Communication and Broadcast Engineering

VOL. [illegible] NO. 2

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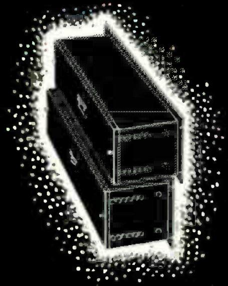

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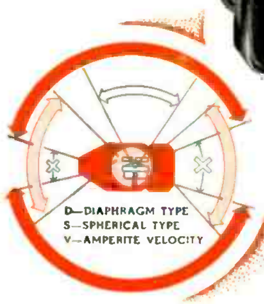

* Diagram shows angle of pickup without frequency discrimination of various types microphones.

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EDITORIAL

SIGNAL-TO-NOISE RATIO

DURING THE PAST few years a great deal has been heard about high-quality programs and as a result much effort has been expended towards improving the signal-to-noise ratio. Radio has certainly progressed to the point where even more conscientious effort must be directed towards improving broadcast transmissions.

At the present time serious consideration is being given to receiver noise-elimination systems, to transmission systems employing volume contracting at the transmitter and a volume expander at the receiver, to higher transmitter powers, to single-sideband transmission, and to pre-distorting—restoring systems . . . to mention a few.

An interesting system for eliminating noise at the receiver was described by James Lamb in the February issue of QST. Briefly this system amplifies peaks of noises which exceed the signal amplitude at radio frequencies, rectifies them and uses this rectified voltage to control the gain of a subsequent i-f stage. This results in the final i-f stage being blocked for the duration of the noise pulse. This noise-elimination system has some very interesting possibilities, especially for short-wave reception and in point-to-point services; it is most effective on interference having a high amplitude of short duration. However, due to the fact that the noise amplitude must exceed the amplitude of the signal, it would appear that this noise-elimination system would make a fair program out of an unlistenable one, but not necessarily a good program out of a fair one.

Volume compressing-expanding systems were discussed in COMMUNICATION AND BROADCAST ENGINEERING'S editorial for January, 1936. As was pointed out there considerable improvement in signal-to-noise ratio can be expected from such a setup. One system is in use on a longwave radiotelephone circuit between New York and London; phonographs with expanders are in use in both this country and abroad: and a radio receiver embodying an expander system has recently been announced.

Another and obvious method of improving signal-to-noise ratio lies in increasing the powers of transmitters. As a matter of fact, the Federal Communications Commission is expected to make a reallocation, setting several broadcast frequencies aside for assignments to stations desiring powers in the vicinity of 500 kilowatts. Several applications for construction permits for high-power stations have already been made to the Federal Communications Commission.

The possibilities of single-sideband transmission is receiving considerable attention. The advantages and disadvantages of this type of transmission are completely discussed on following pages.

Professor Alan Hazeltine, President of the Institute of Radio Engineers, spoke recently before the Emporium Section of the IRE. Part of Professor Hazeltine's paper dealt with unusual methods of increasing the signal-to-noise ratio. It is interesting to note that the possibilities of a pre-distorting—restoring system were pointed out in both that paper and in his inaugural address before the New York Section of the IRE.

It is well known that the percentage modulation of high-modulated frequencies, of the order of 5,000 cycles and upwards, is very small with usual amplitude-modulated systems. This obviously results in a poorer signal-to-noise ratio than would occur if the amplitude of the high-modulation frequencies were increased. In general, predistortion is intended to overemphasize the high audio frequencies before modulation in order that during transmission they will, in effect, be relatively deeply modulated. In the receiver, the high frequencies are attenuated to the same degree as they are emphasized in the transmitter. The result is a flat overall response characteristic for the entire system, but with the attendant advantage of improved signal-to-noise ratio. The greatest disadvantage of a system of this sort appears to be a greater possibility for crosstalk and monkey chatter in the adjacent channel.

All of the systems mentioned have their advantages and disadvantages. However, it seems logical to assume that the high-quality broadcast systems of the future will probably come from one of these systems, or from a combination of them.

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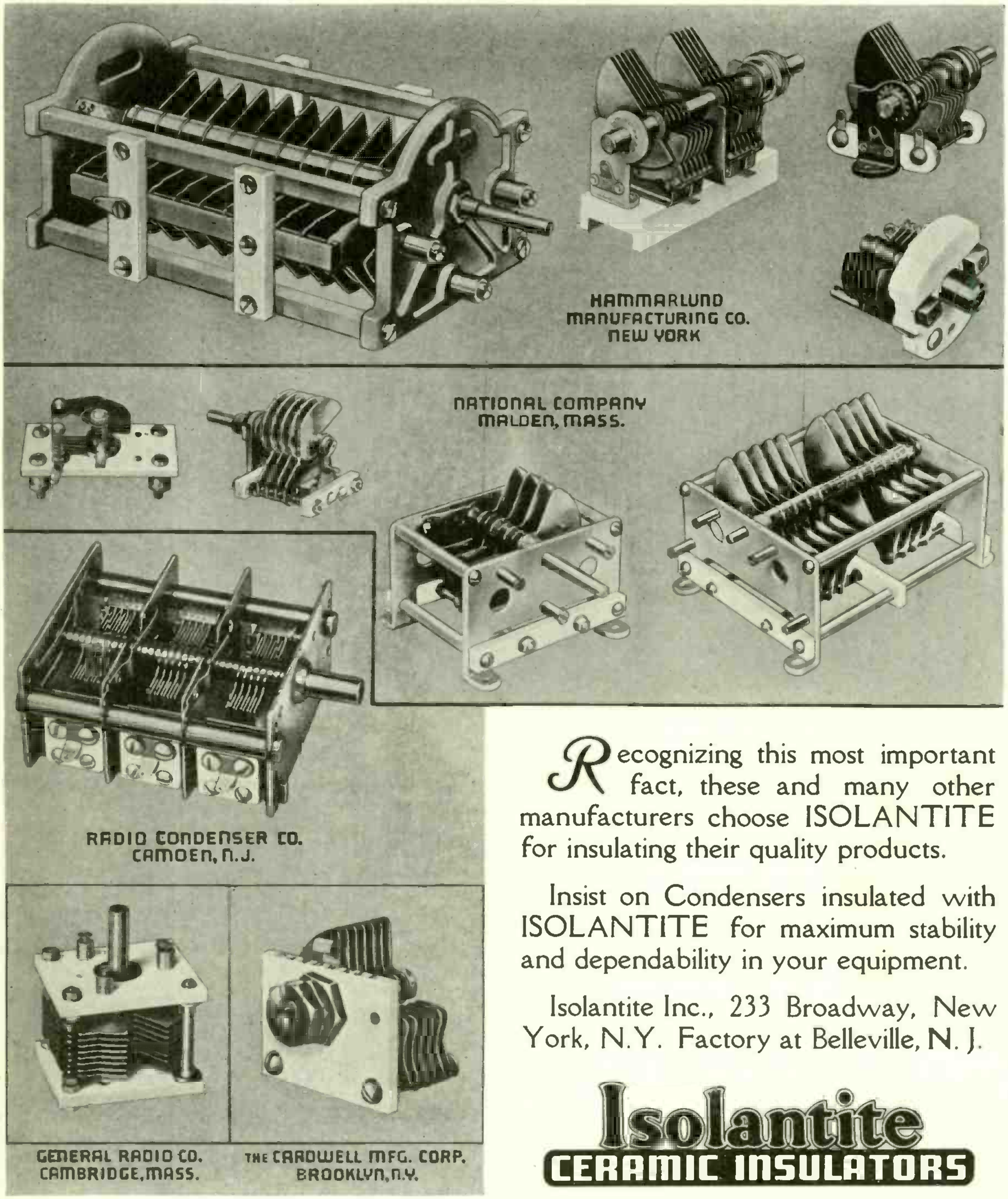

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THE DETECTION OF SINGLE-SIDEBAND WAVES

By CHARLES B. AIKEN

Associate Professor in Charge of Communications
Purdue University

THE ADVANTAGES of single-sideband telephony are being given increasing attention, and it seems likely that this method of transmission will be more widely used in the next few years. The reduction in bandwidth and the increase in signal strength which can be had with a given transmitter power are assets that will become steadily more important. The technical problems involved are gradually being ironed out, and the complexity of the apparatus required will doubtless become less as time goes on.

One of the interesting problems encountered in single-sideband work is that of detection, which differs in many ways from the one met in double-sideband systems. In the numerous papers which have been published on single-sideband operation, many comments have been made on the detecting process, but these are, for the most part, widely scattered, and deal entirely with the square-law detector. There appears to be a general feeling that the linear device is vastly inferior for the reception of such waves, but no theoretical examination of its performance seems to have been made.

In view of these facts, it seems worth while to review the analyses of the detection of single-sideband waves, and to extend the theory to cover the case of the linear rectifier.

TYPES OF SINGLE-SIDEBAND SYSTEMS

There are three cases to be considered: (A) the transmission of one sideband and a large amount of carrier, (B) the transmission of one sideband only, and (C) transmission of one sideband and a small amount of carrier. With all three of these it is possible to effect a saving of frequency space in the ether. The first has the advantage of simplicity, since no special requirements are imposed upon the receiver, but the increase in signal-to-noise ratio for a given transmitter power cannot be realized. In case B the latter advantage may be fully realized, but the receiving equipment is very much more complicated, since it is necessary to reintroduce the carrier and to control its frequency within very close limits. At short wavelengths this becomes an extremely difficult problem. Moreover, when the carrier is suppressed, it is impossible to use automatic volume control, which is a very serious drawback. In case C the carrier is so greatly reduced that practically the full output capacity of the transmitter may be devoted to the sidebands, and, consequently, an increase in signal strength is secured. At the same time, the carrier acts as a pilot frequency which can be filtered out at the receiver, amplified, and reintroduced into the signal channel at the proper level. Or, as an alternative, it may be made to hold in step a carrier-frequency oscillator in the receiver. Furthermore, this pilot carrier can be used to operate an automatic volume control. Obviously, then, case C has the greatest importance from a performance standpoint, but the complexity of the re-

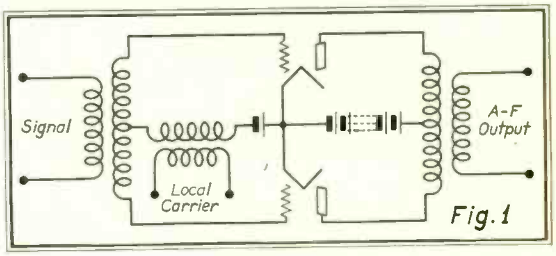


Fig. 1

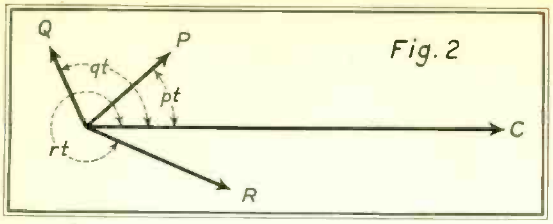


Fig. 2

ceiving apparatus is considerable. As time goes on, all three types of systems will, no doubt, be used for different classes of service, although it would seem that type B will hardly be applicable to the high radio frequencies.

DETECTION OF CARRIER-TRANSMITTED WAVE

When any high-vacuum rectifier is worked at sufficiently low levels, it can be made to act as a square-law detector. The audio-frequency output of such a device may be found by using an equation of the form

$$i = av^2 \qquad (1)$$

in which v is the voltage impressed upon the input of the detector and i is the a-c component of the output current. Let us now consider the reception of waves of types A and B when using a detector of this kind.

