Communication and Broadcast Engineering

VOL. 3 NO. 10

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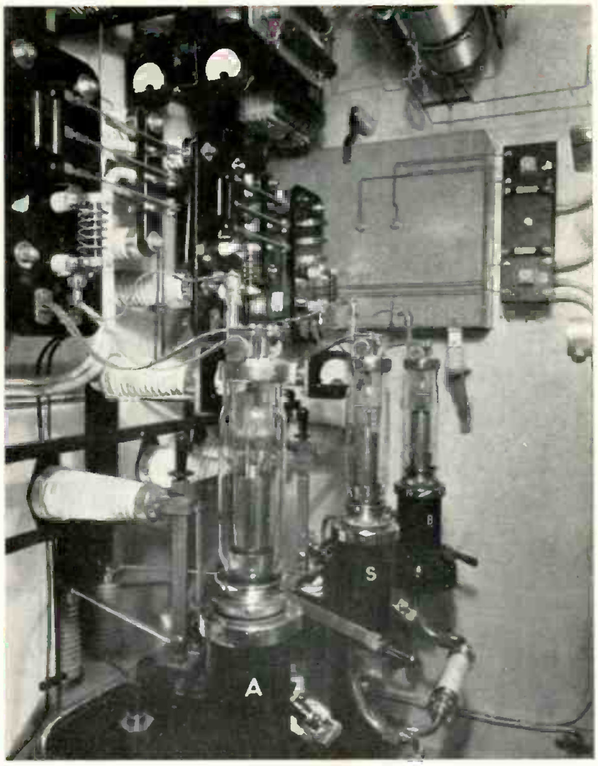

The Journal of World Communication

FROM

TRANSMITTER TO *Antenna*

A Complete Installation with ISOLANTITE COAXIAL TRANSMISSION LINE

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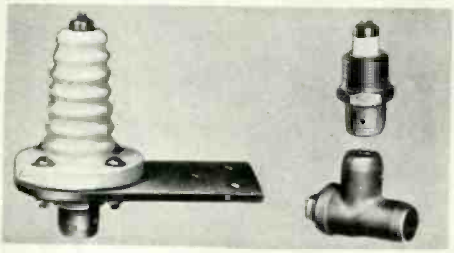

National Newark and Essex Bank Building. Showing location of transmitter and antenna connected by ISOLANTITE COAXIAL TRANSMISSION LINE.

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VOLUME 3 | OCTOBER, 1936 | NUMBER 10

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EDITORIAL

BROADCAST ALLOCATIONS HEARING

SEVERAL HUNDRED representatives of broadcast stations, networks, educational and other organizations were present at the recent broadcast allocations hearing of the Federal Communications Commission. This hearing was held at the offices of the Commission in Washington, D. C., beginning on October 5.

The many important recommendations made at this gathering deserve much more space than is available here. To mention a few, however, the RMA urged maintenance of clear channels, high power and the expansion of short-wave broadcasting; NBC's president, Lenox R. Lohr, discussed the economic and social aspects of broadcasting as it appears in this country; Arthur Van Dyck, also representing the NBC, supplied facts concerning the present performance of receivers in the home; detailed engineering data on receiver selectivity and fidelity, discussion of interference problems and a special recommendation for a protected i-f frequency were presented by L. C. F. Horle who represented the RMA's Engineering Committee: and Paul M. Segal, counsel, and Raymond M. Wilmotte, consulting engineer, also appeared on behalf of the stations on the 940-kc channel.

This hearing served to further emphasize the fact that clear-channel stations do render a distinct service to the radio audience of the United States. As a general rule, they are high-power stations serving large territories and providing good reception in many communities remote from broadcast stations. In this connection it is interesting to note that a recent survey made by the FCC showed that 75 percent of rural radio listeners preferred programs from clear-channel broadcasting stations rather than from regional or local stations. Higher powers on clear channels will mean even better service for this audience.

During the course of Mr. Lohr's testimony he recommended that the period of broadcast licenses be extended to three years. Mr. Lohr also recommended that the power of regional stations be increased to 5-kw for both day and night, and he suggested power increases for local stations "whenever the engineering and economic factors warrant the use of such power."

Mr. Wilmotte, in considering the limitations of and possibilities that may be provided by regional broadcast stations, urged the Commission that "in granting licenses, it give careful consideration to the location of the station, not only relative to other stations, but also relative to the nearest town so that better synchronization, directional effects, etc., may be used when wanted to the best possible advantage. . . . I make a special plea that future engineering developments and the progress of broadcasting be not endangered by freezing the space available on the basis of our present knowledge and technical skill."

The October 5 broadcast allocations hearing was quite comprehensive in scope, and the data presented should go far in helping the Commission to determine future allocations.

ROCHESTER FALL MEETING

THE ANNUAL ROCHESTER FALL MEETING, a joint meeting of the Institute of Radio Engineers and the Engineering Division of the Radio Manufacturers Association, is to be held at the Sagamore Hotel, Rochester, New York, from November 16 through 18.

The following are the technical articles which will be presented at this gathering: *Equipment and Methods Used in Routine Measurements of Loudspeaker Response,* by S. V. Perry (RCA); *Current Measurements at Ultra-High Frequencies,* by J. H. Miller (Weston); *Acoustic Networks in Radio Receiver Cabinets,* by H. S. Knowles (Jensen); *Shot Effect in Space-Charge-Limited Vacuum Tubes,* by B. J. Thompson and D. O. North (RCA); *Automatic Control of Selectivity by Feedback,* by H. F. Mayer (General Electric); *The Federal Communications Commission and the Engineering Division of RMA,* by T. A. M. Craven (FCC); *Radio Tubes Today,* by R. M. Wise (Hygrade Sylvania); *Commercial Television and its Needs,* by A. N. Goldsmith (consulting engineer); *Latest Television Standards as Proposed by the Engineering Division of the RMA,* by A. F. Murray (Philco); *Survey of Receiver Characteristics,* by A. F. Van Dyck and D. E. Foster (RCA License Lab.); *Application of Nickel to Radio,* by E. M. Wise (Int'l. Nickel Co.); *Partial Suppression of One Sideband in Television Reception,* by W. J. Poch and D. W. Epstein (RCA); *Improvements in Performance of Cabinet Type Loudspeakers at Low Frequencies,* by B. Olney (Stromberg Carlson); *Notes on Feedback Amplifiers,* by R. B. Dome (General Electric), and *Improvements in High-Frequency Receivers,* by J. J. Lamb (ARRL).

The Rochester Fall Meetings have acquired an enviable reputation for their interesting technical sessions. This year's convention promises to be even more outstanding than usual.

LISTENERS SAY: "Programs coming in clear as a bell"..."I listened to your change from old to new, and wish to say it was a great improvement"... "WCLO comes to us the clearest of any station"... "Reception so much better we will be among your fans in future"..."Marvelous improvement. As clear and fine as any high powered station."

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RADIO TELEPHONE BROADCASTING EQUIPMENT

COMMUNICATION & BROADCAST ENGINEERING

FOR OCTOBER, 1936

A HIGH-FREQUENCY PACK TRANSMITTER

By PALMER A. GREER

Transmitter Engineer

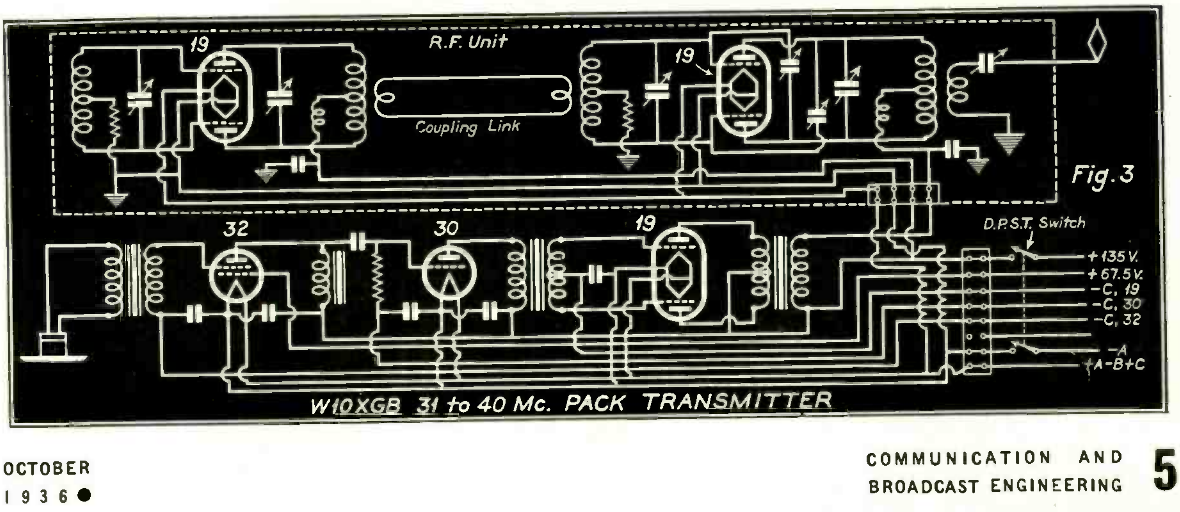
WHIO

FOR THE PAST YEAR there has been a great deal of interest displayed, particularly in broadcasting circles, in the possibilities of portable high-frequency transmitting equipment for use in locations where telephone lines are not readily available. The networks and a few independent stations have obtained or built equipment for this purpose and have rebroadcast programs picked up on it with varied degrees of success.

To meet requirements a pack transmitter must, first of all, be as light and small as possible and must be well balanced, so that it may be carried by an announcer on location without putting such a strain on him that he can not keep his mind on his work. A good deal of weight may be carried on a person's back, provided it is well balanced. The transmitter must have a good overall frequency response, so that broadcast quality is obtainable. The carrier must be stable, as a signal that is shifting in frequency means the difference between a good rebroadcast and a poor one. The antenna should be as short as possible so that the person wearing it on his back may walk through confined spaces. Design of the transmitter circuit must be such that low voltages may be used on the plates of all tubes and, at the same time, current consumption kept at a minimum.

The pack transmitter to be described has been successfully used to broadcast descriptions of circus parades and performances, "man-on-the-street" broadcasts from various downtown locations, broadcasts from tall buildings, airplanes,

SCHEMATIC DIAGRAM OF THE HIGH-FREQUENCY PACK TRANSMITTER.



etc.; stunt broadcasts of many types have been carried out, most of them with good results. However, on a few occasions, unforeseen causes of interference or poor locations have marred broadcasts.

When we first decided to try our luck with some high-frequency rebroadcasts, we were unable to decide on what type of a circuit to use, so considerable experimenting was done, and the resulting transmitter has, we believe, been worth all the time spent in its development.

This pack set is built in two separate sections which are finally bolted together to form a single unit. The audio amplifier, batteries, microphone receptacle, and battery switch are in one case measuring 12 x 12 x 5 inches. The r-f unit is in another case 5 x 5 x 8 inches. Both cases are made of 1/16 inch sheet aluminum, reinforced at necessary points with duralumin angles, as may be seen in Fig. 1. The complete assembly, with antenna disconnected, is shown in Fig. 2. The separation of the audio from the r-f is very essential, as it was discovered that the r-f caused a feedback in the audio amplifier when these units are not isolated from each other. Shields may be removed from either unit independently, thus facilitating servicing.

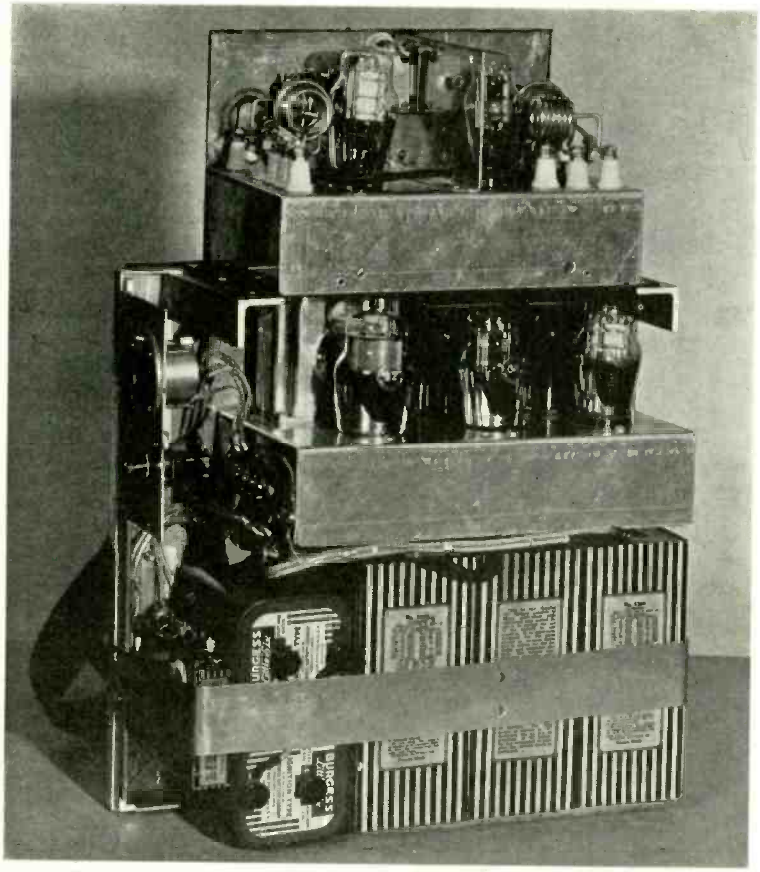


FIG. 1. SHOWING THE ASSEMBLY OF THE TRANSMITTER.

We shall first consider the r-f unit (see Fig. 3). Two type 19 tubes are used in this section, one as a push-pull oscillator and the other as a Class C amplifier. This type of tube was used for several reasons, namely, low filament-current consumption, relatively low plate voltage for normal operation, and the ability to oscillate as well as amplify at the ultra-high radio frequencies. These two stages are link-coupled to each other, this method giving a very good transfer of excitation from the oscillator to the grids of the amplifier, and at the same time making for ease of tuning. The plate and grid circuits of both the oscillator and the amplifier are tuned with variable condensers of 15 mmfds capacity. Grid and plate inductances in both circuits are coils of six turns, 7/8 inch in diameter and wound from No. 12 tinned wire. These coils are 7/8 inch in length. Condensers are mounted so as to permit all controls to come flush with one side of the case, where they may be easily tuned by means of a non-metallic screwdriver. All inductances are mounted on Isolantite stand-off or feedthru insulators, and are made quite rigid by cementing thin strips of celluloid inside the turns. Vibrationless inductances are quite important, especially in the oscillator circuit, as any movement in these coils, due to shocks or jars, will cause the frequency to fluctuate. Neutralization of the r-f amplifier is accomplished by means of two small thumb-nail trimmer condensers, and when properly adjusted, this stage shows no inclination to break into oscillation. The r-f chokes used consist of about 35 turns of No. 28 D. C. C. wire on a 1/4-inch x 1 1/4-inch Isolantite form. The first ten turns are slightly spaced.

It may seem that the use of two tubes in the r-f section of this transmitter is a waste of space and an additional drain on the batteries, when possibly a modulated oscillator would be sufficient for a transmitter of such low power. However, this point can be cleared up by mentioning a few of the difficulties experienced when experimenting with modulated oscillators. A unity-coupled oscillator was tried and found to be very unstable, even after trying every conceivable type of coupling to the antenna. Any movement around this oscillator caused a frequency change that was noticeable even on a super-regenerative receiver. A tuned-plate — tuned-grid oscillator was also tried with about the same amount of success, so we were convinced that in spite of the extra space necessary and the slightly additional current drain, the increased stability of operation more than offset these disadvantages.

