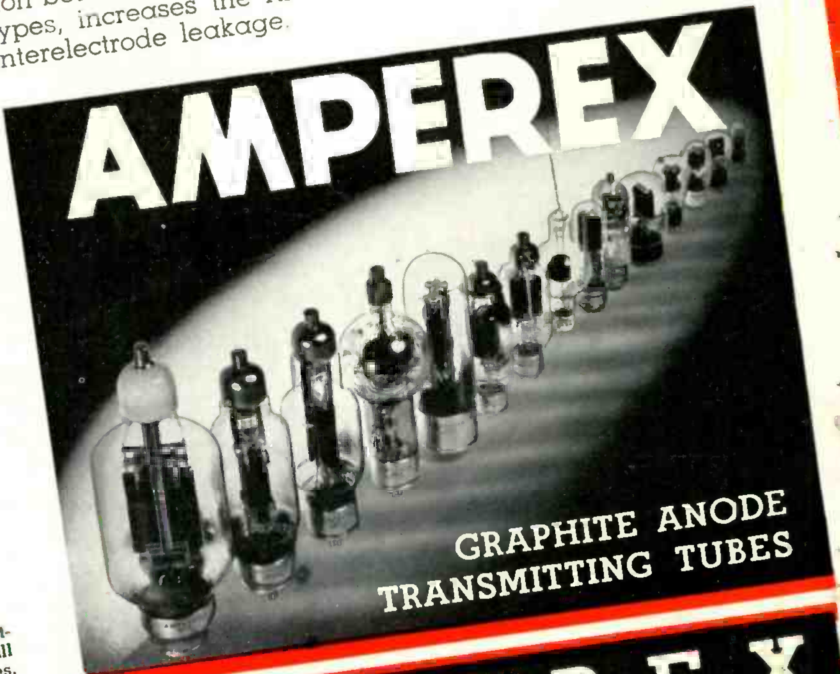
writes **WSYB**
RUTLAND, VERMONT



AMPEREX 849

Built into this 849 is that extra margin of efficiency which is reflected in the unusually long life and superior performance of every Amperex transmitting tube.

The perfect heat radiating graphite anode of the Amperex 849 is mounted in a floating structure with extra high insulation between elements. This feature, exclusive in Amperex types, increases the RF voltage tolerance and minimizes interelectrode leakage.



CHARACTERISTICS

Filament Potential	11 volts
Filament Current	5 amps.
Amplification Factor	19
Transconductance (micromhos)	6000
Plate Dissipation (max.)	400 watts

$160

Write to our engineering department for complete data on the full line of Amperex transmitting tubes.

AMPEREX
ELECTRONIC PRODUCTS, Inc.
79 WASHINGTON STREET • BROOKLYN, NEW YORK