If the wave consists of a carrier and a single side frequency only, corresponding to modulation of the transmitter by a pure tone, we may express the signal wave as

$$v = C \cos \omega t + P \cos(\omega + p)t. \qquad (2)$$

The carrier frequency is $\frac{\omega}{2\pi}$, and the audio-modulating frequency is $\frac{p}{2\pi}$. It is evident from (1) and (2) that the only audio-frequency component of current in the output of the detector will be

$$i_p = aCP \cos pt. \qquad (3)$$

In contrast with the square-law detection of a double-sideband wave, no second harmonic is here generated. This fact seems to have occasionally led to the belief that a square-law device gives distortionless detection of a single-sideband wave. Such is hardly the case, as may be readily shown.

Suppose that the modulation of a transmitter consists of two tones simultaneously applied. We then have

$$v = C \cos \omega t + P \cos(\omega + p)t + Q \cos(\omega + q)t. \qquad (4)$$

When this is inserted in (1), the audio-frequency components of output current that result are

$$i_{a-f} = aCP \cos pt + aCQ \cos qt + aPQ \cos(p - q)t. \qquad (5)$$

In addition to the modulating radian velocities p and q, we have the tone of velocity p — q. If, for example, P, Q and C are all equal, this distortion tone will be as large in amplitude as are the desired tones. This, of course, represents an extreme case, but, for P and Q equal, the ratio of the distortion to one of the modulation-frequency amplitudes in the output will be $\frac{P}{C} = \frac{Q}{C}$.

If the transmitter were modulated 100 percent on the peaks and one sideband were removed, then P and Q would be 25 percent of the carrier and we should have a difference-tone amplitude of 25 percent of the fundamental, which would be extremely objectionable.

It is evident that in order to avoid rather serious distortion with the carrier transmitted, it will be necessary to use a relatively low modulation. An initial peak modulation of 40 percent would give a maximum difference tone of 10 percent of the fundamental P; while, if the difference tone were to be limited to 5 percent, the peak modulation would be only 20 percent. Evidently, for small distortion, low modulation is required, and this is unfortunate since it will result in a reduction of the effective signal strength.

When the transmitter is modulated 100 percent and one sideband is removed, the amount of intelligence carrying power (which is resident in the sidebands) is cut in half. However, if the bandwidth of the receiver is made half as great for the single-sideband case as it would be for the double sideband, the signal-to-noise ratio will be the same for the two systems, since the narrower band will accept only half as much noise energy. But if the modulation is reduced to prevent distortion, the single sideband will give a poorer signal-to-noise ratio. In order to avoid this difficulty, the large carrier required should be supplied at the receiving end.

THE SUPPRESSED-CARRIER CASE

When a system of type B is used, it is absolutely essential that a carrier be resupplied before detection. When this is done, distortion can be practically eliminated by using a sufficiently large carrier; and the difficulties involved are connected with holding this carrier at the proper frequency. One method of doing this, which has been described in a recent paper[1], involves the use of a partially suppressed carrier of amplitude considerably less than the maximum sideband amplitude.

When the carrier is suppressed or greatly reduced, the magnitude of the side frequencies which can be handled by the radio transmitter is considerably increased, and, consequently, the effective signal strength at the receiver is also increased. A single sideband, without any carrier, can have four times the amplitude of the individual bands of an ordinary wave, but since there are two of the latter, the output of the detector is one-half, rather than one-fourth, as great. If the reduction in noise with a narrower received band is taken into account, the improvement in signal-to-noise ratio should be $2\sqrt{2}$, or 9 db.

There is another advantage of single-sideband systems which has not so far been mentioned; namely, that the quality of detection is not affected by any shift in the phase of the carrier. As is well known, the situation is quite different in double-sideband work. In the latter, if the receiver is not tuned so that the carrier lies at the center of the received band, a certain amount of distortion will result because of the upsetting of the proper phase relations[2]. Single-sideband detection is entirely free from this difficulty, with the result that the improvement in signal-to-noise ratio may be more than 9 db as compared with a double-sideband system in which there is phase distortion.

THE BALANCED DETECTOR

When the carrier is resupplied to the receiver, it is

[1] "A Single-Sideband and Short-Wave System for Transatlantic Telephony," by F. O. Polkinghorn and N. F. Schleeck, Proc. I. R. E., vol. 23, pp. 701-718, July, 1935.

[2] "Carrier and Sidebands in Radio Transmission," by R. V. L. Hartley, Proc. I. R. E., vol. 11, pp. 34-56, Feb., 1923.

possible to eliminate the difference-tone distortion by employing a balanced detector such as is shown in Fig. 1. The plate current of each tube will depend upon the voltage applied to the grid of that tube in the manner described by (1). The signal voltages applied to the two grids are equal in magnitude and opposite in sign, while the voltage of the local carrier is of the same sign on both. The voltage applied to the upper tube may be represented by

$$v = C_o \cos(\omega t + \theta) + C \cos \omega t + P \cos(\omega + p)t + Q \cos(\omega + q)t, \qquad (6)$$

while that applied to the lower grid will be

$$v = C_o \cos(\omega t + \theta) - C \cos \omega t - P \cos(\omega + p)t - Q \cos(\omega + q)t. \qquad (7)$$

The audio-frequency output current flowing through the upper half of the output transformer may be obtained by inserting (6) in (1). This gives

$$i_A = a[C_oP \cos(pt + \theta) + C_oQ \cos(qt + \theta) + PQ \cos(p - q)t + CP \cos pt + CQ \cos qt]. \qquad (8)$$

Because of the negative signal voltage on the lower grid, the audio-frequency components of the output current of the lower tube will be

$$i_B = a[- C_oP \cos(pt + \theta) + C_oQ \cos(qt + \theta) + CP \cos qt + CQ \cos qt + PQ \cos(p - q)t]. \qquad (9)$$

Since the currents flow in opposite directions in the two halves of the output transformer, the voltage which is induced in the secondary will be proportional to $i_A - i_B$.

$$i_A - i_B = a[C_oP \cos(pt + \theta) + C_oQ \cos(qt + \theta)]. \qquad (10)$$

It is to be noticed that the distortion component $(p - q)$ is entirely lacking. Moreover, the audio frequency due to beats between the sideband frequencies and the received carrier C is also absent; and hence the output currents are not affected by the presence of this carrier. Even if the two carriers differ in frequency, there will be no undesirable beating effects in the output, but only a distortion due to a frequency shift of the program. It is evident, then, that there is considerable advantage to be gained by using a balanced detector in receiving single-sideband transmissions, provided a local carrier is employed at the receiver.

A balanced detector is of no value when a local carrier is not used. In fact, from the foregoing discussion it is evident that in such a case there would be no output at all from the detector. If, however, a transformer were inserted in the common plate return, the frequencies $\frac{p}{2\pi}$ and $\frac{q}{2\pi}$ would be obtained, but so would $\frac{p-q}{2\pi}$. In the case of the detection of a double-sideband transmission, the same considerations apply, and consequently only unbalanced detectors are used.

DETECTION OF A SINGLE-SIDEBAND BY A LINEAR RECTIFIER

It has often been pointed out that a linear rectifier is inferior to the square-law device for the detection of a single-sideband transmission, since with the former we do not have the freedom from second-harmonic audio output, which is characteristic of the latter. However, the fact remains that a linear detector is inherently more efficient as an r-f to a-f converter than is the square law, and consequently it is of interest to see just how much worse it is in single-sideband work. While examining the distortion which is to be obtained from such a detector, we may also look into the question of the interfering effects of unwanted transmissions. In order to handle this dual problem, let us suppose that we have impressed upon the input of the rectifier four frequencies, one of which is a good deal larger in amplitude than any one of the other three. The largest amplitude will be that of the carrier (either received or locally supplied), while the other three frequencies may be parts of the desired sideband or of some interfering transmission, as the case may be. The total signal can be written as

$$v = C \cos \omega t + P \cos(\omega + p)t + Q \cos(\omega + q)t + R \cos(\omega + r)t. \qquad (11)$$

In order to analyze the linear detection of these frequencies, we may use the artifice of combining all four into a single wave. This wave can be regarded as having a frequency $\frac{\omega}{2\pi}$, and will have a phase angle and an amplitude both of which are variable. However, it has been shown that the phase angle can be ignored without introducing any error whatsoever into the calculation of the rectified currents[3]. The variable character of the amplitude must, of course, be taken into account. In order to effect the combination of these four waves, let us refer to the vector diagram of Fig. 2. This represents the relation between the waves at some particular instant, C being taken as the reference vector. It is evident that the resultant of the four vectors will be equal to $\sqrt{V_x^2 + V_y^2}$, V_x and V_y being the sums of the projections of all four vectors on the x and y axes, respectively. Hence, we have for the resultant amplitude

$$V = \sqrt{(C + P \cos pt + Q \cos qt + R \cos rt)^2 + (P \sin pt + Q \sin qt + R \sin rt)^2}. \qquad (12)$$

We may now say that the wave applied to the detector is $v = V \cos \omega t$. The output of a linear rectifier under the action of such a wave is proportional to

$$V[1 - \frac{\pi}{2} \cos \omega t - \frac{\pi}{1 \cdot 3} \cos 2\omega t - \frac{\pi}{3 \cdot 5} \cos 4\omega t \ldots\ldots]. \qquad (13)$$

The terms such as $V \cos \omega t$, $V \cos 2\omega t$, etc., are all radio frequencies and are of no interest to us, but the term V is, since it contains all of the audio frequencies present in the output of the detector. Therefore, our problem is to extract these frequencies from V, and when we have done this we shall be able to see what the dis-

[3]Appendix B of "Theory of the Detection of Two Modulated Waves by a Linear Rectifier," by C. B. Aiken, Proc. I. R. E., vol. 21, pp. 601-629, April, 1933.

Table

	1	2	3
$\frac{E_{2p}}{E_p}$	0	$\frac{CP}{4A^2}$	$\frac{P}{4C}$
$\frac{E_{p-q}}{E_p}$	$\frac{Q}{C}$	$\frac{Q}{C} - \frac{CQ}{2A^2}$	$\frac{Q}{2C}$
$\frac{E_{p+q}}{E_p}$	0	$\frac{CQ}{2A^2}$	$\frac{Q}{2C}$
$\frac{E_{q-r}}{E_p}$	$\frac{QR}{CP}$	$\frac{QR}{CP} - \frac{QRC}{2A^2P}$	$\frac{QR}{2CP}$
$\frac{E_{p+q-r}}{E_p}$	0	$\frac{QR}{2A^2}$	$\frac{QR}{2C^2}$
etc.			

tortion and interference effects are. Let us, therefore, proceed to the analysis of V.

If in (12) the indicated squaring operations are performed and triogonometric formulas are used to simplify the result, there is obtained

$$V = [C^2 + P^2 + Q^2 + R^2 + 2CP\cos pt + 2CQ\cos qt + 2CR\cos rt + 2PQ\cos(p-q)t + 2PR\cos(p-r)t + 2QR\cos(q-r)t]^{1/2}. \quad (14)$$

We may note the interesting fact that terms in $(p - q)$ etc., appear here, but that there are no terms in $(p + q)$.