An inductor microphone is used. It works into a type 32 tube, which has a fairly high amplification factor when impedance coupled to the succeeding stage. Resistance coupling was tried but the gain obtained by this method was not nearly as great as that of the impedance coupling. A choke of about 1085 henries was used as a plate reactor. The second stage consists of a type 30 tube, which is transformer coupled to the grids of the 19 tube in the final audio stage. This tube is operated as a Class B amplifier and delivers plenty of power to modulate the Class C r-f amplifier. A small amount of bias—about 2 volts—is used on the Class B amplifier and the resulting power output is approximately 2 watts. The selection of tubes was made with gain per tube and battery drain being the major considerations, and a number of different types were tried before being discarded for one reason or another.

One of the biggest problems encountered was the choice of a suitable antenna. Not much power is available in the tank of the r-f amplifier, and hence the necessity for an efficient antenna is apparent—also a means of coupling the antenna to the tank. After experimenting for days with about every type of antenna applicable to a pack transmitter, one was found that seemed to perform better than the others. A piece of duralumin tubing ½ inch in diameter and about four feet long was obtained, and this was cut off about a foot from one end. A small insulator 1 inch long and of the same diameter as the tubing was inserted between the two pieces. By winding a coil around this insulator, a sectionalized antenna, such as used by a number of broadcast stations, was the result. The coil was wound to load the antenna to a quarter wave of the operating wavelength, and our four-foot antenna worked as well as one cut to a full quarter wavelength. Thus a saving of over two feet in the length of the rod was effected when operating at frequency of about 37.6 mc.

The antenna is inductively coupled to the tank coil, one end of the coupling coil being grounded and the other end connected to the antenna through a series variable condenser of 15 mmfds capacity. This series condenser affords a means of tuning the antenna circuit to resonance with the tank. The antenna is anchored to the chassis at the feed-thru insulator and also to a stand-off insulator 2½ inches from the point at which it is fed. Previous to the time the sectionalized rod was adopted, the four-foot rod was loaded at the bottom, and also between the coupling coil and ground, but in both cases the chassis was hot with r-f and any movement around the set seriously affected the antenna current. Touching the microphone caused considerable drop in signal strength. Hence the search until the sectionalized, loaded-top antenna was tried and adopted.

The battery complement of the transmitter consists of two 1½-volt A batteries, three 45-volt batteries, and one 7½-volt C battery. Weight of the complete pack, including all batteries, microphone, and antenna is about 30 pounds. A layer of sponge rubber on the side that rests against the carrier's back makes the load quite easy to bear. Webbing straps bolted to the pack to form a harness furnish the means of strapping it on.

In the event that any of the readers are contemplating the construction of a pack transmitter, it might be well to add a few remarks that will give an idea as to what kind of performance to expect. Consistently good broadcasts over any great distance cannot be obtained, because of the low power available. A good rule to follow is to keep the transmitter in sight of the receiving point if possible. Very good results may be had if too much is not expected of the set. It is always a good policy to test the locations of a proposed broadcast before actually putting it on the air as a rebroadcast. In this manner, dead spots can be located and avoided. The receiving point should be as high and as far from local interference, such as auto ignition, etc., as possible. A good receiving antenna is, of course, as important as a good transmitting antenna.

In order that the pack may be operated in one of the bands authorized by the FCC for broadcast pickup, it is a good idea to have some means of checking the operating frequency. This pack is checked for frequency by means of a simple wavemeter consisting of a pickup coil, thermogalvanometer, and a 35-mmfd variable condenser. These parts are mounted in a small aluminum case about 4 inches square, the coil plugging into pin jacks in the outside of the case. The number of turns in the pickup coil can easily be determined by experiment, according to what frequency range is desired, and the completed wavemeter is calibrated by means of the Lecher wire method, a description of which may be found in most good radio handbooks.

FIG. 2. THE COMPLETE ASSEMBLY WITH ANTENNA DISCONNECTED.

DIRECTIONAL MICROPHONE

By JOHN P. TAYLOR

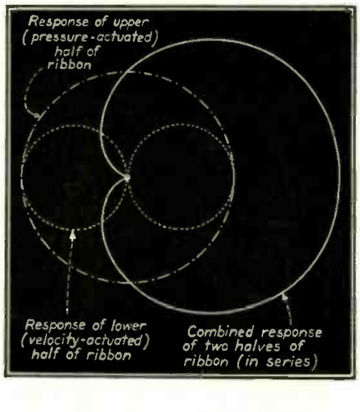
CONSULTANT

CONFIRMING, at least for the time being, the opinion held by many station engineers—viz., that there is no such a thing as an "all-purpose" microphone—the new-model velocity microphones announced for production this fall and winter include three quite different types. First, there are the standard bi-directional models, intended primarily for high-quality studio pickups—and featuring, as an innovation, the use of Alnico magnets. Second, there are junior models which, with only a very small sacrifice in response range, provide a saving of nearly two-thirds in size and weight—qualities that, with the lower cost (about half that of the standard models), should do much to advance the use of this type of microphone for remote pickups—particularly those of the semi-fixed type. And, third, there is a new uni-directional model which is totally different from anything heretofore available.

This uni-directional microphone, the present model of which has been designed by Mr. L. J. Anderson, is based on the idea originally developed by Dr. H. F. Olson. The outstanding feature which it incorporates—and the one which gives it name—is the property of picking up sounds arriving from one direction while rejecting, to all practical purposes, those arriving from the opposite direction. This one-sided, or uni-directional, pickup is markedly different from that of any of the various types of microphones presently in use. In order to fully comprehend the true extent of this difference, it is necessary to recall briefly the meaning and importance of directional characteristics.

Experts in the sound engineering field divide all microphones into two classifications—viz., directional and non-directional. Unfortunately this perhaps-too-simple division has led to some confusion. The difficulty being purely a matter of the definition of directionalism, it is worthwhile to get the matter straightened out. The directionalism of some types of microphones is obvious. For instance, the velocity microphone, with its "figure-8" pattern, is responsive from two sides and dead on the other two sides, and this is true at all frequencies. Thus there can be no question that it is a "directional" microphone. Similarly, the "eight-ball" microphone, and some types of crystal microphones—since they have an identical response all the way around—are definitely "non-directional" microphones. However, after these are eliminated, there remains the large group of microphones sometimes referred to as the "diaphragm" types. These include condenser, dynamic, inductor and similar types. It is in this classification that the difficulty comes. To illustrate, an engineer using a condenser microphone in the field, thinks in terms of its usefulness. It has a satisfactory pickup only from one side—therefore, it is "directional." But the expert in the laboratory says—"not so!" For, according to his definition, a "non-directional" microphone is one which, in general, responds to noises from random (all) directions; a "directional" microphone, one which responds only over certain limited angles. Since the condenser microphone (as well as the other diaphragm types) responds to random noises over more than two-thirds of the audio range (speaking, of course, in octaves), and even though the frequency characteristic maintains no semblance of uniformity at most angles, it is by this definition, a "non-directional" microphone. Thus different definitions lead to different conclusions. If the two viewpoints are understood and kept in mind there need be no confusion—however, this requires some practice. In the meantime—and at the risk of introducing a third definition—it is possible to keep the matter straight by referring to this class of microphones as "semi-directional." Since these microphones are in reality "non-directional" for noise, whereas they are "directional" for music, the in-between terms have a connotation easy to remember.

FIG. 2. GRAPHICAL ILLUSTRATION OF THE ADDITIVE ACTION OF THE TWO PARTS OF THE UNI-DIRECTIONAL MICROPHONE.



With the meaning of directionalism thus fixed in mind, the place which the uni-directional microphone occupies with respect to other types becomes clear. Like the standard velocity microphone it has a limited angle of response *at all frequencies*, and is, therefore, a "directional" microphone by anyone's definition. Unlike the standard model, however, it is responsive on one side only. The pickup pattern associated with it might be likened to one of the lobes of the "figure-8" pattern, with the notable exception that the angle over which substantial uniformity is obtained is much greater. Thus, like the "semi-directional" types, it is particularly suited for those applications where the desired sounds come from one general direction. However, while these earlier types are "non-directional" to most frequencies—and particularly to the lower frequencies which are most easily reflected—the uni-directional microphone responds only to sounds coming from the desired direction, no matter what their frequency. Hence, the total pickup of undesired sounds (extraneous and reflected) is greatly reduced—theoretically fifty percent—and the possible definition correspondingly increased. Finally, like the "non-directional" types, it has a frequency characteristic which is essentially independent of angle—so that artists may be arranged as desired without fear of frequency discrimination. Thus, this new microphone may be said to have adopted features of the three earlier types—that is, the frequency response independent of angle of the "non-directional," the single-sidedness of the "semi-directional" and the true directionalism of the "bi-directional." This does not mean that these other types are obsolete. Quite the contrary, the "non-directional" and "bi-directional" will still be equal or better for many (if not most) applications. And, too, the "semi-directional" will still have a place, especially since the higher price of the new microphone will likely restrict its use to the more critical applications.

DIRECTIONAL CHARACTERISTICS

A more graphic (and, if correctly interpreted, more accurate) comparison of the directional properties of the uni-directional microphone with those of the three other types is provided by Fig. 1. As the methods of portraying directional characteristics are neither standardized nor well-understood, some explanation of these patterns is required. First, it is obviously impossible to show all frequencies—hence the question which to choose to give an unbiased comparison. Since the 1000-cycle point is widely used as a reference, a curve for this frequency is obligatory. To illustrate the low-frequency performance, the obvious choice is 100 cycles—chiefly because it is ordinarily the lowest frequency for which dependable information is available (and, in any event, curves below 100 cycles have, by themselves, little real significance). For a high-frequency point there is no obvious choice—for a variety of reasons. The 5000-cycle point used in the accompanying curves is, admittedly, arbitrary. However, a careful consideration seems to indicate that for present-day operating conditions it gives a fair and quite representative picture.

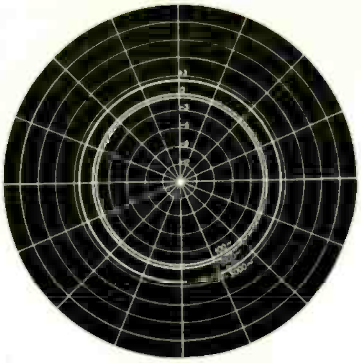


FIG. 1. I—NON-DIRECTIONAL.

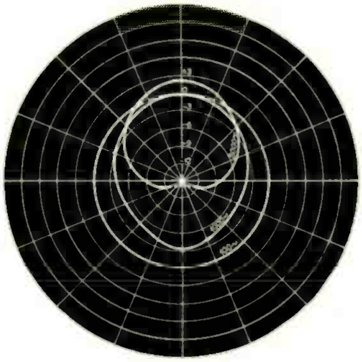


FIG. 1. II—SEMI-DIRECTIONAL.

FIG. 1. III—BI-DIRECTIONAL.

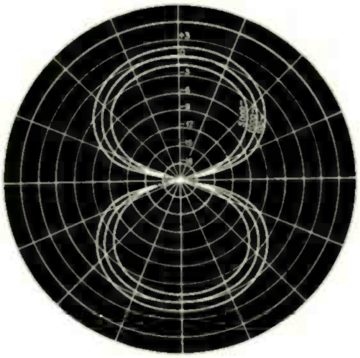
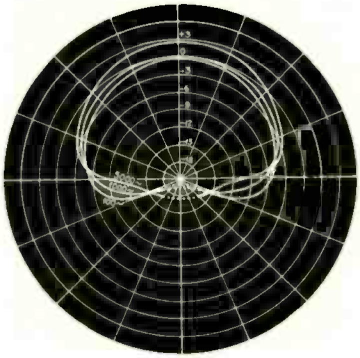


FIG. 1. IV—UNI-DIRECTIONAL.



In plotting these curves a slight departure from more-usual methods has been made. Ordinarily the points of the several frequency curves are all made to pass through a zero point where they cross the normal to the microphone face. This is tantamount to assuming a perfectly flat response along the normal—and the curves plotted can hence only indicate the deviations from whatever the actual response is at the normal. Unless an additional curve of response vs. frequency (along the normal) is given, this may lead to some misconception. In the curves shown here, only the 1000-cycle (reference) curve passes through zero at the normal—and the other two curves are plotted to show the increase or decrease in response at these frequencies. Thus these curves show the actual frequency characteristic at any angle, without necessity of interpolating from another curve. Of course, only three points of any characteristic are available—however, the choice of the three frequencies is such that a representative indication is provided.

The radial ordinate, of all the curves of Fig. 1, is decibels above or below the 1000-cycle response on the normal. Such a decibel scale has more practical meaning to the average station engineer than does the more-usual percent-response scale (which has a tendency to over-accentuate the importance of deviations). In addition to showing quantitatively the performance at various angles, curves so plotted give, at a glance, a general idea of the configuration of artist placing. In the case of the curves given here, the zero point has been chosen so as to give the four patterns size and shape of some comparative value, although it is necessary to realize that factors independent of microphone characteristics have such a large bearing on artist placing that comparisons of theoretical patterns are, at best, only a beginning.

Curves of the kind shown in Fig. 1 could be made to yield even more information by making the reference point to actual measured output level of the microphone for a given input (instead of zero as here). However, the present comparison is between the several classifications of microphones, rather than between individual models, and the fact that the various microphones falling in any particular classification may have widely-different output levels rules out the use of absolute levels. Similarly, it should be understood that *the curves of I, II and III of Fig. 1 are to be considered as typical of these general classifications rather than as the actual values for any one make or model of microphone.* They may be thought of as representing the mean of the outstanding types in each classification.

THE UNI-DIRECTIONAL PATTERN

The method by which uni-directional pickup is obtained will seem complicated to those who do not understand the problem, surprisingly simple to those who do. On first thought it might seem that the directionalism of the diaphragm microphones (at high frequencies) indicates tendency toward single sidedness. However, on examination, it is found that this effect is due to the distortion of the sound field by the solid surface of the microphone—more apparent at high frequencies, of course, because the dimensions of such surfaces are comparable to the wavelengths of high-frequency sounds. *Theoretically all diaphragm-type microphones are "non-directional"* and would be in practice if they could be made sufficiently small that they did not seriously distort the sound field, and if the cavity in front of the diaphragm could be eliminated. (In fact, miniature condenser microphones closely approaching these requirements have been made and used for laboratory measurements.) Thus, there are really only two kinds of characteristics—viz., the "non-directional" characteristic of the pressure-actuated microphones and the "bi-directional" characteristic of the velocity-actuated (pressure-gradient) microphones. All other types must derive from these two. The idea which Olson first called attention to—and which now seems so obvious—was simply to make a microphone in two parts, so designed that one part acted as a pressure-actuated microphone while the other acted as a velocity-actuated microphone. Combining the responses of the two parts provided the desired uni-directional characteristic. This can be seen from inspection of Fig. 2. The response of the "non-directional" pressure-actuated part can be represented by a circle with center at the microphone; that of the "bi-directional" velocity-actuated part by two circles tangent to the microphone faces. One of the latter is in phase with, and hence adds to, the "non-directional" circle, while the other is of opposite phase and hence subtracts. The resulting net response is represented by a cardioid or revolution, providing a very satisfactory degree of directionalism. These figures are, of course, the idealized patterns. However, in practice this theoretically predicted result is closely approached—as can be seen by IV of Fig. 1, which is the actual measured response of the production model. It is interesting to note that the whole action is analogous to that of "direction-finders" in which the non-directional pickup of a vertical antenna is combined with the two-sided pickup of a loop antenna to give the required directionalism.