Now, for convenience, let

$$A^2 = C^2 + P^2 + Q^2 + R^2, \quad (15)$$

and

$$x = CP\cos pt + CQ\cos qt + \ldots\ldots\ldots . \quad (16)$$

Then

$$V = \sqrt{A^2 + 2x}. \quad (17)$$

Now, in order to find what frequencies are contained in (17), let us apply the binomial theorem to the expansion of the radical. If this process is to be mathematically valid, A^2 must be greater than $2x$ at all times, and consequently we must have

$$\frac{C^2 + P^2 + Q^2 + R^2}{2} > C(P + Q + R) + PQ + PR + RQ. \quad (18)$$

From this it can be shown that if P, Q and R are all equal, no one of them should be more than 15.5 percent of C. If R is zero and P and Q are equal, then no one of them should be more than 25 percent of C. However, some work has been done which shows that these limits can be somewhat extended without any great error.

The binomial expansion of (17) gives

$$V = A\left[1 + \frac{x}{A^2} - \frac{x^2}{2A^4} + \frac{x^3}{2A^6}\ \ldots\ldots\ldots\right] \quad (19)$$

If, now, the value of x is substituted into (19), a very lengthy equation results. From this can be extracted terms giving the amplitudes of the various voltages acting in the output circuit. The result is

$$v_p = \left[\frac{CP}{A} - \frac{CPQ^2}{2A^3} - \frac{CPR^2}{2A^3}\right]\cos pt\ ,$$

$$v_{2p} = -\frac{C^2P^2}{4A^3}\cos 2pt\ ,$$

$$v_{p-q} = \left[\frac{PQ}{A} - \frac{C^2PQ}{2A^3} - \frac{PR^2Q}{2A^3}\right]\cos\ (p-q)t\ ,$$

$$v_{p+q} = -\frac{C^2PQ}{2A^3}\cos(p+q)t\ ,$$

$$v_{2p-r} = -\frac{CP^2R}{2A^3}\cos(2p-r)t\ ,$$

$$v_{2p-q} = -\frac{CP^2Q}{2A^3}\cos(2p-q)t\ ,$$

$$v_{p+q-r} = -\frac{CPQR}{A^3}\cos(p+q-r)t\ ,$$

$$v_{p-q+r} = -\frac{CPQR}{A^3}\cos(p-q+r)t\ ,$$

$$v_{p-q-r} = -\frac{CPQR}{A^3}\cos(p-q-r)t\ ,$$

$$v_{2q-p} = -\frac{CPQ^2}{2A^3}\cos(2q-p)t\ . \quad (20)$$

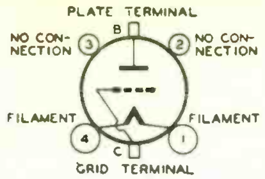
There are additional terms such as v_{2q}, v_{q-r}, etc., which can, if desired, be written down by using as patterns the terms which have been listed. In deriving the above expressions, terms in x were retained only up to the second power. When the relation between the amplitudes, which is imposed by the binomial expansion, is fulfilled, this gives results in which the error of any one frequency term is not more than about 5 percent for the fundamentals and for the important distortion frequencies. The error in terms of the nature of v_{p+q-r}, for which the sum of the exponents of p, q and r is 3, is a good deal larger, since the expansion of x^3 would contribute terms of these frequencies of the same order of magnitude. However, those that are listed serve as a rough measure of the size of these third-order terms.

Let us now compare the distortion components which appear in the output of the linear and the square-law detectors. In the accompanying table, the ratio of a given distortion component to the desired fundamental-frequency amplitude E_p is shown. The first column applies to the square-law rectifier, the second to the linear. The third column shows quantities to which the second column reduces if we use the approximation $C = A$. In writing down the values for the linear rectifier, only the important first terms of the amplitude of each frequency component have been retained. This avoids complication and enables us to get a fairly adequate picture of the relative performance of the two detectors.

From this table we can draw some useful conclusions. The principal distortion frequencies in the case of the square-law detector are E_{p-q}, E_{p-r}, and E_{q-r}. If $P = Q = R$, these are all of the same amplitude, namely, $\frac{P}{C}$. In the case of the linear rectifier, the approximate amplitude of each of these frequencies is one-half as large. However, this latter device gives another group of frequencies similar to those just considered, but having a plus sign in the subscript, and these are equally important. Consequently, we have twice as many important interfering tones, but all of them are of half the amplitude. We should expect the distorting value of these tones to be more or less proportional to the square root of the sum of the squares of their amplitudes, and, if this is the case, the distortion caused by a linear rectifier would be about 3 db less than that caused by a square-law rectifier. This is an interesting result, in that it shows that even for single-sideband work the linear detector is slightly the better of the two.

There are, of course, still other frequencies shown in the second and third columns which do not appear in the first, but, with the degrees of modulation which we are considering, these components are quite small. Consequently, it would seem that we may safely say that in the case in which no local carrier is used the linear rectifier is perhaps slightly better from the distortion standpoint, and it will, of course, be considerably better in point of conversion efficiency.

(*Continued on page* 16)

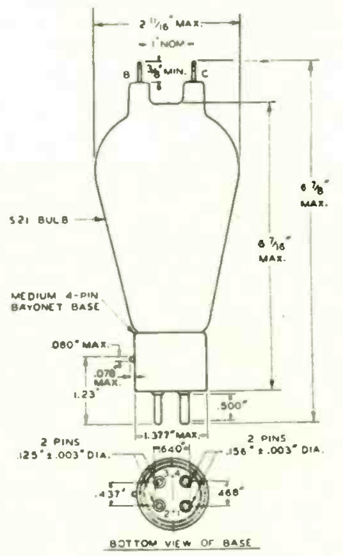


NEW HIGH-FREQUENCY TUBE

A NEW high-frequency transmitting tube, the RCA-834, has just been announced by the RCA Radiotron Division, RCA Manufacturing Co., Inc. This three-electrode tube is for use as a radio-frequency amplifier and oscillator. The grid and plate are supported from the top of the glass bulb by individual leads which are brought out of the tube through separate seals.

The RCA-834 may be operated at maximum ratings at frequencies as high as 100 megacycles; it may be operated at reduced plate voltage and input up to 350 megacycles. Maximum ratings and typical operating conditions of the RCA-834 are given in the accompanying table. The tentative characteristics are as follows:— Filament voltage (a-c or d-c), 7.5 volts; filament current, 3.25 amperes; and amplification factor, 10.5. The approximate direct interelectrode capacitances are:— Grid-plate, 2.6 mmfd; grid-filament, 2.2 mmfd; and plate-filament, 0.6 mmfd.

The highest percentage of maximum plate voltage and power input that can be used, for any class of service, is 100 max. for 100 mc, 75 max. for 170 mc, and 50 max. for 350 mc.



MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

As r-f power amplifier—Class B telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

D-C plate voltage	1250 max.	volts
D-C plate current	100 max.	ma
Plate input	75 max.	watts
Plate dissipation	50 max.	watts

Typical operation:

Filament voltage (a-c)	7.5	7.5	7.5	volts
D-C plate voltage	750.0	1000.0	1250.0	volts
D-C grid voltage (approx.)	-70.0	-90.0	-115.0	volts
Peak r-f grid voltage (approx.)	90.0	100.0	115.0	volts
D-C plate current	50.0	50.0	50.0	ma
D-C grid current (approx.)*	1.0	0.5	0	ma
Driving power (approx.)*[1]	3.3	3.1	3	watts
Power output (approx.)	11.0	16.0	20.0	watts

As plate-modulated r-f power amplifier—Class C telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

D-C plate voltage	1000 max.	volts
D-C plate current	100 max.	ma
D-C grid current	20 max.	ma
Plate input	100 max.	watts
Plate dissipation	35 max.	watts

Typical operation:

Filament voltage (a-c)	7.5	7.5	volts
D-C plate voltage	750.0	1000.0	volts
D-C grid voltage (approx.)	-290.0	-310.0	volts
Peak r-f grid voltage (approx.)	415.0	435.0	volts
D-C plate current	90.0	90.0	ma
D-C grid current (approx.)*	20.0	17.5	ma
Driving power (approx.)*	7.5	6.5	watts
Power Output (approx.)	42.0	58.0	watts

As r-f power amplifier and oscillator—Class C telegraphy

Key-down conditions per tube without modulation[a]

D-C plate voltage	1250 max.	volts
D-C plate current	100 max.	ma
D-C grid current	20 max.	ma
Plate input	125 max.	watts
Plate dissipation	50 max.	watts

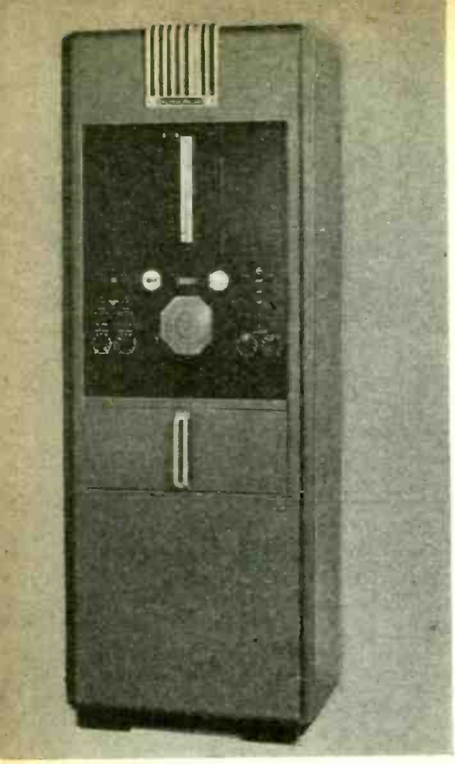
Typical operation:

Filament voltage (a-c)	7.5	7.5	7.5	volts
D-C plate voltage	750.0	1000.0	1250.0	volts
D-C grid voltage (approx.)	-175.0	-200.0	-225.0	volts
Peak r-f grid voltage (approx.)	300.0	325.0	350.0	volts
D-C plate current	90.0	90.0	90.0	ma
D-C grid voltage (approx.)*	20.0	17.5	15.0	ma
Driving power (approx.)*	5.5	5.0	4.5	watts
Power output (approx.)	42.0	58.0	75.0	watts

*Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should be capable of delivering considerably more than the required driving power.

[1]At crest of audio-frequency cycle with modulation factor of 1.0.

[a]Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.



A New Program

FRONT VIEW OF THE NEW PROGRAM SOUND SYSTEM.

ANNOUNCEMENTS MAY BE MADE THROUGH THE DESK MICROPHONE AND SOUND SYSTEM OR THROUGH THE BUILT-IN COMBINATION LOUDSPEAKER AND MICROPHONE DEVICE.

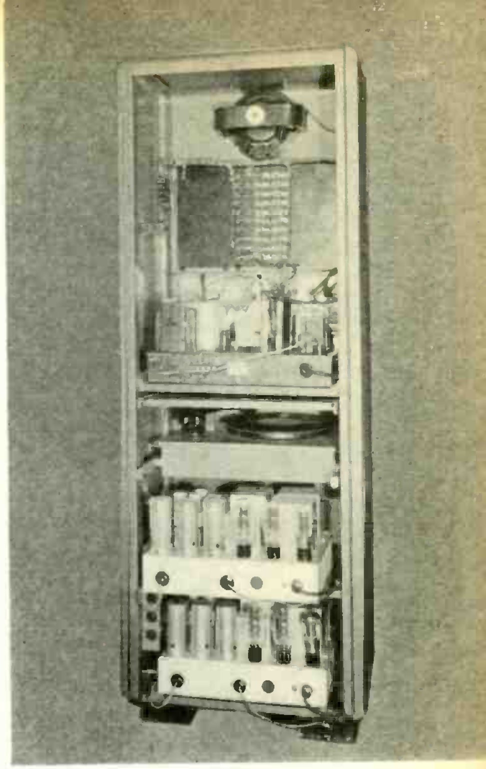
A NEW program sound system embodying unique advantages for sizable buildings has just been introduced. The system has been designed for distributing programs from microphones, from radio receivers or from phonograph records, and is wholly operated from a single cabinet. In the cabinet are centered all controls, the flexible switching arrangements, a radio receiver, an electric phonograph, amplifying equipment and a combination loudspeaker and microphone device. This cabinet also includes all the necessary wiring for interconnecting the various units and for supplying them with power. The complete system operates from 105-120 volts, 60-cycle a-c.

One feature of the system is that it provides "talk-back" facilities. Sound not only may be sent out for reproduction over distant loudspeakers but the same loudspeakers may in turn be used as microphones for picking up sound which is transmitted back to the central point. In many types of service, the "talk-back" feature has special importance, in that it offers a means for overhearing in the central office what is happening at any loudspeaker location.

Two variations of the program sound system are available, the first arrangement providing for a single program, and the second for the choice of two simultaneous programs. In the first case, one amplifier and in the second, two are used. Switching facilities include as many as 60 keys for controlling the loudspeaker or headphone extensions. These keys are mounted in groups of 20, and may be wired so as to control each extension individually or several extensions in groups, as required.

The radio receiver is of the high-fidelity type, employing metal vacuum

Sound System



BACK VIEW OF THE PROGRAM SOUND SYSTEM.

PROGRAMS MAY BE DISTRIBUTED FROM THE RADIO RECEIVER OR FROM PHONOGRAPH RECORDS. THE RADIO RECEIVER IS OF THE HIGH-FIDELITY TYPE AND HAS A FREQUENCY RANGE FROM 520 TO 23,000 KC.

tubes; it has a frequency range from 520 to 23,000 kilocycles, which, of course, includes not only the domestic broadcast stations, but also police, aircraft and amateur stations, as well as foreign broadcast stations. The receiver is equipped with a full-vision, four-section airplane-type illuminated dial. Only that section of the dial which corresponds to the tuning range in use is illuminated, the choice of the tuning range being controlled by a switch which also adjusts its respective antenna circuit. Automatic volume control eliminates to a great extent the fading of foreign short-wave stations.

The two-speed phonograph, which plays standard 10- and 12-inch lateral-cut records, is mounted in a retractable drawer. This may be pulled out for convenient operation or closed up flush with the front of the cabinet as desired. The cabinet is 5 feet 4 inches high, 2 feet wide and 16 inches deep, and its exterior has been designed along modernistic lines so as to present an attractive appearance.

Besides the built-in microphone facilities, additional microphones may be located in offices or nearby halls or ballrooms as required. Controls are arranged so that announcements may be made over any one or any group of loudspeakers or, in emergency, over all of them regardless of whether they are turned on or off at their respective locations.

This program sound system, which has been introduced by the Western Electric Company and designed by the Bell Telephone Laboratories, meets the requirements of business and manufacturing organizations, public buildings and institutions, and other places where public-address or other sound facilities are desired.

Balanced Amplifiers

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA Institutes, Inc.

I. INTRODUCTION

THE BALANCED AMPLIFIER, or as it is more popularly known, the push-pull circuit, was invented by Colpitts, but the use of this circuit dates back to the development of the double-button carbon microphone, at which time its ability to cancel out the even-order modulation products of two non-linear resistances was first recognized.

It was first developed for Class A operation of vacuum tubes, and in inverse connection, as a frequency doubler. Later on its suitability for Class B and AB operation in audio work began to be appreciated, and today this circuit is finding wide application not only in these fields, but also in the fields of detection, modulation, etc.

As is often the case, the analysis of this circuit was not fully developed until quite recently, and it is believed that much of the material offered here is new and original. To the best of the author's knowledge, the earliest analysis correctly given was that contained in an unpublished report by Dr. C. J. Travis on August 18, 1932, and the methods outlined there have been incorporated in this article through the kind permission of the RCA License Laboratory. In addition, independent work has been done by Kilgour[1] and Thompson[2], and the reader is referred to the articles cited below.

The balanced circuit may be resistance or transformer coupled. In the former case it functions as two single-side amplifiers connected in series cumulative for odd-order modulation products, and series opposition for even-order products. In the case of the transformer-coupled type, however, an additional factor enters in, and this is the coupling between the plate circuits of the two tubes through the mutual inductance existing between the two halves of the primary winding. The analysis is therefore more involved, and will be treated in detail here.

[1]Electronics, March, 1933.
[2]Proc. IRE 21, p. 591 (1933).

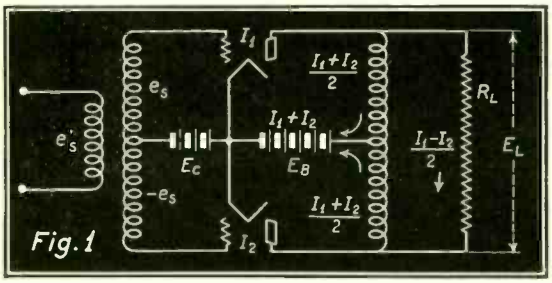


Fig. 1

II. PHYSICAL ANALYSIS

In Fig. 1 is shown this type of circuit. Instead of an output transformer, an output choke is shown. This may be considered a 1:2 auto-transformer, and for the present may be regarded as an ideal transformer, i.e., as having unity coupling, zero ohmic resistance, negligible magnetizing current and no distributed capacity. An actual transformer approximates the ideal transformer over a frequency range depending upon the excellence of its design. The load resistance R_L is called the plate-to-plate resistance, and is the reflected value which an actual load across an actual output-transformer secondary presents to the two tubes.

When a signal voltage e'_s is impressed across the primary of the input transformer, it induces equal and opposite voltages, e_s and $-e_s$, in the two halves of the secondary. Thus, assume the signal voltage acting in the grid circuit of the top tube is in a positive direction and thus opposite to the bias E_c, while that in the grid circuit of the bottom tube is in a negative direction and thus additive to E_c. As a result the top-tube current I_1 increases, while the bottom-tube current, I_2, decreases.

Previously, when only the bias and power-supply voltages, E_c and E_B, respectively, were acting, the two currents I_1 and I_2 were equal and flowing in opposite directions through the output choke. Now, when I_1 and I_2 are varying in opposite directions from their initially equal values, the output choke will allow the currents in its two half-windings to vary only if they are equal to each other at all times. It is clear from the diagram that the power supply must carry the sum of the two currents $(I_1 + I_2)$ at all times, hence each half of the output choke carries half of this current, or $\left(\frac{I_1 + I_2}{2}\right)$, as shown. If I_1 exceeds this amount, the difference, or

$$I_1 - \left(\frac{I_1 + I_2}{2}\right) = \left(\frac{I_1 - I_2}{2}\right) \qquad (1)$$

flows through R_L to the bottom of the choke, and thence combines with I_2 to flow up through the lower half of the choke to the power supply and thence back to the two tubes. If we add these two components, we obtain

$$I_2 + \left(\frac{I_1 - I_2}{2}\right) = \left(\frac{I_1 + I_2}{2}\right) \qquad (2)$$

which satisfies our initial assumption of equality of the two currents through the two halves of the choke.

The current through R_L is the load current, and was found to be $\left(\frac{I_1 - I_2}{2}\right)$. It sets up a voltage, E_L, across R_L of value

$$E_L = \left(\frac{I_1 - I_2}{2}\right) R_L \qquad (3)$$

From the figure it is evident that half of this voltage appears in the plate circuit of the top tube in a direction opposing E_B, while the other half appears in the plate circuit of the bottom tube as additive to E_B. The two plate voltages therefore vary in opposite directions from their normal value, E_B.

If we regard the arrangement as a four-terminal network, we can draw the following conclusions concerning its performance:

(a) An alternating signal voltage is impressed across its input terminals, whose magnitude may be considered as $2e_s$, a grid-to-grid voltage.

(b) An alternating output current $\left(\frac{I_1 - I_2}{2}\right)$ flows through the load R_L connected to its output terminals. This current may be considered a plate-to-plate current.

(c) An alternating output voltage E_L appears across its output terminals, and this voltage may be considered a plate-to-plate voltage.

Thus the input and output voltages and current are alternating in character, and the d-c voltages E_B and E_c are not apparent externally. Unfortunately, our primary information is that concerning the two tubes individually, and is in the form of a family of curves for each, which, for similar tubes, are identical. In addition, the foregoing analysis has provided this further information:

(a) The grid voltages vary oppositely from their common bias value and to equal degree, when an input signal is impressed.

(b) The plate currents vary oppositely from their common d-c value, and in the same direction as the respective grid voltages, but not necessarily to equal degree.

(c) The plate voltages vary oppositely from their common value E_B to equal degree, but in directions opposite to their respective grid voltages.

III. GRAPHICAL APPLICATION

This information is sufficient for a graphical analysis of the performance of the circuit. Thus, as shown in Fig. 2, we lay off our d-c components at the power-supply voltage, E_B, just as in the case of a single-tube stage. The two values are represented by I_{dc}. Now assume that a signal voltage $2e_s$ is impressed (grid-to-grid). One grid changes to a value $(E_c + e_s)$; the other to $(E_c - e_s)$ (where E_c is almost invariably in-

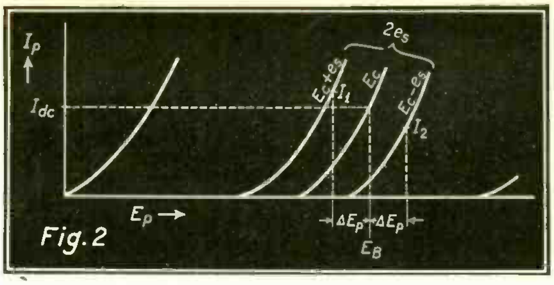


Fig. 2

herently negative). For some value of R_L, the plate voltage for the tube whose grid voltage is $(E_c + e_s)$ will drop by an amount ΔE_p, while for the other it will rise by the same amount ΔE_p. Lines projected up from the axis to the respective grid voltages at these two points represent I_1 and I_2, respectively. Then $(I_1 - I_2)$ represents twice the load current flowing through this particular value of R_L. The latter's magnitude can be found from the fact that

$$\frac{R_L}{2} = \frac{2\Delta E_p}{(I_1 - I_2)} \qquad (4)$$

For some other value of R_L, ΔE_p will be different, hence also I_1 and I_2. In particular, for a higher value of R_L, ΔE_p will be greater, and—as can be found by trial from the figure—$(I_1 - I_2)$ will be smaller. For R_L infinite, ΔE_p will have some finite value, and $(I_1 - I_2)$ will be zero, which checks with Equation (4). For R_L zero, $(I_1 - I_2)$ will have some finite value, but ΔE_p will be zero. If ΔE_p is chosen greater than the value for R_L infinite, $(I_1 - I_2)$ will come out negative. This means that R_L is now negative, i.e.—a source of energy—and is of no practical importance. In this way successive values of $(I_1 - I_2)$ may be had for corresponding values of $2\Delta E_p$, while $2e_s$ is the parameter.

If we now make the latter assume some other value, so that half of it represents a departure from E_c in one direction, and the other half represents an equal departure from E_c in the opposite direction, we can repeat the process outlined in the preceding paragraph, and obtain a new set of values for $(I_1 - I_2)$ and $2\Delta E_p$. This can be repeated until the desired range of $2e_s$ is covered.