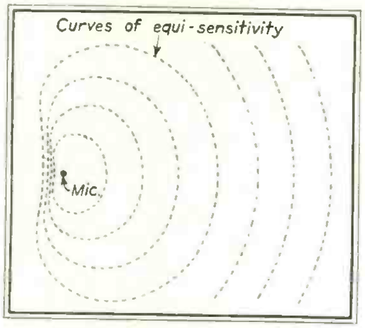


FIG. 6. IN SMALL STUDIOS THIS MICROPHONE PROVIDES MAXIMUM SPACE FOR ARTISTS.

TWO-IN-ONE CONSTRUCTION

The mechanical construction of the uni-directional microphone is shown in the several views (Figs. 3 and 4). The relation of the constructional design to the operation, deserves a short explanation. As can be seen, the moving elements of the two parts of the microphone are the respective halves of a corrugated ribbon identical in dimension and mounting to that of the standard velocity microphone, except that *the ribbon is fixed at the center so that the two parts vibrate independently.* The lower half is free both in front and in back, operates as a velocity microphone and has a "bi-directional" pickup pattern similar to that of Fig. 1, III. The upper half is enclosed in back, operates as a pressure microphone and has a "non-directional" pickup pattern similar to that of Fig. 1, I. It might be well to point out here that the widely-prevalent idea that a ribbon microphone is, per se, a velocity microphone is a misconception. In the standard velocity microphone the ribbon is open front and back—hence the pressure which makes it move is the difference between the dynamic (i. e., varying) pressure in front of it and the dynamic pressure in back of it—or, in other words, the pressure gradient (i. e., change in pressure with distance) in the sound wave itself. This pressure gradient is proportional to the velocity—hence the term, velocity microphone. But the fact that the moving element is a ribbon is not the determining factor—and, *a ribbon microphone is not necessarily a velocity microphone.* In the case of the upper half of the ribbon of the uni-directional microphone, it is strictly a pressure microphone. This half of the ribbon is enclosed in back by a closed labyrinth. The pressure which causes it to move is, therefore, the difference between the

FIG. 4. THE UNI-DIRECTIONAL MICROPHONE DISASSEMBLED TO SHOW LABYRINTH.

nic pressure in front of the ribnd the *static* pressure behind it. In ot er words, its movement is proportional only to the instantaneous pressure in the sound wave—and it is, therefore, a true pressure microphone.

The manner of enclosing the back of the upper half of the ribbon is an essential element of the design. If this enclosure were simply a small closed space, the trapped air would exercise a damping effect dependent on frequency, the response would thus vary with frequency as would also the directionalism. To avoid this it is necessary to present an acoustic impedance to the back of the ribbon. An infinitely long open tube would be ideal—but this being impractical, an equivalent effect has been obtained by using a coiled labyrinth lightly packed with absorbing material. It is interesting to note that this upper half of the uni-directional microphone is not only a new type of pressure microphone, but is, moreover, an unusually good one. Since it presents only very small obstructing surfaces, it does not distort the sound wave as do the diaphragm type microphones. Moreover, the open structure removes possibility of cavity resonance. Thus the pickup pattern it provides, instead of being "semi-directional" like other pressure microphones, is actually "non-directional" like Fig. 1, I. This, together with the "bi-directional" pattern of the lower half of the ribbon, insures the action illustrated in Fig. 2, and makes possible the measured overall response indicated by Fig. 1, IV.

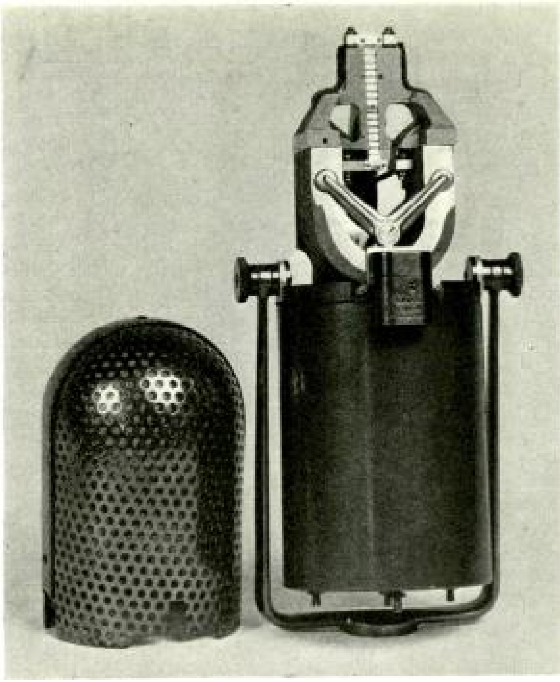


FIG. 3. THE UNI-DIRECTIONAL MICROPHONE WITH OUTER SHIELD REMOVED.

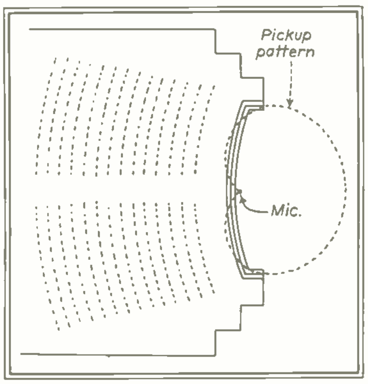
APPLICATION AND USE

From this response characteristic (Fig. 1, IV) the particular qualities of the uni-directional microphone are immediately apparent. Specifically, they are: first, 20 db attenuation of back-side pickup—that is, a 10-to-1 ratio of desired to undesired signal; second, a very broad pickup angle—useful through 150 degrees, or more; third, a very uniform frequency response throughout the whole of this useful angle and, fourth, response to extraneous noises (such as reverberation) only fifty percent of that of "non-directional" and "semi-directional" microphones.

The advantages of these unique qualities are so obvious as to hardly require comment. They are particularly outstanding under certain special situations. Primary of these, of course, is the condition met with in pickups from theatres, auditoriums and theatre or auditorium-type studios, where a large audience is present. In such cases the uni-directional microphone furnishes the only satisfactory method of cutting down audience noises. Placed as in Fig. 5, it is almost 100 percent efficient—and, moreover, the angle of response is so broad that for many, if not most, pickups, one microphone will suffice and will replace several of other types. The same advantage will, of course, obtain in ordinary studios when an audience is present in the studio itself.

In small studios, too, there will be at least occasional times when this microphone will be advantageous—particularly when a more-than-normal number of artists must be accommodated. This statement is at first surprising, since it might be thought that "bi-directional" or "non-directional" types would have the advantage under such conditions. A glance at Fig. 6 gives the answer. Because of its negligible back response the uni-directional microphone can be placed very much nearer to the back wall. With even a small amount of "dead-end" absorbing material it can be placed quite close. Such back response as this microphone does have is practically all at the higher frequencies—and, of course, even relatively poor absorbing materials are quite effective in this range. Thus it allows a maximum number of artists to be placed, means less deviation from conventional seating arrangements and does not require the leader to turn his back on part of his orchestra.

FIG. 5. IN AUDITORIUMS, THEATRES, ETC., THIS MICROPHONE CAN BE USED TO ADVANTAGE.



In use the uni-directional microphone should not require any special technique—and, in fact, should be less critical in most respects than other high-quality types. The output level is of the same order as that of the standard velocity microphones—and impedances and mountings are standard. Thus it should not only be interchangeable with, but also could, if desired, be mixed with these. It provides sound and studio engineers with a new tool of considerable possibilities, and while, at first, it will be in the nature of a special instrument for particularly critical jobs, it seems reasonable to suppose that it will, before long, be used as widely as other types.

COLD-CATHODE

By W. C. EDDY

(Lieut. U. S. N. Ret.)

DURING THE PAST two years, the Farnsworth cold-cathode multipactors have been repeatedly brought to the attention of radio engineers through magazine and newspaper articles, but now, with the advent of this tube on the open market, particular interest is being shown in its theory and application.

In view of this interest, a brief explanation of the fundamental principles of operation of this type of tube should be in order. The multipactor is, primarily, an electron multiplier in which the principle of secondary emission produces both the high efficiency and the rich harmonic content that makes this type of tube adaptable to commercial applications.

Electronic oscillation can occur within the tube in several fundamental modes dependent upon the physical arrangement and number of elements. One type of oscillation will, of course, be more suitable for a given application than another, and for this reason we will discuss the three general forms that apply to present commercial practice.

The first mode considers a double-cathode arrangement in which the electrons, under the influence of an external magnetic field, oscillate between the two disc cathodes by reason of the attraction set up by the ring-type anode (see Figs. 1-A and 1-B). The second mode considers a cylindrical cathode surrounding an open grid-like anode, the oscillation taking place between the inner diametrically-opposed surfaces of the cathode (Figs. 2-A and 2-B). The third mode is similar to the second, except for the addition of a third element erected in the center of the tube; in this mode the oscillation depends upon the effect of a negative field about the third radius rather than the diameter of the tube.

In order to explain the theoretical operation of the multipactor, let us consider a tube similar in construction to the DM10, oscillating in the second mode (Fig. 2). If the potential difference between the anode and cathode is properly established, the primary electrons emitted from the cathode will be accelerated toward the anode. Due to the velocity acquired through this acceleration, they will continue on through the central anode field toward the opposite cathode surface, being gradually decelerated as they approach this cathode surface. If the acceleration is equal and opposite to the deceleration, the electrons will of course arrive at the cathode with zero velocity. The electrons will then repeat their travels and under stable conditions would continue to oscillate about the central structure indefinitely. This theoretical condition, of course, will not produce sec-

FIG. 1-B.

ondaries because an impact velocity has not been furnished to "splash off" the secondaries from the secondary emissive surface. Some method must be employed to give these primaries a definite impact velocity upon their arrival at the second cathode surface.

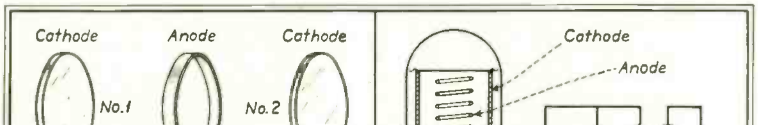


Fig. 2-A shows a circuit capable of fulfilling these conditions. If the tank-circuit frequency is of such order that the electrons make five complete trips per cycle (a purely arbitrary assumption) we can expect the conditions graphically illustrated in Fig. 3 to exist. At the instant the initial electron leaves the cathode the voltage curve of the r-f circuit shows 200 volts negative, with an anode voltage of 500 volts positive. The electrons are, therefore, under the accelerative effect of 700 volts. On leaving the axial anode field in its first transit, the electron is gradually decelerated, but the decelerative effect is now only 680 volts, in that, at the time that the electrons reach the opposite cathode surface No. 1 and the deceleration taken on between the anode and cathode surface No. 2, is 20 volts. The return trip of the secondaries finds a similar difference existing upon their arrival at cathode surface No. 1, and this condition will continue for five transits of the tube. At this point the r-f voltage of the tank has reached its maximum and the electrons approaching the cathode will find the deceleration greater

MULTIPACTORS

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than the acceleration. From this point on, these electrons will be unable to impact upon the cathode and after a

FIG. 2-B.

brief period of damped harmonic vibration about the anode they will be absorbed by this element, delivering their energy to the circuit.

To briefly recapitulate this, on the positive swing of the r-f cathode voltage the deceleration is less than the acceleration and, therefore, on this half cycle secondaries are produced by impact. On the next half cycle, the deceleration being greater than the acceleration, electronic oscillation is damped, resulting in the electrons being picked up on the anode. The electron leaving the cathode does not traverse its path without mishap. The wires forming the anode structure attract and collect about 10 percent of the electrons attempting each passage.

This parasitic action of the anode and the resultant deflection or absorption of a portion of the electrons increases as the square of the distance between anode and cathode because as the distance is increased, the projection of the width of the wires on the cathode follows optical equations.

There are two methods of limiting the current taken up in the anode circuit.

First, it is evident that currents approaching infinity would build up in a circuit in which the fundamental or tank-circuit frequency was of such low order that a great number of transits and corresponding great multiplication of currents were obtained. This is not true, of course, because under low-voltage and low-frequency conditions, the anode's attraction will draw off such a cloud of secondaries that their space charge effect is of such order that no further multiplication is probable. This type of control can be termed "space-charge suppression" and can be used in all three modes at low and intermediate frequencies and voltages.

The second method of suppressing multiplication was illustrated in the explanation of the first mode of oscillation; i. e., when the frequency is high enough to limit the number of electron transits and suppress further multiplication by reversing its polarity and collecting the energy. This effect will not be encountered below 20 mc. With an understanding of the fundamental principles of multipactor oscillation, the theory behind the other modes can be briefly covered.

In the first mode, the double-cathode ring, anode arrangement, the electrons travel from cathode to cathode. An external magnetic field maintained axially through the anode prevents the drift of the electronic stream into the anode until sufficient multiplication trips have been performed. This type of multipactor is particularly useful for high-frequency work where the half period of the tank-circuit oscillation equals the electron transit time. The tank-circuit arrangement as shown in Fig. 1-A is modified push pull.

In the third mode (Fig. 4), a metallic pillar brought out as a third element is held at such a negative potential that the electrons are forced to oscillate over a portion of the radius rather than the diameter of the structure. In this type of oscillation the production of harmonic frequencies will be intensified. This is due to the fact that we have approximately linear acceleration and deceleration in the space between the anode and outer cathode, but with much larger deceleration near the small axial cathode, producing both odd and even harmonics.

If we make an analysis of the electronic currents developed in a multipactor we find that it is only during the last few transits preceding suppression that currents of any amount are developed. To all intents and purposes, then, we can consider the power absorbed and delivered to the circuit to be comparable to a current pulse of considerable magnitude. If the circuit's impedance is of such order that oscillation is maintained under shock-excitation conditions harmonic output comparable in power to that of the fundamental can be obtained.