A point worthy of note is that for small values of ΔE_p (low values of R_L) and large values of the parameter $2e_s$, the $I_p - E_p$ curve for $(E_c - e_s)$, will strike the E_p axis at a point higher than $(E_B + \Delta E_p)$, so that apparently I_2 cannot be determined. It must be remembered, however, that no curve of the family ends on the E_p axis, but continues from that point to the left along the axis. Hence we see that the above values of $2\Delta E_p$ and $2e_s$ merely mean that I_2 is zero under those conditions. This brings out the fact that if the grid swing is great enough, or R_L sufficiently small, each tube cuts off during alternate half-cycles. This mode of operation may be defined as Class AB (sometimes called Class A Prime). If $2e_s$ is not excessive, or if R_L is sufficiently great, neither tube's current cuts off, and this may be considered Class A. In addition we must note that cut-off also depends upon the operating point, which we shall for the moment assume is determined by I_{dc}.

The sets of values of $(I_1 - I_2)$ and $2\Delta E_p$ for various values of the parameter $2e_s$ may now be plotted on a separate sheet of paper as shown in Fig. 3. These give rise to a family of curves which may be considered the characteristics for the balanced circuit, and correspond to the families for the individual tubes. The difference, as noted previously, is that this family is for alternating voltages $2e_s$ and $2\Delta E_p$, and alternating currents $\left(\frac{I_1 - I_2}{2}\right)$, since the balanced circuit or four-terminal network is responsive to these only. We see that the larger $2e_s$ is, the greater are both $2\Delta E_p$ and $\left(\frac{I_1 - I_2}{2}\right)$ for a given load resistance R_L. It is also to be noted that for each set of operating values, E_c and E_B, a different family is obtained. As shown in the figure, the curves occupy the second quadrant, which is the only one of practical interest in the case of a passive resistive load. For reactive loads all four quadrants are involved due to the energy storage, and discharge in and from this type of load during different portions of the cycle of grid swing (assumed sinusoidal). This latter type of load, however, presents too many difficulties to be discussed here.

In a subsequent article it is intended to show that for parabolic tube characteristics, the curves of the above family are straight lines. For actual tubes, however, they may not be, but if they are essentially parallel to one another, at least over a certain range, and equidistant, the distortion products for a suitable value of R_L will be small. This will serve as a guide for R_L.

The optimum value of R_L for Class A operation is that

$$R_L = 2r_p \qquad (5)$$

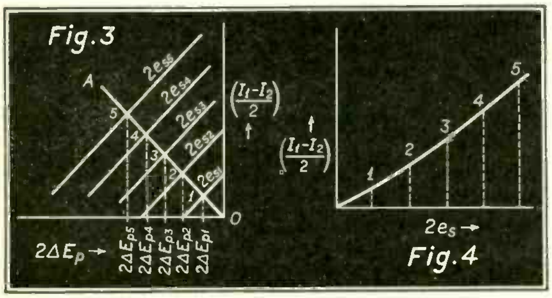
where r_p is the plate resistance at the operating point of either tube, the latter being assumed to have parabolic characteristics. For Class AB operation a good value is

$$R_L = 4r_p \qquad (6)$$

where r_p is the plate resistance of either tube at peak positive grid swing and for a value of tube current in the neighborhood of that to which it will rise for this value of R_L. Although this means that we have defined R_L in terms of itself, it will be found that r_p in this range does not vary much, and moreover the power output is not materially changed with nominal variation in R_L from the value set by Equation (6).

In case the positive grid swing is such as actually to drive the grid positive with respect to the cathode (sometimes called Class AB2), then a new consideration enters in, and that is that the minimum plate voltage at that instant should be from two to three times the amount by which the grid is positive with respect to the cathode. Since the minimum plate voltage is given by

$$E_p \min = (E_B - E_p) \qquad (7)$$



and the positive grid voltage, e, by the algebraic sum

$$e = (E_c + e_s) \qquad (8)$$

we can determine for $2e_s$ what $2\Delta E_p$ should be. This in turn will determine R_L.

Equation (4) indicates that the relation between $\left(\frac{I_1 - I_2}{2}\right)$ and $2\Delta E_p$ is linear. Hence, the load line for R_L is a straight line on Fig. 3, and passes through the origin. It may be determined in exactly the same manner as that for single-tube operation, and is shown in Fig. 3 as *AO* for the desired value of R_L. The intersections of *AO* with the various curves give the load current $\left(\frac{I_1 - I_2}{2}\right)$ and voltage ($2\Delta E_p = E_L$) for various values of grid swing $2e_s$ and for the chosen value of R_L. We can now plot $\left(\frac{I_1 - I_2}{2}\right)$ versus $2e_s$ and obtain the push-pull dynamic characteristic, as shown in Fig. 4. Corresponding points here are labelled as in Fig. 3. If the tubes are suited for this mode of operation, and the operating point is satisfactory, the characteristic obtained will be straight or nearly so. Actually, it occupies both the first and third quadrants, although it is evident that the plot in the third quadrant is the same as that shown in the first quadrant, only inverted, and hence has been omitted in the figure. As a result, only odd-order terms are present in the power series for the characteristic, and thus the circuit has eliminated the even-order terms in its output, which for a sinusoidal signal voltage, means suppression of the even harmonics. The plot of $\left(\frac{I_1 - I_2}{2}\right)$ versus time may now be made if the waveshape of $2e_s$ is known or assumed, and the former waveshape then analyzed for its sinusoidal components.

We can now plot the relation between the individual tube currents and their respective grid swings on Fig. 2, and thus determine the load line of R_L on each tube characteristic. Referring to Fig. 3, we see that when the grid-to-grid voltage is $2e_{s1}$, the plate-to-plate voltage is $2\Delta E_{p1}$; when the grid-to-grid voltage is $2e_{s2}$, the plate-to-plate voltage is $2\Delta E_{p2}$, and so on. Half of each plate-to-plate voltage is to be associated with each tube in the proper direction. Thus in Fig. 5 we repeat Fig. 2 and on it show half of $2\Delta E_{p1}$, $2\Delta E_{p2}$, etc., laid off on the E_p axis on either side of the quiescent voltage E_B. From these points lines are projected vertically to the curves having corresponding values for the grid parameter. In this way we obtain points 1, 1, 2, 2, 3, 3, etc. These represent at any instant the magnitudes of I_1 and I_2 in the respective tubes, or the values of the current in either tube for corresponding moments in the alternate half-cycles. According to the latter viewpoint, if we join these points by a smooth curve, we have the relation between the current in either tube and its grid voltage, i.e., the load line of R_L for each tube.

In general this load line will be curved, rather than straight, as is the case for a single tube, and—as shown in the figure—may cut off on the right-hand side of E_B (just beyond point 3). For parabolic characteristics, the load line will be a parbola, too, up to the point of cut-off. The reason for the curvature of the load line is that the tubes may be regarded as two generators connected in parallel to the load R_L through the output choke. The tubes may be regarded as generating equal voltages, and in the same direction for the above equivalent circuit, but as having internal resistances variable throughout the grid cycle, and in opposite directions. As a consequence, the division of load throughout the cycle will be unequal (except at the operating point, where they have equal internal resistances) and hence the impedance R_L reflected to either will be variable. Specifically, at the operating point. R_L appears as $R_L/2$ to either; beyond cut-off of either tube R_L appears infinite to it, and as $R_L/4$ to the other.

As indicated by Equation (4), the lines joining points 1 and 1, 2 and 2, etc., of Fig. 5 all make the same angle θ with respect to the E_p axis of value

$$\theta = \cot^{-1} \frac{R_L}{2} \qquad (9)$$

Moreover, it will be evident from the geometry of the figure that these lines will all be bisected by the E_B ordinate; that is, by the ordinate through the operating point, and projections $(2\Delta E_p)$ will be bisected by this ordinate, too. Accordingly, Kilgour[3] has suggested sliding a rule, at the angle given by Equation (9), along the paper so that the segment intercepted by equal grid curves to either side of E_C will be bisected by the operating ordinate. The intersection of the rule under this condition with each pair of curves gives the value of I_1 and I_2 immediately on the original tube family of curves, from which all other relationships may be plotted. This method has much to recommend it when R_L is known, as it avoids a great deal of labor; it will be used here for further work.

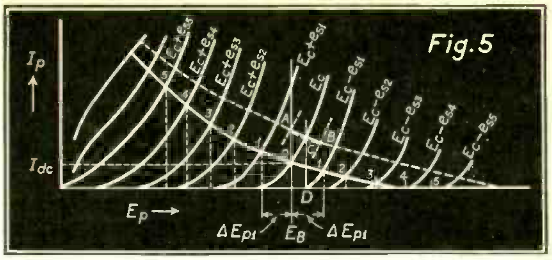
IV. CORRECTION FOR TUBE RECTIFICATION

In the general case of a tube with curved characteristics, the plate current—when a signal voltage is impressed upon the grid—contains not only a-c components, but often a d-c component in addition to the normal d-c component. The former d-c component may be additive to or subtractive from the latter. For curves concave upward—as in the case of a triode—the former is additive, and thus, under the impress of a signal voltage, the total d-c component will rise, so that the source of energy (the "B" supply) will be able to furnish all that is required for plate dissipation and output into R_L. This effect is known as self-rectification, and is more pronounced if the plate current reaches cut-off early in the grid signal-voltage cycle. For maximum power output from a tube, it is necessary to use large grid swings, and adjust R_L to a relatively low value, so that the self-rectification is, in general, large.

This additional d-c component flows through the low—and often negligible—resistance of the choke windings and "B" power supply, whereas the a-c components have to flow through R_L and the power supply. As a consequence, the operating point shifts not only away from the quiescent point, but also off the load line shown in Fig. 5, and hence the graphical construction just described must be corrected to obtain the true results.

To determine the new d-c component, we can plot either tube current against time by first assuming some time function for e_s—almost invariably a sine function,

[3] Loc. Cit.



for simplicity and for the purposes of standardization. The values of current for each value of e_s, for each angular interval of the cycle, can be found from Fig. 5. The resultant current-versus-time wave can then be analyzed by well-known methods to obtain the total d-c component.

An alternative method, which the author believes is labor-saving is to plot $(I_1 + I_2)$ as a function of time This is the current which flows through the power supply. For linear tubes $(I_1 + I_2)$ would remain constant for all values of e_s, and equal to the sum of the original d-c components $(2I_{dc})$. Due to the non-linearity of the tubes $(I_1 + I_2)$ pulsates above the value of $2I_{dc}$ at twice the frequency of the signal voltage. More accurately, it contains the even-order terms of the tube components, which terms do not get into R_L, but instead flow in parallel through the circuit. In particular $(I_1 + I_2)$ contains the zero-order terms of the tubes: that is, the additional d-c components. Hence, if it be plotted against time, the latter can be found by suitable analysis of this wave. The latter, due to its symmetry, need be plotted for only 90° of the grid-voltage cycle. The area can then be found and divided by the time base to get the average height, or d-c component. The latter is then divided in half to give the additional d-c component for each tube.