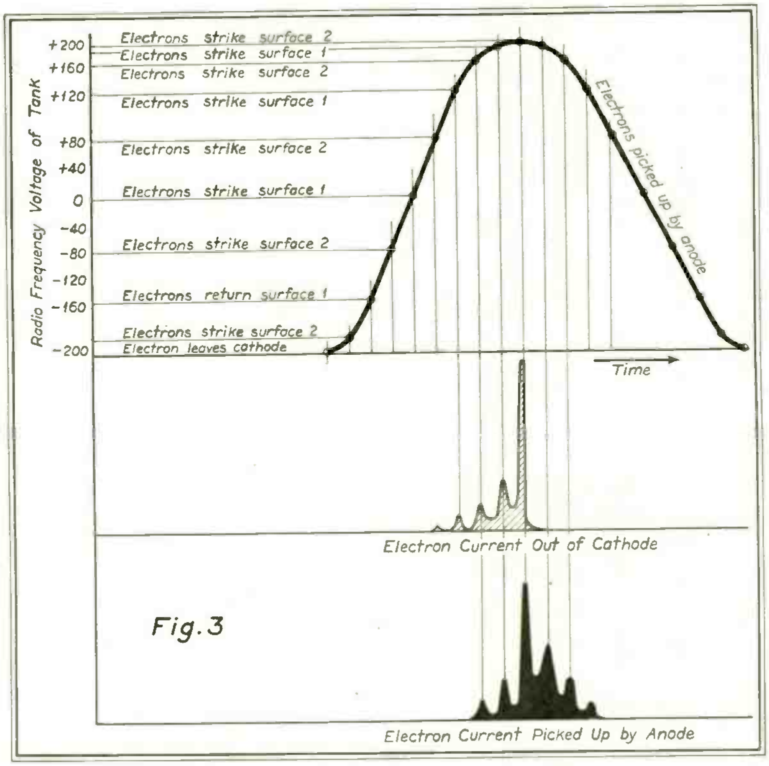


Fig. 3

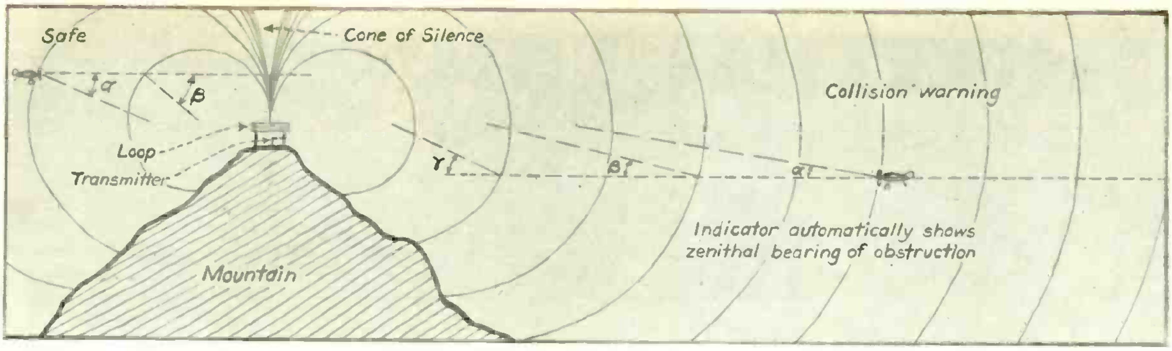


FIG. 4. UTILIZATION OF THE SIMON SYSTEM FOR COLLISION WARNING.

THE SIMON SYSTEM of INSTRUMENT LANDING and COLLISION WARNING

By HENRY W. ROBERTS

THE NEED for a reliable method of locating a fog-bound airport, and then making a safe landing within the airport limits without seeing the ground, has long been realized in aviation. A transportation system is valuable only in proportion to the regularity of its schedules. To maintain schedules, our air liners must be able to operate under all conditions of weather and visibility.

It is not an exaggeration to say that radio makes commercial aviation possible. The array of dials on the instrument board can only tell the pilot how he is flying; only radio can tell him where he is. The invisible tentacles of radio range beacons reach into the darkness and guide the invisible ships to their invisible destinations. Radio direction finders, on the ground and in the air, pick up wisps of song and code and translate them into bearings and position. The ubiquitous radio keeps the pilot on his course, tells him of the weather ahead, and brings him to his destination—and if needs be, to a safe landing.

The problem of instrument landing of aircraft is extremely complex. Several tons of metal, traveling at a minimum safe speed of over a mile a minute through an opaque void where there is neither up nor down, must be gently brought down to an invisible strip of land less than a hundred feet wide and but a few hundred feet long, and its mode of travel transferred from three dimensions to only two—from air-borne wings to earth-borne wheels. Just as "blind" flying instruments reproduce for the pilot the invisible horizon, so must the "blind" landing instruments reproduce for him the invisible spatial landing path from a point in space above the ground to a point within the airport limits.

Reduced to elementals, the problem is to provide for the pilot automatic and continuous information on his position in space with respect to the airport. This information must be three-fold: in what direction the airport lies; how far down; and how far away.

Not less than seven systems of instrument landing have so far been developed and successfully tested in flight, each contributing something to this new art, and although the ideal system has not yet been devised, it is already possible to forsee the solution.

The problem of providing lateral guidance, i.e., indicating in what direction the airport lies, is easily solved either by the use of an equisignal zone type of directional radio beacon or by the use of a radio direction finder aboard the airplane. The problem of longitudinal guidance, i.e., indicating how far away the airport lies, is likewise solved by measuring the increase in the field intensity as the beacon is approached, for approximate distance indications, and using suitably located marker beacons for definite position check.

The problem of vertical guidance, i.e., determination of the gliding path in a vertical dimension, has, however, so far presented difficulties. The solutions proposed by Diamond, Lorenz, Loth and others, while extremely ingenious and workable, cannot be regarded as final. The solution described in this article, proposed by Emil J. Simon, approaches the matter from an entirely new angle and has the paramount advantage in that the pilot can approach the field from any direction and at any altitude, and bring his ship to the center of the airport at any convenient gliding angle.

The Simon system of instrument landing and collision warning is predicated on the use of a ratio-type radio

FIG. 2. THE INDICATING INSTRUMENT AND RECEIVER.

direction finder. Such an instrument, called the Simon Radioguide, was described in the August 1936 issue of COMMUNICATION AND BROADCAST ENGINEERING and, for the benefit of those who are not familiar with it, we will briefly describe the principle of its operation.

When used for radio direction finding, i.e., determination of position and course in azimuth, the Radioguide consists of two small electrostatically shielded loops fixedly mounted within the airplane; a special twin-channel superheterodyne receiver; and an indicating instrument. The loops are disposed, in a vertical plane, at equal and opposite angles with respect to the longitudinal axis of the airplane, each feeding its corresponding channel of the receiver; and the indicating instrument measures the ratio of the outputs of the two channels.

It is known that a vertical loop is most receptive to signals emanating from points lying within its plane and least receptive to those at right angles to it; between these two positions its receptivity varies as the cosine of the angle between the plane of the loop and the source of signal. Therefore, given two identical loops equally and oppositely disposed with respect to the longitudinal axis of the airplane, feeding two identical channels of amplification having equal gain, and means of comparing the output of the two channels, it is possible to obtain constant and automatic measurement of the ratio of signal intensities induced in the two loops and, consequently, the direction and the angular bearing from which the received signal emanates.

Thus, in an airplane heading directly at a transmitting station, the two loops of the instrument are at equal (but opposite) angles to the source of the signal and, consequently, the voltages induced in the two loops are equal. If the airplane veers away from this heading, there is an increase in signal strength in one of the loops and a corresponding decrease in the other loop. The ratio of the signal intensities in the two loops remains constant for a given angle irrespective of the field strength or the distance from the station. It is, therefore, possible to calibrate the indicating instrument in degrees.

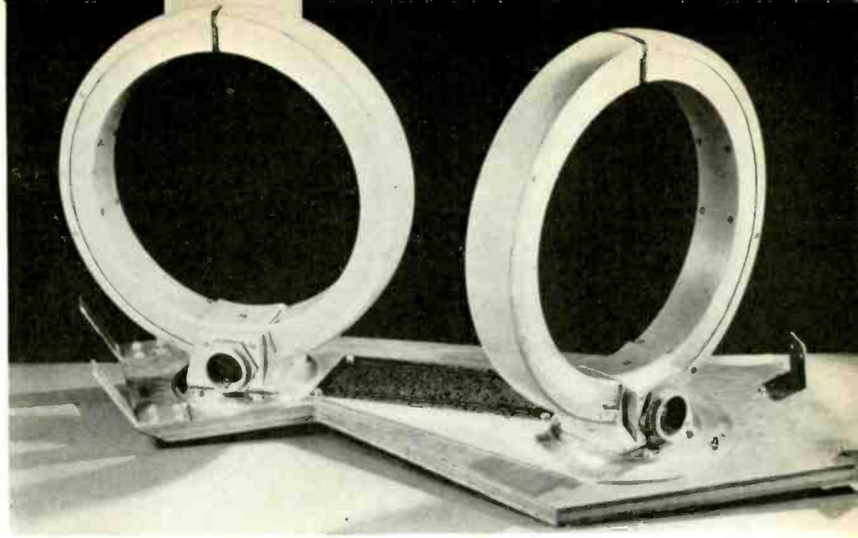


FIG. 1. THE LOOP UNIT OF THE SIMON RADIOGUIDE.

When used for obtaining vertical guidance, i.e., determination of position and course in zenith, the two loops are disposed, in a horizontal plane, at angles equal and opposite with respect to the horizontal axis of the airplane; and if a suitable transmitter is provided on the ground, the zenithal bearing of the transmitter can be continuously and automatically measured.

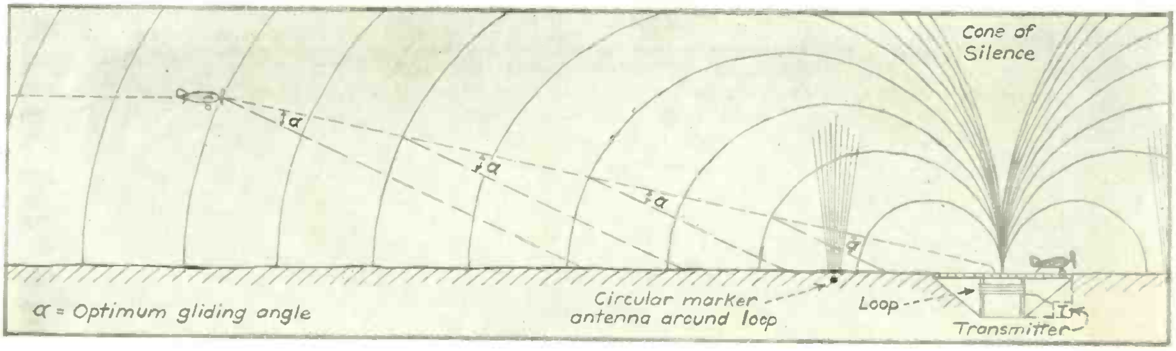
Such a transmitter is found in a horizontal loop antenna located underground at the center of the airport (Fig. 3). The field pattern of this antenna arrangement is shown in the drawing, and its horizontal components, received by the horizontally disposed loops, provide vertical guidance and enable the pilot to measure, in zenith, his bearing on the center of the airport in degrees.

Perusal of Fig. 3 will disclose the manner of making the "blind" approach and "blind" landing. First, the pilot approaches the airport at any convenient altitude, taking his radio course on the airport transmitter by means of a radio direction finder. When the airport is near, he puts his Radioguide in operation and obtains a vertical bearing on the airport. Knowing the flying characteristics of his airplane and the weight it carries, the pilot is in a position to select the optimum gliding angle to suit his needs. He approaches the airport, flying level, until the vertical-bearing indicator shows that the airport lies at that angle, whereupon he begins his glide. Throughout his descent he has a constant check on his bearings, in both azimuth and zenith, and is immediately warned by his instruments of any corrections needed in his course because of wind drift or errors in piloting.

It is interesting to note that the Radioguide permits such constant check in both horizontal and vertical dimensions. Comparison of azimuthal radio course with the directional gyro reading gives the check for horizontal drift, while comparison of zenithal radio course with the inclinometer angle gives information on whether the airplane is descending along the correct landing path, irrespective of the attitude of the craft's axis with regard to the earth's surface. In this manner the glide can be made in either tail-low or tail-high

(*Continued on page 27*)

FIG. 3. APPROACHES MAY BE MADE FROM ANY DIRECTION, ALTITUDE AND ANGLE.



Balanced Amplifiers

PART IV

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA INSTITUTES, INC.

XIV. CONSTANT-MU PARABOLIC TUBES

ANOTHER FORM for equation (27) of practical interest is that where

$$A_{11} = 2\sqrt{A_{20} A_{02}}$$

(in which case the second-degree terms form a perfect square) and

$$\left(\frac{A_{10}}{A_{01}}\right)^2 = \left(\frac{A_{20}}{A_{02}}\right) = \mu$$

a constant to be identified with the amplification factor of the tube. Under these two conditions equation (27) becomes

$$A_{01}(\mu e_g + e_p) + A_{02}(\mu e_g + e_p)^2 = i_p \quad \text{.......... (28)}$$

which is a parabolic cylinder, Fig. 19, and gives rise to a family of parabolas with equidistant spacing upon the $e_p - i_p$ and $e_g - i_p$ coordinate planes, Fig. 20. If it is remembered that the general definition of the amplification factor is

$$\mu = \frac{\delta i_p}{\delta e_g} \Big/ \frac{\delta i_p}{\delta e_p} \quad \text{.......... (29)}$$

and that the A's of the power series are formed according to the law of a McLaurin Expansion, namely

$$A_{hk} = \frac{1}{h!k!}\,\frac{\delta^{h+k} i_p}{\delta e_g^{\,h}\,\delta e_p^{\,k}} \quad \text{.......... (30)}$$

then, if μ is assumed constant, it can be shown that

$$A_{10} = \mu A_{01}$$

$$A_{11} = 2\frac{\delta^2 i_p}{\delta e_g\,\delta e_p} = 2\mu\frac{\delta^2 i_p}{\delta e_p^{\,2}} = 2\mu A_{02}$$

and

$$A_{20} = \mu^2 A_{02}$$

so that

$$\left(\frac{A_{20}}{A_{02}}\right) = \mu^2 = \left(\frac{A_{10}}{A_{01}}\right)^2 \quad \text{.......... (31)}$$

which are exactly the assumptions made in order that equation (27) reduce to (28).

It is an experimental fact that in most triodes, the tube surface is tangent to the $e_g - e_p$ coordinate plane so that $\frac{\delta i_p}{\delta e_g} = \frac{\delta i_p}{\delta e_p} = 0$ where i_p is zero, and (28) becomes

$$i_p = A_{02}(\mu e_g + e_p)^2 \quad \text{.......... (32)}$$

which is the well-known Van der Bijl's Equation.

XV. PROPERTIES OF SQUARE-LAW TUBE

This type of tube has some interesting properties. Referring to (32) we may write for the balanced-amplifier circuit having a resistive load, R_L

$$I_1 = A_{02}\left[E_B - (I_1 - I_2)\frac{R_L}{4} + \mu E_c + \mu e_s\right]^2$$

$$= A_{02}\left[E - (I_1 - I_2)\frac{R_L}{4} + \mu e_s\right]^2 \quad \text{.......... (33)}$$

where $E = (E_B + \mu E_c)$ is the equivalent diode voltage for the d-c component and

$$I_2 = A_{02}\left[E + (I_1 - I_2)\frac{R_L}{4} - \mu e_s\right]^2 \quad \text{.......... (34)}$$

From (33) and (34) we obtain

$$(I_1 - I_2) = \left[\frac{4A_{02}E}{1 + A_{02}ER_L}\right]\mu e_s = 2I_L \quad \text{.......... (35)}$$

If we substitute the value of $(I_1 - I_2)$ from (35) in (34), and set I_2 equal to zero, we obtain the value of grid swing for cut-off of I_2, namely:

$$\mu e_s = E(1 + A_{02}ER_L) \quad \text{.......... (36)}$$

If we substitute the latter value of μe_s in either (33) or (35) we obtain the value of I_1 where I_2 cuts off, to wit:

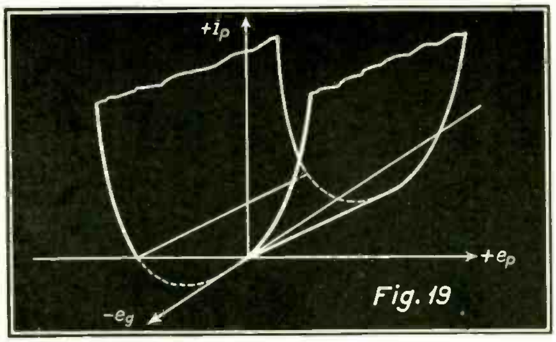


Fig. 19

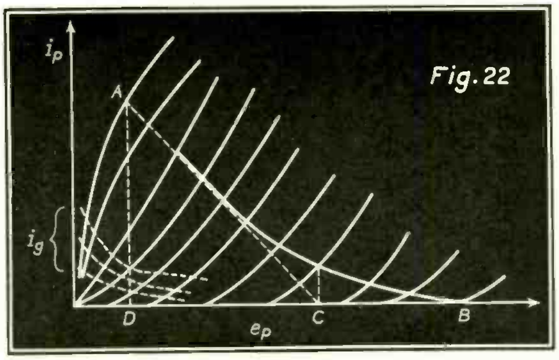


Fig. 22

$$I_1 = 4\,A_{02}\,E^2 \qquad (37)$$

At this point the plate voltage has dropped by the amount (from (37))

$$I_1 \frac{R_L}{4} = A_{02}\,E^2\,R_L \qquad (38)$$

and the effective voltage has been changed from E by the amount of the corresponding grid swing given by (36), or is now equal to $E\,(2 + A_{02}\,ER_L)$. Let the remainder of the grid swing be designated by e_s', then the equation for I_1, beyond cut-off for I_2, is

$$I_1 = A_{02}\left[E\,(2 + A_{02}\,ER_L) - \frac{I_1 R_L}{4} + \mu e_s'\right]^2 = 2\,I_L \qquad (39)$$

The reader can check from this equation that I_1 equals $4A_{02}\,E^2$ when $\mu e_s'$ is zero.

Equation (35) gives the relation between the load current I_L and μe_s above cut-off of I_2 (Class A operation), while (39) gives the relation below or beyond cut-off of I_2 (Class AB operation), for the particular tube given by (32).

The slope of I_L above cut-off is evidently (differentiating (35))

$$\frac{dI_L}{d\,(\mu e_s)} = \frac{2\,A_{02}\,E}{1 + A_{02}\,ER_L} \qquad (40)$$

The slope beyond cut-off, found by differentiating (39) is

$$\frac{dI_L}{d\,(\mu e_s')} = \frac{A_{02}\left(2\,E + \mu e_s' + A_{02}\,E^2\,R_L - \frac{I_L R_L}{2}\right)}{1 + \frac{A_{02}}{2}\left(2\,E + \mu e_s' + A_{02}\,E^2\,R_L - \frac{I_L R_L}{2}\right)} \qquad (41)$$

When $\mu e_s'$ equals zero, this becomes

$$\left.\frac{dI_L}{d\,(\mu e_s')}\right]_0 = \frac{2\,A_{02}\,E}{1 + A_{02}\,ER_L} \qquad (42)$$

which is the same value given by (40). In other words, the Class A characteristic blends smoothly into the Class AB characteristic for this type of tube, and hence the overall characteristic may be assumed to have less higher harmonics than one exhibiting a sharp break at this point. This matter may be conveniently represented graphically by plotting one tube's characteristics inverted with respect to the other, but so that their operating points line up. Thus in Fig. 21 $(I_1 - I_2)$ is tangent at

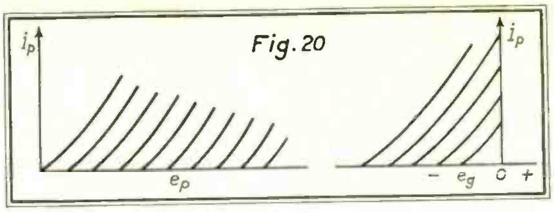


Fig. 20

cut-off to the I_1 and I_2 curves. The broken lines indicate the individual tube characteristics if they were parabolic beyond cut-off. It will be noted from (37) that I_1 at cut-off is independent of R_L: the smaller the latter is, the faster I_1 increases, but also I_2 to cut-off. Also the blending shown in Fig. 21 is true regardless of the value of R_L or E $(= E_B + \mu E_c)$: the greater the bias, or the smaller R_L is, the sooner does cut-off begin, and the sooner does the characteristic become I_1 alone and continue parabolically as shown previously or given by (39). The latter parabolic departure from linearity is not great unless the grid swing is very much beyond cut-off, and is moreover upward and in a direction to offset the effects of grid current. Hence the relation between load current I_L and grid signal voltage e_s may be linear for quite a large value of the latter.

Equation (36) shows that the cut-off grid voltage is smaller, the the smaller R_L is, or E. The smaller E is, the greater E_c is relative to E_B for a given μ. The significance is that Class AB operation, namely operation up to and beyond cut-off, is obtained either by means of overbias or by using a low value of R_L. At the same time, the preceding paragraph has indicated that the distortion products may nevertheless be small under these conditions. The value of overbiasing is that a high power-supply voltage E_B may be used and yet the quiescent d-c component I_{dc} may be kept down to where the plate dissipation at no-signal (equal to $I_{dc}\,E_B$) is within safe limits. The possible increase, thereby, of E_B results in greater maximum power output.

The value of being able to use low values of R_L is that the latter can be chosen for maximum power output for a given E_B without the restriction (so cramping in single-side amplifiers) that the plate currents do not approach too near cut-off and produce too much distortion.

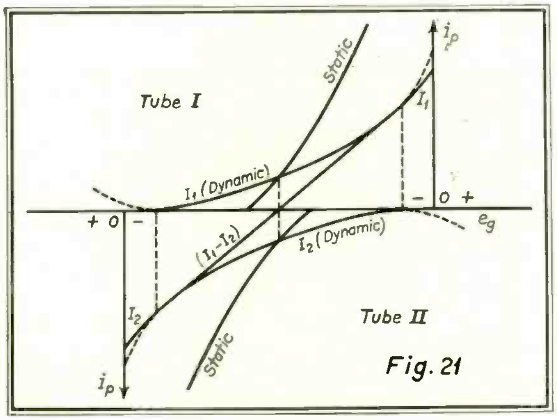


Fig. 21

XVI. OPTIMUM VALUE OF LOAD RESISTANCE

The optimum value of R_L for Class A operation is easily formulated. Thus, for values of μe_s below cut-off (given by (36)), and from (35), we have that the power output is

$$P_o = \frac{(I_1 - I_2)^2\,R_L}{8} = \frac{2\,A_{02}^2\,E^2\,\mu^2\,e_s^2\,R_L}{(1 + A_{02}\,ER_L)^2} \qquad (43)$$

The optimum value of R_L occurs where

$$\frac{\delta P_o}{\delta R_L} = 0, \text{ or}$$

$$R_L = A_{02}\,E = 2r_p \qquad (44)$$

since the plate resistance, r_p, is given by

$$r_p = \frac{\delta e_p}{\delta i_p} = \frac{1}{2\,A_{02}\,E} \qquad (45)$$

It is to be noted that the above value of r_p is that at the operating point.

(*Continued on page 22*)

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

"MIRROPHONIC" SOUND SYSTEM

THE NEW Western Electric sound system for theatres, known as the "Mirrophonic," was announced at a recent ERPI sales convention held in New York City. This system is said to achieve a degree of naturalness exceeding anything heretofore heard by theatre audiences . . . featuring higher quality, increased volume range, and a speaker system that provides uniform sound over the entire theatre.

A new reproducer set is employed as standard in the "Mirrophonic" system. This unit employs a film-pulling mechanism known as the "Kinetic Scanner," in which a damped mechanical impedance is utilized to provide uniform film velocity. It has also an improved optical system in which the physical slit is replaced by a cylindrical lens combination.

The amplifier equipment is of advanced type. In addition to the excellent frequency characteristic and high degree of reliability there is employed a new device, termed a "Harmonic Suppressor." This may be compared to an electrical governor which automatically, and without any moving parts, causes the amplifier to maintain constant quality, free from distortion, over an output range in which the loudest sounds heard in the theatre may exceed the weakest by more than 100,000,000 times.

The new amplifiers are very simple to operate. They run entirely on a-c and all parts of the circuit requiring adjustment can be checked by means of a selector switch associated with a "Percentage Meter"—that is, a meter whose scale is graduated to read percentages of the normal or correct value, which is taken as 100 percent.

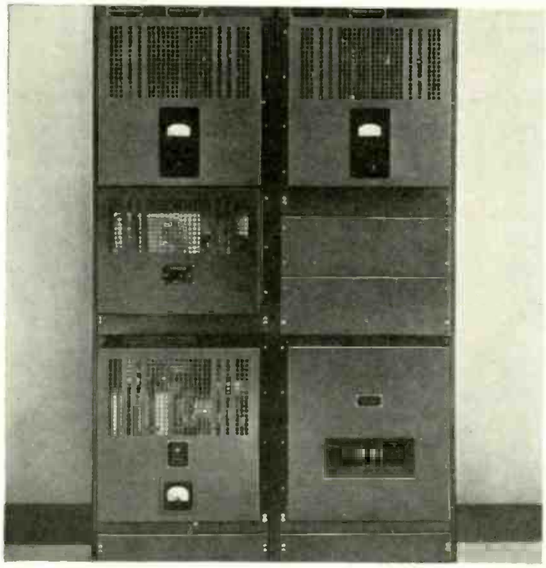
The "Di-Phonic" speaker system employed forms part of the well-known Stereophonic system. The term "Di-Phonic" indicates that the sound is reproduced in two frequency ranges, upper and lower. The upper range is handled by cellular high-frequency horns of the type employed in the Philadelphia - Washington demonstration.* The low-frequency speakers are of the dished-baffle type, in which the principle of cellular sub-division is again employed to obtain proper low-frequency distribution.

*See *Bell Laboratories Record*, May, 1933, p. 254.

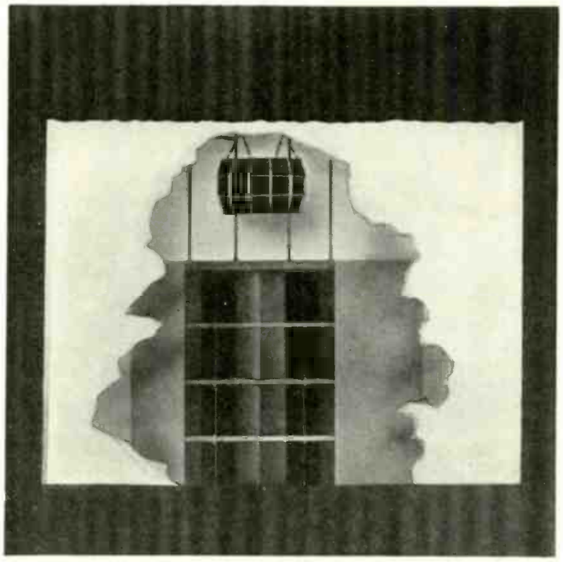
TELETYPE FOR WEATHER BUREAUS

WEATHER BUREAUS in a dozen cities in four southern states are now linked together by teletypewriters in an improved hurricane warning service. Heretofore it has often been difficult to find the center, intensity, and direction of hurricanes in the Caribbean Ocean and Gulf of Mexico because ships, upon whose reports the weather bureau must rely, naturally avoid the path of the storm. Now these twelve weather bureaus are organized into a connected series of reporting stations. Their reports, together with reports received from vessels, give accurate indication of where barometric pressure is low, where it is rising or falling, and other data which may be interpreted into a general weather condition and into a forecast for a certain period in advance. This information is made instantly available, through the 24-hour teletypewriter service, to the cities linked in this weather-reporting chain. These are: Jacksonville, Miami, Key West, Tampa, and Pensacola, Fla.; Mobile, Ala.; New Orleans, La.; Port Arthur, Galveston, Houston, Corpus Christi, and Brownsville, Tex. In case of emergency, bulletins can be given to the newspapers for publication and to radio stations for broadcasting by the weather bureaus in any of these cities which are in the path of a storm of hurricane proportions.

THE "MIRROPHONIC" HIGH-POWER AMPLIFIER.



A TYPICAL "DI-PHONIC" SPEAKER INSTALLATION.



Most Complete Transformer Line in the World

QUALITY · RELIABILITY

UTC Linear Standard Audio Transformers are

Precise measurements of high quality audio transformers in the net price range of $8 to $25 show:

LINE TO GRID TRANSFORMER	UTC LS-10 ($9 net)	Best competitive unit found ($25 net)	Poorest characteristics of any high fidelity units
Measured deviation between 30 and 1000 cycles	1.0 DB	1.5 DB	13 DB
Measured deviation between 1000 and 10,000 cycles	.4 DB	1.2 DB	3 DB
Measured deviation between 1000 and 15,000 cycles	.9 DB	2.8 DB	7 DB
Measured deviation between 1000 and 20,000 cycles	1.2 DB	2.5 DB	17 DB
DB rise at resonance (Approx. measure of phase shift)	0 DB	2.8 DB	2.8 DB
Hum at maximum position	1 DB	4 DB	42 DB
Hum at minimum position	0 DB	2 DB	10 DB

Critical organizations, that check claims, buy UTC Linear Standard audios

best by test

• UTC *Leads . . . others follow*

FREQUENCY RANGE

Claims for wide frequency response are common today. UTC is the only organization that **GUARANTEES** its frequency response and it specifies the widest range of all: 30 to 20,000 CYCLES ± 1 DB.

PHASE SHIFT

Low distributed capacity is of paramount importance in audio components. The exclusive UTC winding method costs more but assures lowest possible capacity . . . makes 20,000 cycle response possible . . . and assures negligible phase shift.

HUM PICKUP

Most manufacturers have already adopted some form of humbucking coil structure and cast ferrous case. Both of these developments were pioneered by the UTC engineering staff. But UTC's hum balanced coil structure is designed for **POSITIVE SELF BALANCE** and the UTC cast alloy has **FIVE TIMES THE PERMEABILITY OF ORDINARY CAST IRON.**

TRI-ALLOY MAGNETIC FILTER

In addition to their normal shielding, UTC low level input transformers now incorporate **TRI-ALLOY MAGNETIC FILTERING**, a new method of shielding which reduces hum pickup tremendously. This **MAGNETIC FILTER** was developed after a thorough analysis of hum reduction methods. Rotation in one plane was found of practically no value. Orientation in two planes, while much better, makes necessary unusual and unworkmanlike mounting and loses most of its effect if the field plane is altered or if stray flux from surrounding equipment is encountered (frequent in remote pickup equipment). The **MAGNETIC FILTER** makes possible a transformer which in its worst pickup position has a hum level far lower than any other transformer in its best position. The nearest available transformer on the market under $25 shows 17 DB greater hum than the UTC LS-10. This UTC advancement in shielding is the greatest forward step in ten years.

UNITED TRANSFORMER CORP.

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

THE MARKET PLACE

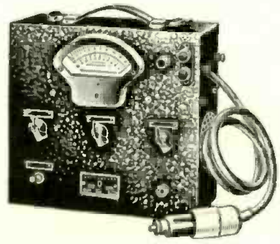
NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

VACUUM-TUBE, PEAK VOLTMETER

The Clough-Brengle Co., of 2815 W. 19th St., Chicago, Ill., nave just announced their Model 88 combination vacuum-tube voltmeter and peak-voltage indicator.

As a vacuum-tube voltmeter, a range of 0-1.2 volts rms is covered by direct connection to the tube (Type 6F5 metal) grid without any shunts. Thus, a large deflection is secured by potentials as low as 0.1 volt on the 4½-inch fan-type meter. The voltmeter tube is placed at the end of a 30-inch extension cable, making possible direct connection of the tube grid-cap in the circuit, the potential of which it is desired to measure, and thus eliminating all capacity effects.

As a peak voltmeter, ranges of 0-10 and 0-100 are provided without the necessity of external power supply. These find wide usage in measuring avc, c-bias, and other potentials where no current drain is permitted and where the wave shape is other than sinusoidal with the resultant lack of fixed relationship between rms and peak potentials.