Once determined, it is added to the original d-c component vertically along the E_B ordinate, since the load line to it represents in general zero resistance. Thus, in Fig. 5, *OA* represents the additional d-c component added vertically along ordinate E_B to the original d-c component, I_{dc}. The load line for R_L must now pass through point *A*, but since this is on a tube curve for which the parameter is less than E_c, it is not the point about which equal signal swings can be taken. To find this latter point, a line at the angle θ given by Equation (9) is drawn, and where it intersects another curve of the tube family (point *B*) for which the parameter is as much more negative than E_c as that for the curve through *A* is less negative, is the complementary point to *A* on the new load line. The ordinate which bisects *AB* is the new one about which equal excursions of ΔE_p will be made, and where this ordinate intersects the E_c curve: namely, point *C*, is the value of plate current for which the instantaneous signal voltage e_s is zero. The rest of the load line can now be drawn either by the method described by Travis or the sliding-rule method of Kilgour. *A*, *B*, and *C* will be three points on this new load line.

It will be found that this new line approaches the slope for $\frac{R_L}{4}$ more slowly than the original one because the cut-off point is farther to the right, but due to the curvature of the tube characteristics, it will in general not meet the old one, but lie entirely above it. This, in turn, means that the peak current for peak grid swing will be greater, and hence also the power output, than before the correction. A new $(I_1 + I_2)$-versus-time wave can be drawn similar to the previous one, analyzed for still further d-c component, the latter added to that at the new operating point *CD* to give the total, and laid off along the E_B ordinate, and then the new load line found. The process—which is one of successive approximations—is repeated until no further d-c component is obtained. Usually three approximations are sufficient.

The result of these corrections is that a greater value of

$$\left(\frac{I_1 - I_2}{2}\right)$$

and power output is obtained, and—of equal importance—the increase of d-c component at the voltage E_B represents greater d-c power input from the power supply. If from this value we subtract the power output, we obtain the plate dissipation, and if this exceeds the maximum allowable for the tube, a higher value of R_L will be required, or a lower value of grid swing, or a greater bias E_c, or all three,

A further discussion of balanced amplifiers will appear in a following issue. This material, which is new and original, will include, among other things, a proof of the construction of the case of winding resistance in the output transformers, and a typical set of calculations made on the 6F6 tube.

THE DETECTION OF SINGLE-SIDEBAND WAVES

(*Continued from page* 8)

It has been pointed out that when a carrier is re-introduced in the receiver, there is an advantage to be obtained in using a balanced detector. If this is done, all of the distortion products disappear in the square-law case, while in the linear case the large amplitude components vanish, leaving only the smaller ones such as E_{p+q-r}. Terms of this type will remain, as well as others that are contributed by higher order portions of the expansion, which have here been neglected. Hence, it appears that the linear rectifier is, from a theoretical standpoint, slightly inferior. But when it is remembered that the magnitude of this residual distortion can be made extremely small, by using a sufficiently large local carrier, this objection is of no practical consequence.

EFFECT OF INTERFERING TRANSMISSIONS

Let us now consider the relative response of the two detectors to interference outside of the desired frequency band.

We shall assume that the desired station is modulated only by the radian velocity p, and that an interfering transmission removed from ω by a superaudible frequency interval contains two components, $\omega + q$ and $\omega + r$. Let us suppose that this interference gets through the selective circuits of the receiver and makes its presence known by giving a detector output component $q - r$. The importance of this interference will depend upon the ratio $\frac{E_{q-r}}{E_p}$. From the table we see that it is approximately half as great in the case of the linear rectifier as it is for the square law. Moreover, if we have a locally introduced carrier and a balanced detector, this type of interference is entirely eliminated.

This last consideration shows an outstanding advantage of the single-sideband suppressed-carrier system of transmission as compared with the ordinary double-sideband system. However, there must be set against it a disadvantage which may sometimes be troublesome. Suppose we are receiving a single-sideband on a receiver having exactly the correct bandwidth, and that there is another transmission in a channel whose edge is immediately adjacent to our desired carrier frequency. Frequency components lying in this interfering channel will be capable of beating with the desired carrier, whether the latter be transmitted or re-introduced at the receiver, to give interfering tones in the neighborhood of 1000 to 2000 cycles. These will be particularly objectionable because of the high sensitivity of the ear to such frequencies, and, to take care of this situation, additional circuits must be used to discriminate against the band immediately adjacent to the desired carrier frequency. Such circuits are, of course, unnecessary in the case of the usual double-sideband transmissions.

The operation of two or more single-sideband stations on the same frequency would give rise to very serious "flutter effects"[4] if systems of type A were used. The low modulation would make the desired program weaker, as compared with the noise flutter, than is the case in conventional shared-channel operation. However, if type B or C transmissions were employed, the flutter should very nearly disappear. This may be seen by reference to the section on the balanced detector, which shows that the audio-frequency output is independent of the incoming carrier. Since it is the heterodyning of the interfering carriers that ordinarily causes flutter, this very annoying form of interference might be eliminated by using single-sideband broadcasting.

[4] "The Effect of Background Noise in Shared-Channel Broadcasting," by C. B. Aiken, B. S. T. J., vol. 13, pp. 333-350, July, 1934.

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

NEW WESTINGHOUSE GRID GLOW TUBE

IMPORTANT ADVANCES in gaseous-discharge tube design have been made in the

new Westinghouse KU-676 tube. This tube has two new features: A built-in time delay for protection of the cathode when starting the tube and a new cathode design resulting in a high ratio of crest-to-average current rating. High ratios of crest-to-average current rating are especially important for such applications as welding timers, six-phase rectification and the like.

An outstanding feature of this tube is the structure of the cathode. The directly heated portion of the cathode is an edge-wound helix, which is closely surrounded by an indirectly-heated portion of perforated metal, coated only on the inside surface. The discharge is thus forced to pass through the perforations in the screen and then outward through the annular space between the screen and the first radiation shield. This construction has been developed with the object of electrostatically shielding the active surfaces of the cathode to such an extent that they are not subject to high field strengths and are also protected from excessive positive ion bombardment.

The current rating of the KU-676 tube is 6.4 amperes average and 75 amperes crest while the cathode heating energy required is only 55 watts.

NEW TRANSMITTER FOR WSAI

FOLLOWING THE ACTION of the Federal Communications Commission authorizing the transfer of WSAI's transmitter from Mason to Cincinnati, Ohio, the construction of a new transmitter plant, in the heart of the city, was started, according to Powel Crosley, Jr., President, Crosley Radio Corporation.

The site of the new station is in Clifton Heights, on the south side of Warner Street, between Chickasaw and Wheeler. One of the most modern and complete stations within its power classification will be built. New equipment of the very latest design is being installed throughout.

The plant will also include the latest single vertical-radiator type antenna; a 3-cornered, all-steel, 230-foot tower serving as the antenna. This tower is designed to withstand winds of 120 miles per hour.

The new transmitter plant, which is being erected under the direction of Joseph A. Chambers, WLW-WSAI Technical Supervisor, will be completed within a few weeks.

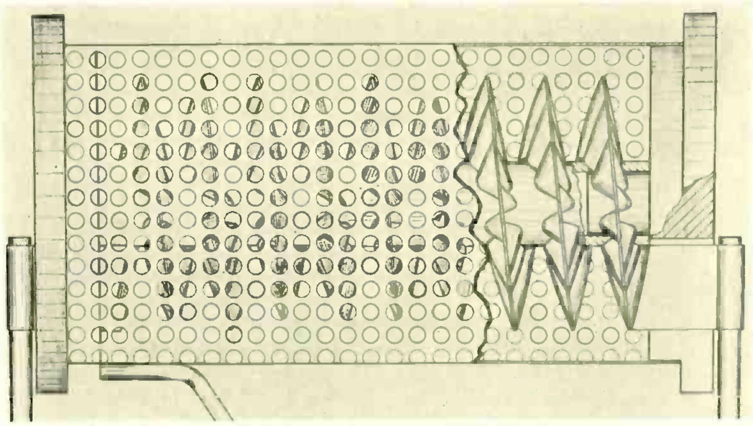
SOUND RECORDING ON GLASS

THE ELECTRICAL RECORDING of sound on glass discs is now being employed very extensively in the Netherlands, according to the Electrical Review, London. Recently, a demonstration of the making and playing of a record of this type (the "simplat") was given at the works of the V. G. Manufacturing Company, Ltd., Gorst Road, Chase Estate, Park Royal, London, N.W. 10.

Any ordinary electrical recording apparatus may be used for cutting the dics and, though a sapphire cutter lasting about sixty records is preferable, a steel needle may be used. A special non-inflammable composition on the glass receives the impression, a continuous non-sticky thread collecting round the center stud, clear of the cutting needle.

Immediate playing back is possible without any further treatment, but should the record be required to be used more than twelve times a simple hardening and polishing process, taking about five minutes, is desirable, this giving it a life of at least 150 runs. Viewed through a microscope the groove appears much clearer and more polished than that of any ordinary record.

Glass having scarcely any audible resonance of its own, a very wide frequency range and great volume are possible without distortion, and there is an almost complete absence of background noise. The records are not affected by climatic conditions and, it is claimed that the glass is not so breakable as the materials usually employed.



ILLUSTRATING THE CATHODE CONSTRUCTION OF THE WESTINGHOUSE KU-676 TUBE.

BOOK REVIEWS

WIRELESS TELEGRAPHY—Notes For Students, by W. E. Crook, Senior Wireless Instructor, Air Service Training, Ltd., published by Sir Isaac Pitman and Sons, Ltd., London, England (U. S. Representative, Pitman Publishing Corp., 2 West 45 *Street, New York City),* 189 *pages, price* $2.25.

This book is intended to be used as a student's notebook, it is intended as an accompaniment to suitable textbooks rather than as a textbook. The ground covered is that required for the Postmaster-General's Air License for Wireless Telegraphy Operators, and represents the theoretical part of the wireless course given for this purpose at Air Service Training, Ltd., Hamble, Southampton.

Only elementary mathematics have been introduced; but the student is expected to be able to manipulate the simpler algebraic expressions, to be familiar with Pythagoras's Theorem, and to know the trigonometric functions of an angle. Little beyond this is required, but the author feels that the student should be familiar with the basic ideas of mechanics, and possess clear conceptions of the meaning of such terms as force, work, power, energy.

Mr. Crook states that "It will probably be thought that the notes are too full in some respects and too sketchy in others. The author's defense against criticism of this kind is, first, that past experience in teaching wireless science has shown the importance of dealing more fully with certain parts, notably the earlier fundamental principles and, secondly, that the book has been prepared with the requirements of an examination constantly in view."

This book has value for reference purposes, and for the purpose for which it is intended has much to recommend it.

PHOTO-ELECTRIC AND SELENIUM CELLS, by T. J. Fielding, published by Instruments Publishing Company, Pittsburgh, Pa., 140 *pages, price* $1.75.

To attempt to cover in any detail all the varied applications of photoelectric cells in a 140-page book would, to say the least, mean the undertaking of an exceptionally difficult task. Logically the author of *Photo-Electric and Selenium Cells* originally set forth as his objective the provision of an introduction to the theory and use of light-sensitive cells from a practical standpoint. While much has been written on the subject of photoelectric cells and related phenomena, there has been little written for the practical man and experimenter in the field. This book treats its subject matter in a rather elementary manner.

Chapter I deals with the fundamentals of photoelectricity and includes certain historical data pertaining to the subject. The experiments of Hertz, Elster, Geitel, Hallwachs and others are discussed. The old type potassium cell is described and the advantages and disadvantages of selenium are outlined.

Chapter II is concerned with the building of selenium cells and goes into the matter quite thoroughly. Chapter III takes up the subject of amplification, while Chapter IV is concerned with the building of the amplifier.

Following chapters are devoted to: Photoelectric-cell response to different colors, the characteristics of sodium, potassium, rubidium and caesium being discussed; home experiments with light-sensitive cells; applications, such as, burglar alarms, automatic switching, shadowgraphs, and various control circuits; and television and talking pictures. The last chapter deals with the potentialities of photoelectric cells.