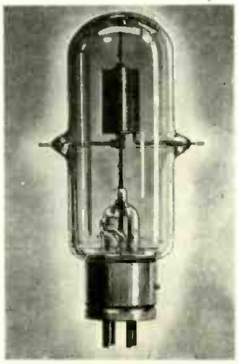
VACUUM-TUBE VOLTMETER.

CRYSTAL COUPLER

The Radio Engineering and Manufacturing Co., 26 Journal Square, Jersey City, N. J., has just developed a preliminary coupling amplifier for use with any type crystal pickup.

The new unit is known as the R20-A Crystal Coupler and the entire unit, which incorporates such features as low-and high-frequency compensation, complete a-c operation, and 50-200-ohm output terminations, is built within a round metal casing that may be mounted directly in the top of transcription tables, or when independent floor-type turntables are used, the coupler may be supplied with a special floor stand and pickup bracket which fastens to the side of the coupler unit.

Bulletin 14A is now being prepared. It fully describes this new equipment.



GAMMATRON 154.

NEOBEAM OSCILLOSCOPE

The Neobeam oscilloscope is an electronic measuring device using a gaseous discharge tube to make sound visible. The wave pattern is traced on a 4-inch calibrated screen with clear definition between amplitude and frequency.

The principle by which the gaseous oscilloscope tube operates is that the area of the glow covering the elongated cathode is proportional to the current passing through the tube. On alternating current the electrodes glow alternately depending upon the frequency of the impressed voltage. This development, while new, is along the line of experiments started by Mr. E. Gherke in 1904.

The oscilloscope tube as now developed measures 6 inches overall by ½ inch diameter and is filled with neon gas. The two electrodes are 2 inches long by 1/16-inch diameter and set at each end of the tube so as to develop a 4-inch image.

A power generator keeps the neon tube ignited. This is made up with a 6L6 beam power tube as a 100 kc radio-frequency oscillator feeding directly into the neon oscilloscope tube. This system keeps a constant glow on the tips of the electrodes.

The input potentials are amplified by a 6J7 and 6L6 high-gain audio amplifier and impressed on the power generator. This fluctuating power corresponds to the vertical deflection of the wave pattern.

Complete information may be obtained from Sundt Engineering Company, 4238 Lincoln Ave., Chicago, Ill.

NEOBEAM OSCILLOSCOPE.

GAMMATRON 154

Heintz & Kaufman, Ltd., South San Francisco, Calif., have recently announced a low-voltage transmitting tube, known as the Type 154 Gammatron.

In physical appearance the 154 stands approximately 6¾ inches from top to toe and has a straight-sided glass envelope 2 inches in diameter. The base is of the standard UX type. The grid and plate leads are rigid tungsten rods extending through opposite sides of the glass envelope. These form the double side-arm construction which has proved so satisfactory at ultra-high frequencies.

Tantalum grid and plate, solidly supported, are incorporated in this tube. Ample plate emission is also said to be obtained, the actual safe rating of 175 milliamperes being conservative.

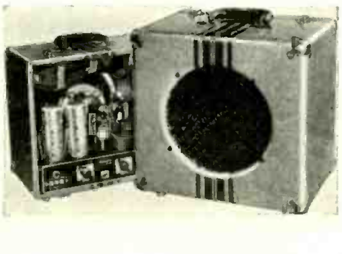
The main feature of this tube is low plate-voltage operation. Whereas 1,500 volts is safe, high outputs may also be secured with 750 volts. This is said to hold whether the tube is used in a-f or r-f circuits at waves as low as 5 meters.

The general ratings of the Type 154 are:

Filament voltage....	5.0 volts
Filament current....	6.5 amperes
Plate dissipation....	50 watts
Plate voltage.......	1,500 volts (max.)
Plate current.......	175 ma (max. aver.)
Grid current.......	30 ma (max. aver.)
Plate resistance.....	1,750 ohms
Amplification constant	6.7

Complete information may be secured from the above organization.

PORTABLE SOUND SYSTEM.



PORTABLE SOUND SYSTEM

The Clarion Model C-45 is a portable 5-watt sound system. The speaker, amplifier, microphone and desk stand are all contained in a luggage case which measures 12¼ by 12¼ by 8⅞ inches.

In operation the amplifier is removed from the case, the case then acting as a baffle for the speaker. Twenty-five feet of rubber-covered cable is attached to the speaker for connecting to the amplifier. The amplifier is of the high-gain type and the system can be used with any modern type of microphone.

The Clarion Model C-45 is a product of the Transformer Corporation of America, 69 Wooster St., New York City.

AMPERITE BOOM STAND

By merely a slight pressure of the hand, the new Amperite boom stand is silently

adjustable in a vertical or horizontal position. The microphone can therefore be placed at any height and at any angle desired. No adjusting screws are required. This action is obtainable by using a ball clutch for the vertical adjustment. Obtainable in chrome or gunmetal finish. Complete information may be obtained from Amperite Corporation, 561 Broadway, New York City.

RECTIFILTER

The Raytheon RectiFilteR, shown in the accompanying illustration, has been designed to supply d-c power (direct from 110-volt a-c) for speech-amplifier filaments in broadcast stations, motion-picture theatres, motion-picture studios, public-address and centralized radio systems.

An essential design feature of this unit is the stabilized d-c output. A special circuit is used which holds the d-c output essentially constant regardless of the load imposed on the RectiFilteR. The ripple (a-c component) remaining in the d-c output is -80 db, and it is stated that this may be reduced to -120 db through the use of an auxiliary filter.

Further details may be obtained by requesting Bulletin DL48-118 from the Raytheon Manufacturing Company, Electrical Equipment Division, 102 Willow Street, Waltham, Mass.

MYCALEX PRODUCTS

The American Radio Hardware Co., Inc., 476 Broadway, New York, announce

a new line of Mycalex radio parts and accessories.

In addition to the extensive line of coil forms, midget variable condensers, crystal holders, and all the popular size glass-tube sockets have been made available. Depicted herewith are two of the more specialized types of Mycalex sockets for use with the RCA-803 and RK-28.

Write for Catalog No. 36A.

BALANCED AMPLIFIERS

(*Continued from page* 17)

If the grid swing is greater than the cut-off value, (Class AB1 or AB2) we must modify the above results, since the two tubes are in the picture for only part of the grid swing. A complete mathematical treatment is involved and unnecessary, since actual tubes are only approximately parabolic in their characteristics. If the grid swing is sufficiently great (particularly if the grid goes positive) the $e_p - i_p$ curves are practically linear and parallel near the peak swing (for a triode) and may be considered as straight lines in this region. Thus, in Fig. 22 we have a plate family of curves, with the tube load line AB superimposed. The line AC represents half of the load line as it would appear to an equivalent tube capable of conducting in either direction, or to a pair of equivalent linear tubes in Class B (biased to cut-off). It may also be regarded as the push-pull load line, since the latter is usually practically straight and coincident with it. The power output may be taken as $\frac{AD \times DC}{2}$, or the area of triangle ADC, since AD and DC represent the peak current and voltage, respectively, through the load. It can be shown that where C is fixed, and A is on one of a family of parallel lines ($(e_p - i_p)$ curves, assumed linear in this region), then triangle ADC has maximum area when AC forms an isosceles triangle with the plate-current curve through A. This in turn means that

$$R_L = 4r_p \quad \text{(46)}$$

where r_p is now the plate resistance at peak swing, namely, the tangent to the plate-current curve through A. This follows from the fact that AC represents $R_L/4$ (as shown in the previous article) and for AC at the same angle as the plate-current curve through A, $R_L/4$ must equal r_p.

The value of r_p in this region is fairly constant, and may at least be a guide for a subsequent graphical calculation. The latter, when corrected for self-rectification, will give a load line higher than AB, and an operating point farther to the right of C. A recalculation of R_L may result in a better optimum value.

The extent of grid swing e_s is determined by how far the grid may be swung positive. For the value of R_L determined as above, e_s must not be so great that line AD cuts through the grid-current curves where they are rising steeply, otherwise the driver-tube requirements will be excessive, and the plate-current curve will droop off from linearity and thus produce a flat-topped output wave. The grid swing may be increased if R_L is decreased, and greater power output obtained, but usually in Class AB operation this results in excessive plate dissipation at full signal swings, and also in excessive power-supply demands, particularly as regards filtering and bypass requirements.

XVII. PLATE DISSIPATION

The plate dissipation at no-signal swing has been given and it has been stated that it can be kept down by using sufficient bias. The plate dissipation at full signal swing w_{pd}, however, is a function of R_L and e_s, and is not easily determined nor controlled. It is equal to the product of the d-c component of the plate current I_{dcs} at full signal swing by the power-supply voltage, minus the a-c power output of the tube, which is half of the total a-c power output, P_o, or

$$W_{pd} = (I_{dcs} \times E_B) - P_o/2 \qquad (47)$$

An analytical expression for I_{dcs} is very complicated, and hence the best means of ascertaining it are from a graphical analysis, including the correction for self-rectification. P_o is also best calculated from the corrected load line. It will be noted from the graphical analysis that the greater e_s is, or the smaller R_L, the greater the peak current of each tube, and the greater the d-c component. On the other hand, the greater the initial bias (the closer to Class B operation), the smaller is the d-c component. Hence, by varying these factors as indicated above, the designer can obtain the maximum power output of the tubes consistent with permissible plate dissipation. In passing, it is worthy of note that since the peak power demands are not continuous, it may be desirable to rate vacuum tubes on an intermittent-duty basis similar to that of a railway motor. The vacuum tube, however, has a smaller thermal capacity and consequently a lower thermal overload capacity.

XVIII. SELF-BIAS, SELF-RECTIFICATION

Where self-bias is employed, the change in d-c component must be small, otherwise the bias will be increased with impress of e_s, and this in turn means a lower operating point and decreased output. It is assumed, of course, that the bias resistor is adequately bypassed, otherwise as pointed out above, odd harmonics will be generated too. Small change in d-c component is obtained by using a higher value of R_L than for fixed bias, since then the cut-off grid voltage is prolonged, and the self-rectification in each tube is less. The grid swing generally has to be decreased, too, to minimize the latter effect. The result of increasing R_L from its optimum value and reducing e_s is to decrease the power output, hence fixed bias is preferable when available.

The matter of self-rectification requires some comments. In a single tube, employing inductive feed (paralleled by the load resistor R_L), the load line for d-c is vertical through E_B, and the quiescent point is determined by the intersection of this load line and the plate-current curve whose parameter is E_c. It is then assumed, as a first approximation, that the locus of the plate current for e_s is along the load line for R_L. If the time function for the plate current reveals an additional d-c component due to self-rectification, then this component must flow through R_L and produce a d-c voltage drop across it. But this voltage cannot be supported by the parallel inductance, hence the load line for R_L must be shifted until it reveals no further d-c component. The corrected load line will in general intersect the E_c plate-current curve[7] at some value, E_B', different from E_B. If the additional d-c component is positive (as in ordinary triodes) it will result in E_B' being greater than E_B. We may regard the tube as operating at a higher supply voltage E_B', but that the resistance to the *additional* d-c component is the same as that to the a-c components, namely R_L. This is analogous to the usual viewpoint of considering inductive feed as equivalent to ordinary resistance coupling at a higher supply voltage.

In the case of a balanced-amplifier stage we have a similar state of affairs. The load line for either tube reveals odd and even harmonics, including additional

7. See Kilgour—*IRE Proceedings*, January, 1931.

(*Continued on page 24*)

BALANCED AMPLIFIERS

(*Continued from page 23*)

d-c component in the time function for the plate current. Since the output choke is assumed a linear device, we may superimpose the effects of the two tubes upon one another and R_L. Thus each tube's current due to e_s may be regarded as flowing through a reflected resistance $R_L/4$. The odd harmonics produce odd-harmonic voltage drops across this reflected resistance, that is—across one-half of the output choke. Due to the mutual inductance between the two halves of the choke, equal odd-harmonic voltages are induced across the other half. The other tube similarly develops odd-harmonic voltages across its half of the choke, and induces equal voltages across the other half. For the odd harmonics, these voltages are additively superimposed, so that there is twice as much odd-harmonic voltage, plate-to-plate, as across either half.

In the case of the even harmonics, however, the voltages are subtractively superimposed, so that the voltages across either half and from plate-to-plate are zero. The even harmonics from each tube are in time phase, but flow in opposite directions through halves of the choke.

All this checks with the physical analysis given in the previous article, consequently the individual tube load lines require no correction so far. When we come to the case of the additional d-c components, however, we run into an inconsistency. By hypothesis, these, too, flow through $R_L/4$ and develop d-c voltages across the two halves of the choke. Since there is no mutual reactance between the two halves at zero frequency (tacitly assumed even for an ideal choke) there can be no d-c voltage induced in the one half by the other, hence no such balance obtains, i.e., there are d-c voltages across the two halves. These must be liquidated separately by each tube, and hence the correction for each tube's load line due to the effects of self-rectification.

It is of interest to show, analytically, how the individual tube's load line is straightened out by a mid-branch resistance, R_b. The plate voltage can be written

$$e_{p1} = \left[E_B - (i_{p1} + i_{p2})\, R_b - (i_{p1} - i_{p2}) \frac{R_L}{4} \right] \qquad (48)$$

If R_b is equal to $R_L/4$, (48) becomes

$$e_{p1} = \left[E_B - i_{p1} \frac{R_L}{2} \right] \qquad (49)$$

or the plate voltage of tube I is not dependent upon the plate-current of tube II, $-\,i_{p2}$. This means that that particular value of R_b ($= R_L/4$) has decoupled tube I from tube II by introducing a coupling equal and opposite to that of the two halves of the output transformer. The load line for either tube will therefore be a straight line determined by the resistance $R_L/2$, and is tangent at the operating point to the curved load line of either tube when there is no mid-branch resistance.

In the case of winding resistance in the output transformer, the corrections as detailed in the previous article give the individual tubes' currents. From these the power output can be calculated, but it must be remembered that this is the output into the transformer. To obtain the power output into the load resistance R_L, the losses in output transformer must be subtracted.

In this article there has been formulated some general theorems on balanced-amplifier circuits. Assuming truly balanced conditions, it has been shown that

(1) The output contains odd-order, and no even-order modulation products.

(2) The mid-branch current contains even-order, but no odd-order modulation products.

(3) Mid-branch impedances produce voltages which cross-modulate with the signal voltage to produce odd-order modulation products in the output, in vector addition to those normally produced by the tubes themselves.

(4) Mid-branch voltages produce no output directly, but do cross-modulate with the signal voltage to produce odd-order terms in the output.

(5) A tube whose power series contains no term higher than the second will give distortionless output in a balanced amplifier operating Class A. This is true even if its amplification factor is variable subject to the above restrictions.

(6) In the case where the above type of tube has a constant amplification factor, it was shown that even in Class AB a nearly distortionless output can be obtained. In particular, the square-law tube, (Van der Bijl's equation) gives a smooth dynamic characteristic for the above operation, which indicates a lack of high-order modulation products. This is true for all reasonable values of load resistance, bias, and signal voltage.

(7) The above tube can give greater output in conjunction with a similar tube in balanced-amplifier operation than in single-side operation, because a higher supply voltage can be used, with overbias to keep the no-signal plate dissipation down. Also, an optimum value of load resistance can be used, even though either tube cuts off before the peak of the signal swing is reached. Thus, for this tube operating Class A, when the load resistance (plate-to-plate) is twice the tube resistance (at the operating point), maximum power output is obtained. If operation beyond Class A is desired, namely Class AB, maximum power output is obtained when the load resistance is four times the tube resistance at the point of peak signal swing. The above results are approximately true for tubes of parabolic characteristics.