While this book will probably have little appeal for the expert and advanced student in this field, it does contain some excellent material for beginners and those interested in photoelectric-cell applications.

THE RADIO AMATEUR'S HANDBOOK, 1936 *Edition, by the A.R.R.L. Headquarters Staff.* 480 *pages, published by The American Radio Relay League, West Hartford, Conn., U.S.A. Price, paper binding.* $1.00 *postpaid in U.S.A. and possessions; elsewhere,* $1.15; *buckram binding,* $2.50 *in all countries.*

The present 1936 edition of the Radio Amateur's Handbook, published by The American Radio Relay League, is the completely revised and greatly enlarged successor to the previous series of 12 editions. In these nine years the Handbook has established itself the world over as the standard manual of amateur radio communication. The present edition actually constitutes an entirely new book, having a total of 21 chapters with an appendix of miscellaneous information and an exceptionally comprehensive topical index which makes quick reference easy.

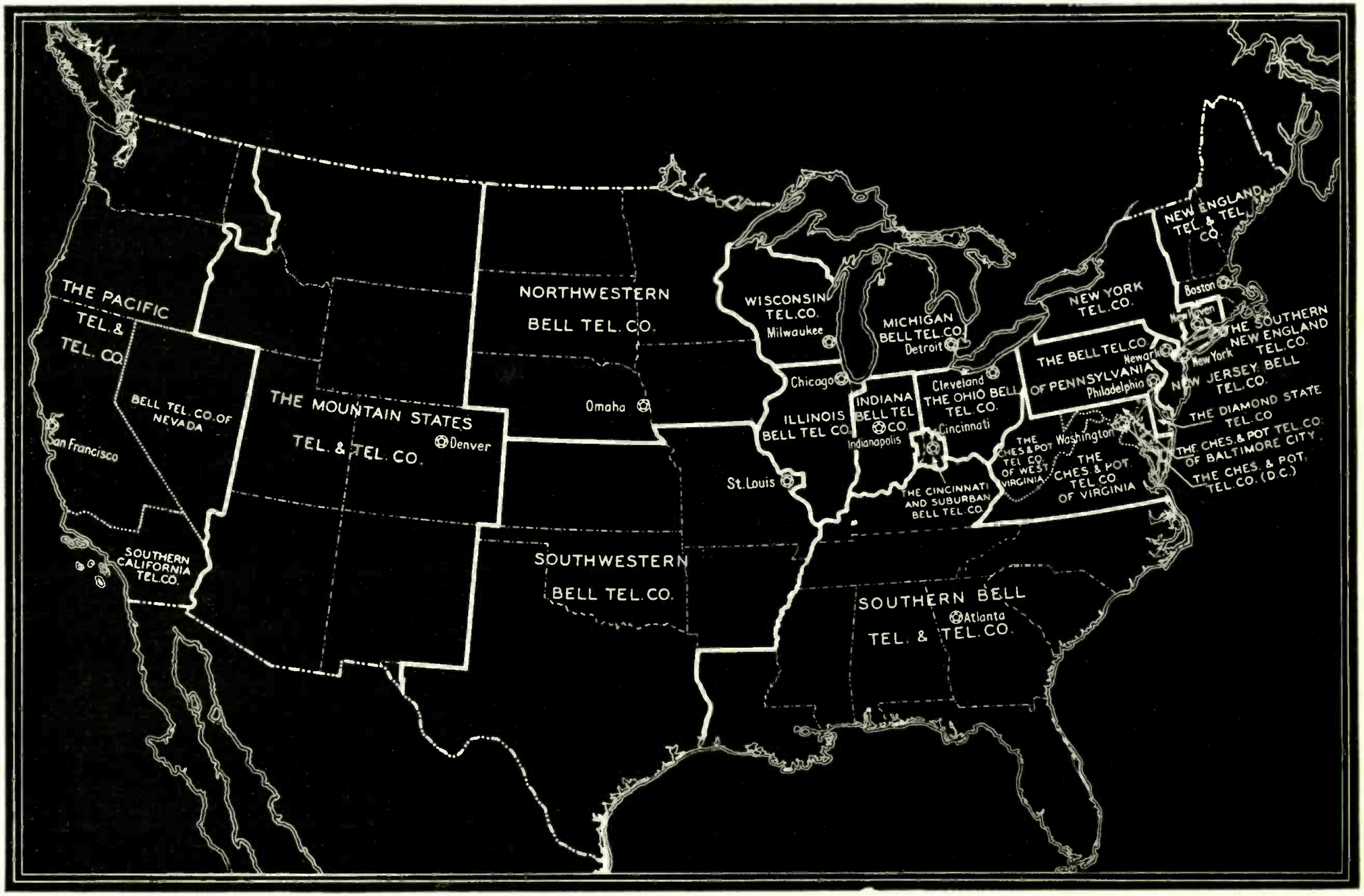
An entirely new 30-page chapter on vacuum tubes contains comprehensive tabulated tube data, including 10½ pages of rating and characteristic tables for all types of metal and glass receiving tubes, as well as for transmitting and special-purpose tubes, supplemented by practical information on operating characteristics determinations and applications. The new receiver design chapter contains a wealth of circuit features described in concise, practical detail. Modern receiver construction is given a separate chapter.

In the chapter devoted to transmitter design, the theoretical and practical considerations involved in transmitter circuits are given sectionalized treatment, while in the chapter on transmitter construction the very latest circuit developments of proven merit are exemplified. An enlarged chapter on keying methods is followed by a chapter on the principles of modulation and fundamentals of radiotelephony circuits, from microphones to controlled-carrier systems. The constructional chapter on radiotelephone transmitters gives design and operating details of successful types ranging from low to high power.

Ultra-high-frequency communication has two chapters devoted to it, telling how super-regenerative receivers work, and how to build them, describing superhets and the new super-infragenerator receiver. The u-h-f transmitter chapter is a practical treatment of proven circuits, from the simplest self-excited oscillator through linear oscillators, and oscillator-amplifiers.

Power supplies are treated in greater detail than ever, covering receiver-packs, voltage dividers, and supplies for grid-bias, as well as all the standard rectifier-filter equipment.

Antenna design is especially complete. Numerous charts facilitate the planning, from simple single-wire antennas to complex directional arrays; transmission-line design being given particular attention.



MAP No. 15--The Bell Telephone System (Territories of Associated Telephone Companies).

AVIATION SERVICE

THE TELEGRAPH DIVISION of the Commission has modified the rules governing the aviation service in several particulars.

All airport stations, unless specifically exempt, are required to maintain a continuous listening watch on the itinerant aircraft calling frequency, 3105 kilocycles, and are to be prepared to render a communication service at any hour of the day or night.

Equipment has been developed but has not yet been put into general use which will permit the simultaneous transmissions of radio range signals and voice. If facilities of this nature are installed at any airport and if satisfactory arrangements for the prevention of interference are made with adjacent airports, the Commission will give consideration to the adoption of an amendment to the rule so as to permit the continuous operation of runway localizer ranges during conditions of poor visibility, in lieu of the present requirement that stations transmit range signals upon request.

The Commission also definitely vested in the airport station the responsibility for communication with aircraft in the vicinity of an airport. The effect of the changes is to require that an airport station communicate only with aircraft within 10 minutes flight or 30 miles from the airport and require that all aircraft communicate with the airport station when within 10 minutes flight or 30 miles of the airport.

The Commission also modified the restrictions now placed on frequencies used by the aviation service in the 6000-7000 kilocycle band from "day only" to "unlimited upon the express condition that no interference is caused to the international mobile service."

The frequency 4335 kilocycles was withdrawn from availability for public aviation service and assigned for aeronautical stations of the Yellow Chain. The frequency 5310 kilocycles was assigned for aeronautical point-to-point stations of the Green Chain to be shared with stations of the same class of the Red Chain.

APPLICATIONS GRANTED FOR NEW STATIONS

Telegraph Division

December 3, 1935.

LOUIS C. HUCK, NC-15220, granted aviation-aircraft license, 3105, 3120 kc, 20 watts.

December 10, 1935.

CITY OF FLINT, Michigan, granted construction permit, portable-mobile, general experimental, 30,100 kc, 10 watts.

CITY OF HIGHLAND PARK, Michigan, granted 5 construction permits, mobile, general experimental, authority to communicate as municipal police in emergency service on an experimental basis (under exceptions of Rule 320), 30,100, 33,100, 37,100, 40,100 kc, 10 watts.

PACIFIC ALASKA AIRWAYS INC., Lake Minchumina, Alaska, granted construction permit, aeronautical point-to-point, 1638, 3082.5, 5692.5, 8220 kc unlimited; 1638, 2648, 3082.5; 4125, 8015 kc unlimited; 6570 kc day only; 20 watts.

CITY OF LOS ANGELES, California, Police Department (Los Angeles County), granted construction permit and license, portable, special emergency service, 2726, 3190 kc, 50 watts.

CITY OF MANCHESTER, New Hampshire, Police Department, granted construction permits (3 applications), portable-mobile, special emergency service, 30,100 kc, 5 watts.

CITY OF SAGINAW, Michigan, granted construction permits for 4 general experimental stations, 30,100 kc, 10 watts.

CITY OF BURLINGAME, California, granted construction permits (2 applications), mobile, general experimental, 30,100, 33,100, 37,100, 40,100 kc, 5 watts.

HUMBOLDT COUNTY, Eureka, California, granted construction permit, emergency municipal police, 2422 kc, 100 watts.

AERONAUTICAL RADIO INC., Burbank, California, granted construction permit, aviation-aeronautical, 2906, 5692.5 kc, 400 wats.

R. R. M. CARPENTER, NC-2OY, granted license, itinerant aircraft, 3105, 3120 kc, 7 watts.

HANFORDS TRI-STATE AIRLINES INC., NC-2875, granted licenses for itinerant aircraft (8 stations), 5887.5 2994, 3105 kc, 50 watts.

December 17, 1935.

CITY OF GRAND RAPIDS, Michigan, granted construction permit, portable-mobile, general experimental, 37,100 kc, 10 watts.

CITY OF EL PASO, Texas, granted construction permit, mobile, general experimental, 33,100, 37,100 kc, 15 watts, unlimited time.

WILLIAM H. WINEAPAW, NC-159-V, granted license, itinerant aircraft, 3105 kc, 10 watts.

CITY OF JACKSONVILLE, Florida, granted construction permit, mobile, general experimental, 30,100, 33,100, 37,100, 40,100 kc, 5 watts.

CITY OF PIEDMONT, California, granted construction permits (2 applications), portable-mobile, general experimental, 37,100 kc, 2 watts, unlimited time.

CHALAN COUNTY, Wenatchee, Washington, granted construction permit, emergency police, 2414 kc, 250 watts, unlimited time.

HARRY PAYNE BINGHAM, Jr., NC-14178, granted license, aviation-aircraft, 3105, 3120 kc, 10 watts.

DUNBAR W. BOSTWICK, NC-13833, granted license, itinerant aircraft, 3105 kc, 10 watts.

STATE OF FLORIDA, State Road Department, Miami, Florida, granted temporary authority, portable (5 stations), emergency service, 2,726, 3,190 kc, 200 watts.

VANDERBURGH JOHNSTONE, NC-15347, granted license, aviation-aircraft, 3105 kc, 5 watts.

VILLAGE OF KENILWORTH, Illinois, granted construction permit, general experimental, emergency police, 30,100 kc, 5 watts.