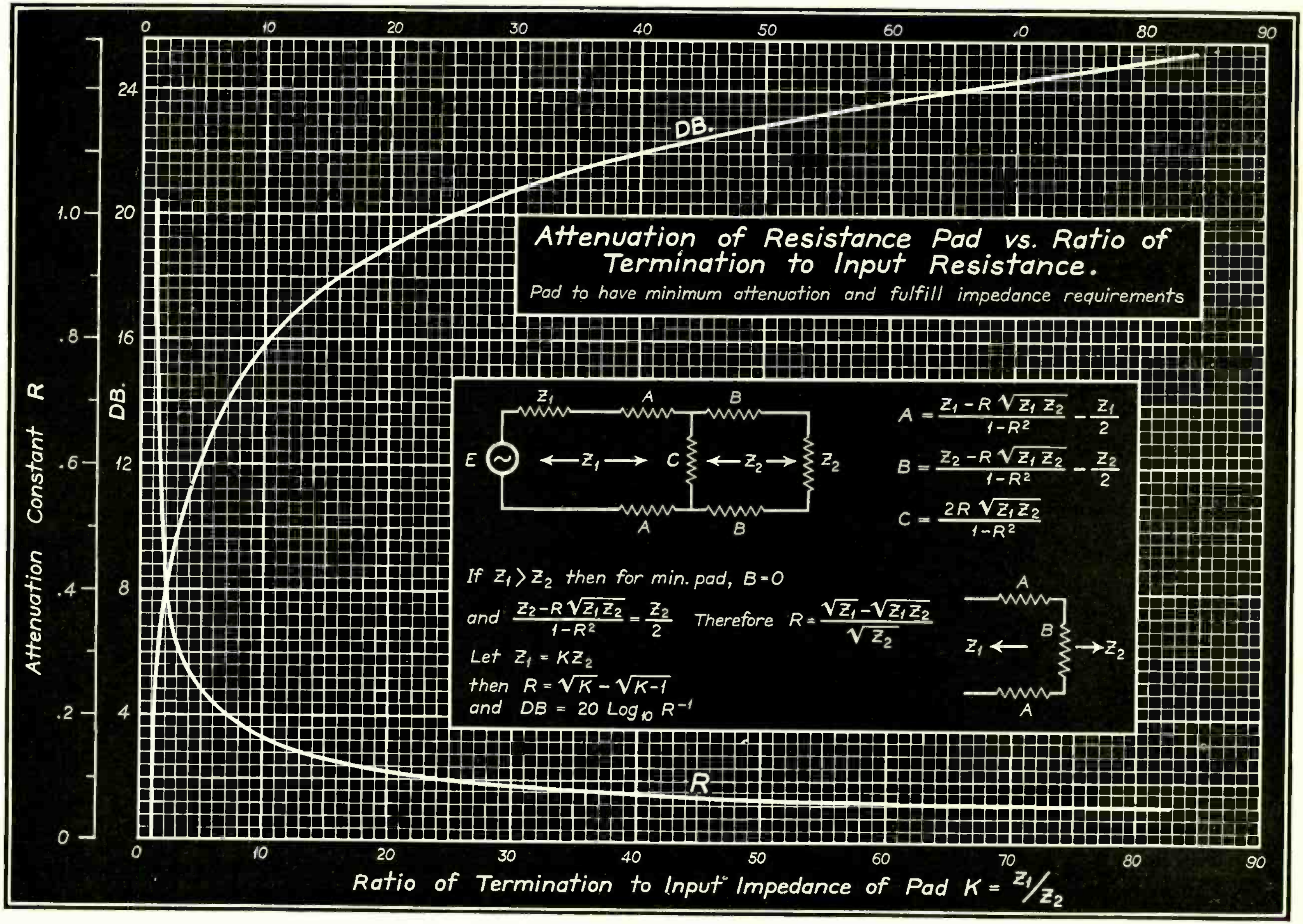
(8) Maximum grid swing is determined by the grid current. The latter depends, however, upon the plate voltage, which is at a minimum when the grid voltage is at a maximum. The value to which the plate voltage drops is determined by the load resistance, as well, hence the peak grid swing is best determined graphically for the value of load resistance determined previously.

(9) The full signal plate dissipation depends upon a number of factors, so that it is best calculated after the additional d-c component has been determined graphically. It can be reduced to within safe limits by reducing the grid swing, increasing the load resistance, or increasing the bias. The latter is often done, which results in more nearly Class B operation. The advantage is better all-day operating economy; the disadvantage is mainly higher percentage of distortion products.

(10) For self-bias, the change in d-c component, hence change in bias, must be minimized. This can be done by operating more nearly Class A, which means generally a higher value of load resistance and reduced signal voltage, for the same percentage of distortion products.

(11) The analytical method is theoretically correct, and requires no corrections if a sufficient number of terms have been used in the power series. The graphical method is correct as far as determination of the a-c components is concerned, but requires a correction for the change in d-c component. This correction, in turn, changes the operating point, and thereby changes the magnitude and phase of the a-c components.

(To be continued)


Attenuation of Resistance Pad vs. Ratio of Termination to Input Resistance.
Pad to have minimum attenuation and fulfill impedance requirements
$A = \frac{Z_1 - R\sqrt{Z_1 Z_2}}{1-R^2} - \frac{Z_1}{2}$
$B = \frac{Z_2 - R\sqrt{Z_1 Z_2}}{1-R^2} - \frac{Z_2}{2}$
$C = \frac{2R\sqrt{Z_1 Z_2}}{1-R^2}$
If $Z_1 > Z_2$ then for min. pad, $B = O$
and $\frac{Z_2 - R\sqrt{Z_1 Z_2}}{1-R^2} = \frac{Z_2}{2}$ Therefore $R = \frac{\sqrt{Z_1} - \sqrt{Z_1 Z_2}}{\sqrt{Z_2}}$
Let $Z_1 = KZ_2$
then $R = \sqrt{K} - \sqrt{K-1}$
and $DB = 20 \log_{10} R^{-1}$
E
Z_1
A
B
C
Z_2
DB.
R
Attenuation Constant R
Ratio of Termination to Input Impedance of Pad $K = Z_1/Z_2$

THE SIMON SYSTEM

(Continued from page 15)

condition, and at the correct drift angle if a cross-wind approach is necessary.*

The Radioguide also provides approximate distance indication which is automatically shown on the dial, in percent of distance traveled. This indication, however, is derived from the increase in the field strength as the transmitter is approached, and therefore may not be sufficiently accurate for purposes of instrument landing during the last few critical feet: the field intensity may vary with irregularities of transmitter output or changes in the dielectric potential of the ground. For this reason, a provision is made for two suitably arranged marker beacons for definite position check: one to indicate the immediate vicinity of the airport, the other to indicate when the center of the airport is reached and the actual landing should be made.

For the sake of technical accuracy, it should be noted that the theoretical path so defined is not a straight line, but rather one-half of a hyperbolic curve somewhat similar in shape to one-half of a hairpin. For all practical purposes, however, this can be considered a straight line as the sharp downward curvature of this path at the transmitting loop begins but a few inches from the ground. This curvature is determined by the relative sizes of the transmitting and receiving loops: the greater the difference, the smaller is the curve.

The future will undoubtedly show that the most important application of the Simon system lies in its utilization as a collision warning device to indicate proximity and three-dimensional bearing of obstructions in the path of the airplane, such as mountains, towers, or other aircraft. The principle of its operation is shown in Fig. 4 and is identical with that employed for instrument landing. It should be noted that the bearing shown by the instrument is determined by the wave front of the received signal, resulting in a slight over-indication when at a distance from the beacon and gradually increasing in accuracy as the beacon is approached—a most desirable characteristic when the speed of modern aircraft is taken into consideration.

Preparations are now under way for exhaustive flight tests of this system, which will undoubtedly be watched with interest in both radio and aviation circles.

* It has also been proposed to suspend the zenithal bearing loops in gyroscopic gimbals, to assure true angular indication of the path followed irrespective of the altitude of the craft.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

VWOA CONSTITUTION AND BY-LAWS

ARTICLE II, SECTION 2. "At the December meeting the Board of Directors shall submit a list of nominees for Officers and Board of Directors, of not more than three (3) names for each office, President, Vice-President, Secretary and Treasurer, and not more than twenty (20) names for Board of Directors. Printed ballots shall be prepared and mailed to each member eligible to vote. These ballots shall be returned to the Secretary sealed, not later than midnight prior to day of January meeting."

ARTICLE III, SECTION 1. "Following the November meeting the Board of Directors will receive petitions in writing, signed by not less than thirty (30) members entitled to vote, setting forth the name of the candidate and the office for which it is desired he be nominated. These petitions shall be considered by the Board of Directors and shall be included in the final list of nominees when submitted at the December meeting."

The above two Sections quoted refer to nominations for National Officers and Directors and in no way do they affect the functioning of local chapters. They are included at this time for the information of the membership at large.

CHICAGO

E. J. NECKER was recently elected treasurer of the Chicago Chapter to fill the unexpired term of Sidney Winsberg, who, because of pressure of business, found it necessary to resign. EJ has started an extremely active campaign to line up the Mackay Radio personnel in Chicago. . . EJ being associated with that organization. The following are the members he has signed up: L. E. Thiele, Louis Leeda, L. O. Gorder, Irving R. Quay, and Henry E. Wegner.

L. E. Thiele attended the Marconi Institute back in 1915 and was later associated with the Alaskan Steamship Company of Seattle, Wash., and the Canadian Pacific Steamship Company of Vancouver, B. C. Mr. Thiele's war experience included service in the Signal Corps and the Artillery, being discharged as a Radio Sergeant in the 39th Artillery. At present, he is Division Traffic Superintendent of the Postal Telegraph-Cable Company.

Louis Leeda was transoceanic radio operator at Amsterdam, Holland, from 1925 to 1928. He then came to the United States where, from 1929 to 1934, he was employed with the Bull Line. He is at present with the Mackay Radio Company as operator at their Chicago terminus.

L. O. Gorder, who started professional operating just after the war, includes among his employers the Shipping Board, Goodrich Transit Company, Lykes Brothers and several others in the marine field.

Irving R. Quay was employed by the United Wireless Company at Chicago in 1914, then with Pershing expeditionary forces in Mexico, and old "WUJ," Fort Sam Houston, Texas, in 1915 and 1916, continuing in the Signal Corps with the AEF in charge of Third Army Headquarters Radio Station at Coblenz, Germany, during 1917 to 1919. At present he is engaged as Division Testing and Regulating Inspector with the Postal Telegraph-Cable Company in Chicago.

Henry E. Wegner obtained his first commercial license in March, 1924, and subsequently operated for the Reiss Steamship Company, Intercity Wireless Telegraph Company, Southern Pacific and Radiomarine Corporations and the Universal Wireless Company. Duty at the receiving station of the Mackay Radio Company at Merrillville, Indiana, keeps him busy eight hours a day at present.

George I. Martin, Chicago Chapter Chairman, continues his efforts to make the Chicago Chapter one of our largest. He includes with a recent interesting communication the application of William H. Barlow, who began operating on shipboard in 1921 with the Radiomarine Corporation and continued for a considerable period on board various Great Lakes vessels. WHB served in the Signal Corps of the Canadian Army during the War. At present he is employed as Instructor in the operating department of the Coyne Radio School and in his spare time operates amateur radio station W9UEU.

Keep up the good work GIM and EJN, and Chicago will soon have the largest of the VWOA Chapters.

BOSTON

WE ARE SORRY to learn that Harry Chetham, Boston Chapter Secretary, is in the Naval Hospital at Chelsea, Mass., with an infected foot. Harry has quite a record (not an enviable one to be sure) of successive hospitalizations. He has been in the hospital on forty different occasions since the war—in almost as many different hospitals. We sincerely trust that Harry's present visit will be a short, pleasant one. (You know, Harry, you've got to be on deck for the big affair on the 11th of February. It won't be a success without your aid and attendance!) Despite his difficulties, however, Harry has gone right ahead and solicited new members in the Boston area. Among those signed up recently are the following: T. C. J. Prior, who operates at WJAR in Providence, R. I., his home town; Lawrence S. Bennett, who started operating with the Marconi Company back in 1913; J. Frank Sullivan, President of the Rhode Island Radio School, who also worked for the Marconi Company way back in 1910; R. G. Webster, who is with the Sam Curtis Radio School in Boston; James E. Rigby, with the Radio Corporation from 1920 to the present; Walter S. Rogers of the well known "Radio Shack" in Boston, who started operating in 1910; J. A. Loyall, with RCA Communications in Boston, who started in the United States Navy in 1924 and then went with RCA; and Edward F. Tierney, Chief Radio Operator of the Cambridge Police Department, Cambridge, Mass.

Harry tells us in his notes—"Bill English, who now owns and operates a gas station at West Hartford, Conn., was formerly at old 'BN' at 88 Broad St. Mark MacAdam is very busy at the Ware Radio plant in Brockton, Mass. Guy Entwistle, our jovial Vice-Chairman, and his partner, Raymond F. Trop, Treasurer of our Chapter, opened the fall season with large classes in attendance at their Massachusetts Radio and Telegraph School. Arthur Ericson spends many enjoyable hours at his 'ham' rig in Beverly, Mass., with which he has worked all continents. Sam Curtis has opened his new Communication Industrial Electronic and Television School on Massachussetts Avenue, Boston, and has engaged Ted McElroy, world's fastest radio telegrapher, and a Boston Chapter member, as one of his instructors. J. Frank Sullivan, of the Rhode Island Radio School, reports excellent registration for the fall term." Then Harry adds—"Seems as tho' we have a monopoly on the school business up this way."

PERSONALS

"LEST WE FORGET"— Karl Baarslag writes the Secretary as follows:— "I called on Doc and learned to my indignation that none of his old friends or pals had been to see him in a long time. I was his first visitor in over a year. You know, Bill, Doc's sight is none too good and failing and he can no longer go out alone or visit New York. It is, therefore, up to old-timers to pay Doc a call for old times sake. He is the only Radio Operator in an institution of over 900 sea captains, engineers and sailors. Old timers with cars ought to pay Doc a visit and take him out for a ride. It is but a short bus ride to the door after leaving the Staten Island Ferry at St. George. He can be visited anytime of the day, but after 3 p.m. is best for him. Doc asks old friends who can't call to drop him an occasional post card from foreign ports now that he can no longer sail the seas and visit them himself.

"I think it a —— shame the way fellows have forgotten him so completely! Nearly blind—alone in the world—and forgotten by all his old 'friends' (?). Not a pleasant outlook."

On our visit to "Doc" James Forsythe at Sailor's Snug Harbor, Staten Island, N. Y., within the next few days, can we assure him of your visit or letter? A post card, letter or personal visit will make life for "Doc" immeasurably more pleasant. Thank you.

Bliley Broadcast Crystals are approved by F. C. C. Write for complete Catalog G-9.

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING ERIE, PA.

THIS MODEL D-2 CRYSTAL MICROPHONE, WE MEAN!

Utilizing the exclusive Astatic Dual Diaphragm principle, this NON-DIRECTIONAL bimorph crystal microphone possesses a frequency response substantially flat from 50 to 6000 c.p.s. Because of its ruggedness, beauty and size (only 2½" by ½") it is sweeping the country as the preferred P.A. and studio model. List Price $25.00. Your request for Bulletin 62 will bring complete information.

Licensed under Brush Development Co. patents. Astatic patents pending.

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

TRANSFORMERS
for Transmitting

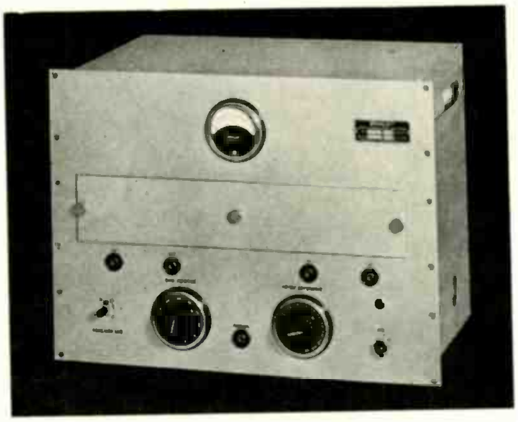
Above—AmerTran air-cooled transmitting plate transformer—sizes up to 7 kva.

Below—AmerTran air-cooled transmitting filament transformer.

AmerTran's line of air-cooled transmitting transformers are designed to meet the most rigid broadcast station requirements. Units are of the highest quality and standard types are available to meet all usual requirements in rectifiers utilizing either type '66 or '72 tubes. The illustrations show our new improved mountings and standard ratings are listed in Bulletin No. 1002 . . . *May we send you a copy?*

AMERICAN TRANSFORMER CO.
175 Emmet St., Newark, N. J.

REMLER Apr-29 BROADCAST Line Amplifier



Three stage push-pull line amplifier, gain 67 db. Undistorted output plus 20 db. Response within plus or minus 1½ db. 30 to 12,000 cycles. Input and output impedance is 500 ohms balanced to ground. Key provided to switch to auxiliary input. Tubes: 2 - 6A6 dual triode, and 2 - 89 triode connected. Shielded input transformer, cushioned in rubber. 100,000 ohm Remler wire wound potentiometer gain control. V.I. reference variable from minus 10 to plus 20 db.

Operates from 118 volt 50 to 60 cycle line; supplies 6.3 volts AC—180 volts DC for preamplifiers. Standard 19" x 14" attractive brushed dural panel.

Preamplifiers, line and bridging amplifiers and complete speech input systems. Attractive prices.

REMLER CO., Ltd. 2101 Bryant St., San Francisco

OVER THE TAPE . . .

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

MARINE EXHIBITION

The Third Annual Marine Exhibition will be held from November 12-20 at the Maritime Exchange Building, 80 Broad Street, New York City. This exhibition is under auspices of The Maritime Association of the Port of New York.

CORNELL-DUBILIER CATALOG

A special catalog has been issued by the Cornell-Dubilier Corporation covering the new reduced prices recently announced for their line of "Dwarf-Tiger" condensers.

This catalog lists the entire line of this series, together with catalog numbers, and shows both the old and new price schedules. The savings shown average over 30 percent. This catalog No. 132A will be mailed to those requesting it from the Cornell-Dubilier Corporation, 1000 Hamilton Boulevard, South Plainfield, New Jersey.

"PROGRESSIVE" II

"Progressive" II, a supplement to the "Progressive" Transmitter Guide for Amateurs, is now off the press. It covers a simple plan to build a complete "rig" in steps. Complete diagrams and parts lists are included. This booklet may be obtained from the Amateur Press, 1300 W. Harrison St., Chicago. The price is fifteen cents.

TURNER APPOINTMENT

The Turner Company of Cedar Rapids, Iowa, have announced the appointment of L. G. Cushing Company, 540 North Michigan Avenue, Chicago, Illinois, as their new Illinois representative.

WILLIAM BRAND CATALOG

A new catalog, No. 11, listing the various types of electrical insulating materials produced by their organization, has just been issued by William Brand & Company, 268 Fourth Avenue, New York, N. Y. This catalog will be sent free upon request.

"SOUND ENGINEERING MANUAL"

After many delays and corrections, due to rapid advances in sound engineering, Webster-Chicago has announced that the first completed copies of the "Sound Engineering Manual" are expected off the press within a few days.

Every dealer who has previously requested one of these manuals will receive it free of charge, although due to the magnitude of the book and consequent expense, it has been found necessary to establish a price of 10 cents. As edited, this manual now contains 18 diagrams covering different phases of sound engineering from details of microphone construction to complete installations.

WALTER BIDDICK SALES

The transcription service of the Walter Biddick Co., Los Angeles, Calif., including its own program productions and those for which it has the sales rights, has been extended to foreign countries. Fall sales have included purchases by stations in Panama, Mexico, Cuba, England, Canada, Australia, New Zealand and other countries.

STUDIOS FOR WFIL

Station WFIL, Philadelphia, has completed plans for the construction of a suite of modern, air-conditioned studios and offices to be located on the eighteenth (top) floor of the Widener Building, at Broad and Chestnut Streets.

Work on construction is to be rushed so that the new quarters will be ready for occupancy early in 1937, in time to commemorate the station's second anniversary. Horace Trumbauer, prominent Philadelphia architect, and Frank V. Becker, WFIL's chief engineer, who designed the general plans for the studios, are supervising building operations.

BALLANTINE BULLETIN

Ballantine Laboratories, Inc., Boonton, N. J., have recently issued Bulletin 1 on "Telephone Receiver Test Equipment." Contained in this bulletin is a complete discussion of the artificial ear, Type 502, and telephone receiver test equipment, Type 500A.

AEROVOX CATALOG

An enlarged and revised catalog has just been issued by Aerovox Corporation, 70 Washington St., Brooklyn, N. Y., and is now ready for distribution. Known as the Second Edition 1936 Catalog, this literature covers an extensive line of condensers and resistors for radio and allied applications. Many new condensers are announced. A copy of the catalog may be obtained from the local Aerovox jobber or by writing the company direct.

CENTRALAB CATALOG

A new catalog on controls, resistors and selector switches has just been issued by Centralab, 900 East Keefe Ave., Milwaukee, Wis. Of particular interest with regard to selector switches are the Isolantite switch sections for use in short-wave and ultra-short-wave work. Also of interest are the midget replacement controls for auto-radio receivers. This catalog may be obtained from the above organization.

ADAMS JOINS ASSOCIATED CINEMA

Larry Adams, Hollywood sound engineer, this month became affiliated with the technical staff of Associated Cinema, Hollywood transcription organization.

"KENYON ENGINEERING NEWS"

Vol. 1, No. 1 of *Kenyon Engineering News* will make its appearance at an early date. This monthly publication, which will be edited by J. B. Carter, is to be devoted entirely to the amateur, sound technician and experimenter. The first issue will feature, among other things, the following: a new combination mixer and preamplifier; tone equalization; audio amplifiers; modulation improvements in transmitters, and four handy engineering data charts, known as Ken-O-Grafs.

Kenyon Engineering News is published by the Kenyon Transformer Company, 840 Barry Street, New York, N. Y.

RECTOX BOOKLET

A new 12-page booklet (B-2078), describing the selection and application of Rectox copper-oxide rectifiers for changing a-c to d-c without moving parts or chemical reaction, is announced by Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. The Rectox is finding an increasing use for supplying d-c power from an a-c source for industrial applications such as operating d-c brakes, control elements, fire alarms and signal and communication systems, battery charging, electro-plating, metering and many others. The booklet may be secured without cost.

"PERPETUAL CATALOG"

A "Perpetual Catalog" on transformers for sound engineers and radio amateurs has recently been issued by the General Transformer Corporation, 500-532 S. Throop St., Chicago, Ill.

Upon request the above organization will mail direct any additions and changes to this catalog as issued . . . or send additional forms. These supplementary forms may be easily inserted in the same binding.

Complete technical information on the GTC line of transformers is contained in this catalog. The price is 20 cents.

U. S. RUBBER PRODUCTS MANUAL

The United States Rubber Products, Inc., 1790 Broadway, New York City, is issuing a new handy manual—"Laytex, The New Dielectric in Communication and Control Wires and Cables"—for use by engineers, contractors and designers when specifying wire and cable installations for signal and control service.

The manual gives detailed information, graphs and tables indicating the characteristics and proper uses of the various types and gauges of "U.S." Laytex insulated communication cables, fire-alarm and police-signal cables, supervisory control cables, telephone cable, outside telephone wire, inside telephone wire, and emergency telephone wire.

INDEX TO ADVERTISERS

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912 AND MARCH 3, 1933, OF COMMUNICATION & BROADCAST ENGINEERING

Published monthly at New York, N. Y., for October 1, 1936.

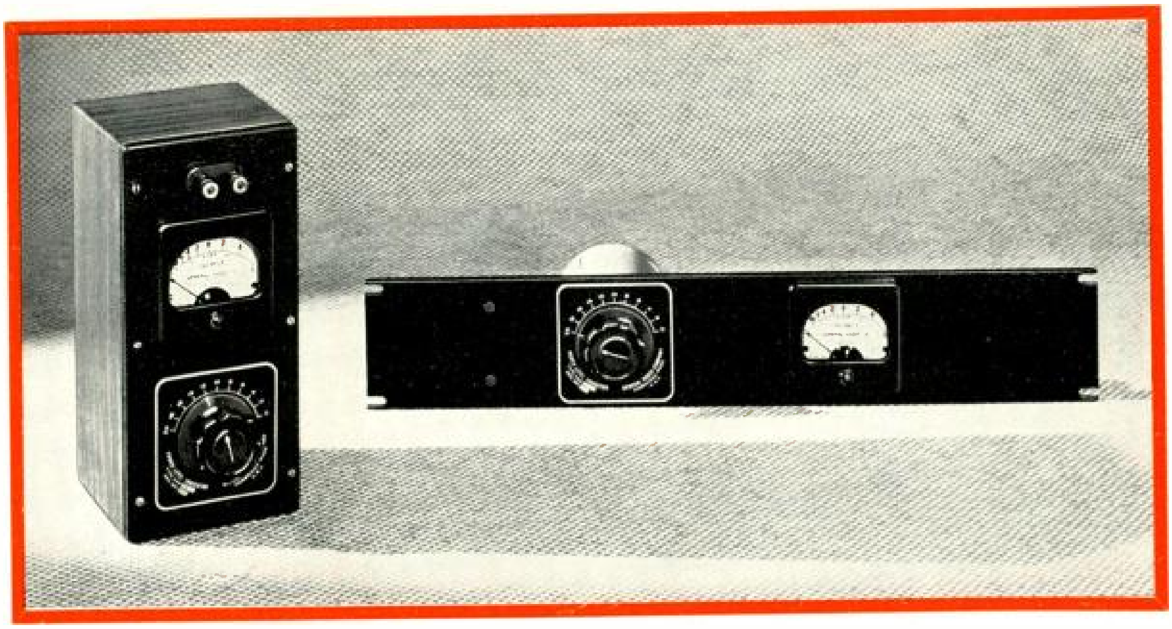
State of New York,
County of New York, } ss.:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of COMMUNICATION AND BROADCAST ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York. Editor, Ray D. Rettenmeyer, Madison, N. J. Managing Editor, None. Business Manager, B. S. Davis, Ghent, N. Y. 2. That the owners are: Bryan Davis Pub. Co., Inc., 19 East 47th St., New York, N. Y.; B. S. Davis, Ghent, N. Y.; J. C. Munn, Union City, Pa.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given: also, that the said two paragraph's contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustee, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me this 26th day of September, 1936.
(Seal) J. A. WALKER, Notary Public.

Queens Co. Clk's No. 3149, Reg. No. 7476.
New York Co. Clk's No. 831, Reg. No. 7-W-514.
Commission expires March 30, 1937.



NEW Power-Level Indicators

RECTIFIER-TYPE METERS as power-level indicators were developed and introduced by General Radio Company several years ago. General Radio now announces its latest line of improved power-level indicators which have been developed after an extensive survey of the requirements of the broadcast, motion picture and public address system fields.

Features of these new indicators include:

- High Accuracy—error less than 0.2 db.
- Ruggedness—simplified construction—ceramic insulated resistors.
- Compactness—rack model requires only three and one-half inches.
- High-Speed Meters—on the -DM and -DR models.
- Attractiveness—designed to match other station and studio equipment in neatness.
- Enclosed Multiplier Switch—contacts protected—multiplier adjustable in 2 db steps over range of 20 db.

These indicators are available in two models. One, the DR and DM, has a power-level range of −10 to +26 db. The ER and EM model, equipped with a normal speed meter, has a range of −20 to +16 db.

Type 586-DR—Relay-Rack Model	$55.00*
Type 586-DM—Cabinet Model	55.00
Type 586-ER—Relay-Rack Model	60.00*
Type 586-EM—Cabinet Model	60.00

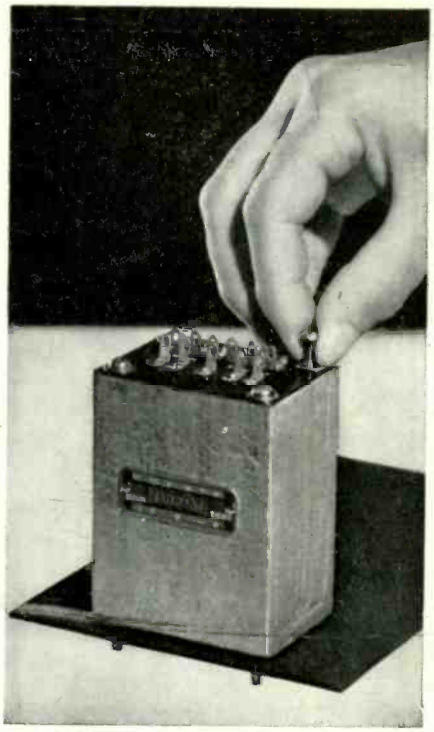
*These can be supplied with panel finish to match Western Electric or RCA gray, or RCA flat black, $4.00 additional. Standard models are G-R black crackle finish.

WRITE FOR BULLETIN 70-K FOR COMPLETE DATA

GENERAL RADIO COMPANY

30 State Street Cambridge, Massachusetts

Announcing 2 *entirely* NEW TRANSFORMERS *by* FERRANTI



Series B ± 1/2 db. 30 to 16,000 cycles
Case 2 1/4" x 1 7/8" x 3 5/8" h.
Mntg. 2 1/8" x 1 3/8"

Series A ± 1 db. 30 to 12,000 cycles
Case 2 3/4" x 2 1/8" x 3" h.
Mntg. 2 1/4" x 1 3/4"

Mirror illustrates New Sub-Panel Mounting

FEATURES . . .

1. 90 New Transformers in All
2. New Low Prices
3. New Designs Throughout
4. Latest High Fidelity Standards
5. New Self Shielding Core Type Construction
6. Free from Hum and Pickup
7. New Reversible Through-Type Mountings
8. No Waste Space for Mounting Flanges or Feet
9. Electrostatic Shields Between Windings
10. Small in Size
11. Light in Weight
12. Exceptionally Low Insertion Loss
13. Moisture-Proof Construction
14. Available for Immediate Shipment from Stock
15. Designed and Manufactured in the United States

The "A" Series is the lowest priced self-shielding transformer available . . . New straight-through mounting on both series, plus self-shielding enables units to be actually mounted against each other . . . no waste space . . . every unit designed for either top or subpanel mounting.

SEND FOR COMPLETE LISTING.

FERRANTI ELECTRIC, INC.

30 Rockefeller Plaza, New York, N. Y.