OIL FIELD AIRLINES OF DALLAS, INC., NC-13747, granted license, itinerant aircraft, 3,105, 3,120, 3,127.5, 3,232.5, 3,257.5, 3,242.5, 3,447.5, 3,467.5, 4,917.5, 5,602.5, 5,612.5, 5,632.5, 2,912, 5,042.5, 3,457.5 kc, 50 watts.

December 24, 1935.

CITY OF SAN MATEO, California, granted construction permit, general experimental, emergency municipal police, 30,100, 33,100, 37,100, 40,100 kc, 5 watts. Same for portable-mobile equipment, 4 watts.

RCA COMMUNICATIONS, INC., New York City, New York, granted construction permit, general experimental, 86,000-200,000 kc, 100 watts.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, California, granted construction permits (2 applications), general experimental, authority to communicate under exceptions of Rule 320 for purpose of transmitting scientific data, 31,600, 35,600, 38,600, 41,000 kc, 100 watts.

WINNEBAGO COUNTY, Oshkosh, Wisconsin, granted construction permit, municipal police, 2,382 kc, 100 watts.

CITY OF BELLINGHAM, Washington, granted construction permit, municipal police, 2,414 kc, 50 watts.

GOVERNMENT OF PUERTO RICO, Lares, Puerto Rico, granted construction permit, special emergency, 2,726 kc, 50 watts. Granted similar construction permit for Irrigation Camp, Guayama, Puerto Rico. Also same for Mayaguez, P. R.

GEORGE WALTON McCAULEY, NC-14080, granted license, itinerant aircraft, 3,105, 3,120 kc, 20 watts.

CITY OF WHEELING, West Virginia, granted construction permit, general experimental, municipal police, 30,100, 33,100, 37,100, 40,100 kc, 50 watts. Same, mobile equipment, 3 applications.

CITY OF ALTUS, Oklahoma, granted construction permit, police, 2,450 kc, 50 watts.

D. D. WALKER, NC-15463, granted license, aviation-aircraft, 3,105, 3,120, 3,485, 5,682.5 kc, 10 watts.

MEMPHIS COMMERCIAL APPEAL, INC., NC-12593, granted license, aviation-aircraft, 3,105 kc, 7 watts.

VARNEY AIR TRANSPORT, INC., NC-6526, NC-288-W, NC-176-W, NC-483-M, granted license, aviation-aircraft, 3,172.5, 5,582.5 kc, 50 watts.

CITY AND COUNTY OF DENVER, Colorado, granted construction permit, aviation-aircraft, 278 kc, 15 watts.

WEST PRODUCTION COMPANY, Texas Gulf Coast, granted construction permit, portable, geophysical, 1,700 kc, 5 watts.

December 31, 1935.

CITY OF BIG SPRINGS, Texas, granted construction permit, municipal police, 2,458 kc, 50 watts.

January 7, 1936.

AERONAUTICAL RADIO, INC., Chicago, Illinois, granted construction permit, aviation, 3,485, 5,682.5 kc, 50 watts.

DANIEL H. WALLACE, Carpinteria, California, granted construction permit, aviation-airport, 278 kc, 15 watts.

CITY OF HORNELL, New York, granted construction permit, 30,100, 33,100, 37,100, 40,100 kc, 15 watts.

VILLAGE OF KENILWORTH, Illinois, granted construction permit, mobile, 30,100 kc, 5 watts.

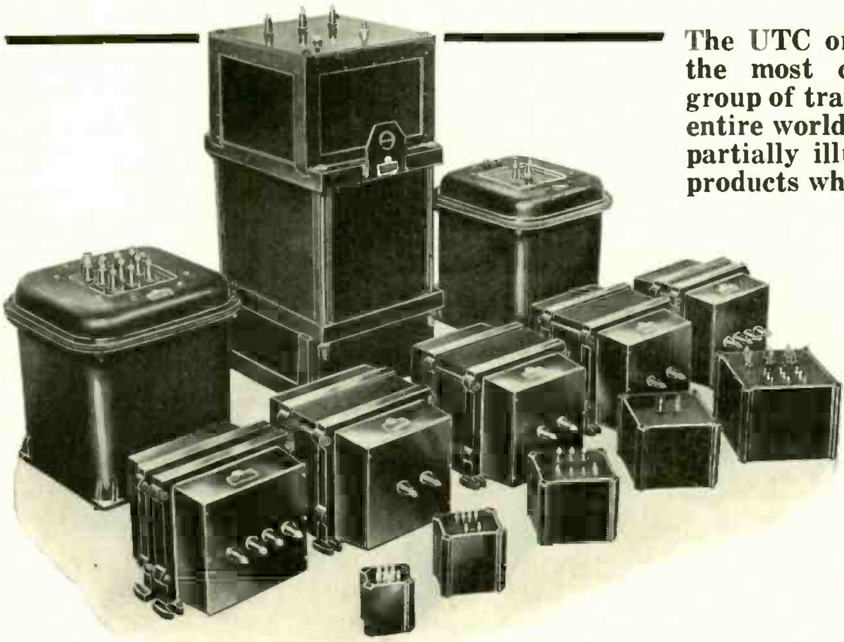
(*Continued on page 22*)

Most Complete Transformer Line in the World

QUALITY · RELIABILITY

Audio Power *and* Filter Components *for* High Powered Broadcast Transmitters

Typical UTC units used in better equipped High Fidelity Broadcast Stations



The UTC organization manufactures the most complete and diversified group of transformers produced in the entire world. The scope of activity is partially illustrated by the following products which UTC produces.

- Aircraft — portable audio and power components weighing but 6 oz. completely poured with compound in drawn metal containers.
- Television transformers linear from 30 to 200,000 cycles.
- High Q audio reactors with Q factor (L/R) as high as 200 and over.
- Audio equalizers and filters.
- Saturable control reactors.
- Battery chargers and speaker field exciters.
- Rectifiers for broadcast and industrial applications.
- Automatic voltage regulators.
- Oscillation transformers.
- Plate and distribution transformers up to 200 KVA 100,000 volts.
- High potential and high current test sets.
- Audio and carrier frequency amplifiers for special applications.

The units illustrated—top row, left to right—are: an oil-filled class B output transformer; plate transformer for output and RF stage; oil-filled modulation reactor. Second row, left to right: audio and filter reactors. Bottom row: speech and voltage amplifier audio units, etc.

UTC specializes in custom-built audio transformers in power ranges of −120 DB. to 50 KW.; power transformers to customer's specifications in dry or oil-filled types from 1 watt to 100 KVA.—up to 100,000 volts.

UTC has set a new precedent in matched audio units used by high fidelity broadcast and communication systems.

UTC LINEAR STANDARD and HI-PERM ALLOY audio transformers are calibrated and guaranteed to be ±1 DB. from 30 cycles to 20,000 cycles. All pertinent technical data and frequency response in DB. indelibly imprinted on outer transformer shield for customers' protection.

Mail 25c for:

A CIRCULAR SLIDE RULE . . . **A NEW 48 PAGE TECHNICAL BULLETIN** which includes data and circuits on amplifiers from ½ watt to 1,000 watts output. Chapters on audio transformer design, application of power transformers and filters, also charts on decibel conversion in terms of watts and conversion of power or voltage ratios to DB. reactance data, filter ripple calculations, etc. . . . **A NEW TRANSMITTER BULLETIN** covering circuits and laboratory built transmitters from 5 watts to 1,000 watts output . . . **ALL LABORATORY CIRCUITS** as they are released over a period of one year covering new amplifiers and variactor controlled carrier RF transmitters.

UNITED TRANSFORMER CORP.

72 SPRING STREET NEW YORK, N. Y.

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

January 14, 1936.

AERONAUTICAL RADIO, INC., Omaha, Nebraska, granted license to cover construction permit, portable, aviation-aeronautical, 5,887.5, 2,994 kc, 50 watts.

JOHN L. VETTE, Jr., NC-14618, granted license, itinerant aircraft, 3,105, 3,120 kc, 50 watts.

G. T. BAKER, doing business as National Airlines System, NC-10807, NC-10804, NC-432-N, granted license, transport aircraft, 2,946, 5,652.5 kc, 10 watts.

THE SOUTHERN SIERRAS POWER CO., Randsburg, California, granted construction permits (2 applications), general experimental, emergency service, 90,000 kc, 20 watts.

CITY OF KANSAS CITY, Missouri, granted construction permits (10 applications), portable-mobile, general experimental, municipal police in emergency service, 30,100, 33,100, 37,100, 40,100 kc, 7.5 watts.

RCA MANUFACTURING CO., INC., Wilmington, Delaware, granted construction permit and license, general experimental, 2,398, 3,492.5, 6,425 kc, 1,500 watts.

TERRITORY OF ALASKA, Homer, granted authority to erect and operate point-to-point telephone and telegraph station, 2,986, 2,616 kc, 40 watts.

CITY OF TRACY, California, granted construction permit, police, 2,414 kc, 15 watts.

CITY OF SAN BUENA VENTURA, California, granted construction permit, police, 2,414 kc, 50 watts.

CITY OF SPARTANBURG, South Carolina, granted construction permit, general experimental, municipal police in emergency service, 30,100, 33,100, 37,100, 40,100 kc, 25 watts.

TWENTIETH CENTURY-FOX FILM CORP., Beverly Hills, California, granted construction permit, 1,652 kc, 100 watts. Also granted similar construction permit for portable equipment.

CITY OF EVERETT, Massachusetts, granted construction permit, 1,712 kc, 50 watts.

MRS. WARRINGTON DORST, NC-15483, granted license, itinerant aircraft, 3,105 kc, 5 watts.

ALBERT C. BOSTWICH, NC-15401, granted license, itinerant aircraft, 3,105, 3,120 kc, 20 watts.

PAN AMERICAN AIRWAYS, New York City, New York, NC-14744, granted temporary authority to operate radio equipment, orange chain frequencies, 20 watts.

BELMONT INVESTMENT CO., NC-14946, granted temporary authority, 3,105, 3,182.5, 5,592.5, 4,937.5 kc, 50 watts.

January 21, 1936.

VILLAGE OF ECORSE, Michigan, granted construction permit, general experimental, municipal police in emergency service, 37,100 kc, 25 watts.

CITY OF ALAMEDA, California, granted construction permit, general experimental, municipal police in emergency service, 30,100 kc, 30 watts.

CITY OF LANCASTER, Nebraska, granted construction permit, mobile, general experimental, municipal police in emergency service, 30,100 kc, 10 watts.

CITY OF BUFFALO, Buffalo Harbor, New York, granted construction permits, general experimental, special emergency service, 41,000, 38,600 kc, 5 watts.

CITY OF NEW CASTLE, Pennsylvania, granted construction permits (4 applications), portable-mobile, general experimental, municipal police in emergency service, 30,100, 33,100, 37,100, 40,100, 86,000 kc, 7.5 watts.

PALM SPRINGS, California, granted construction permits (2 applications), general experimental, municipal police in emergency service, 30,100, 33,100, 37,100, 40,100 kc, 3 watts. Also granted construction permit for similar mobile equipment.

CITY OF DETROIT, Michigan, granted construction permit, special experimental, to be used in connection with point-to-point police radiotelegraph system, 2,040, 2,812 kc, 500 watts.

CITY OF DAVENPORT, Iowa, granted construction permit, special experimental, to be used in connection with point-to-point police radio system, 2,040, 2,808 kc, 500 watts.

CITY OF ST. LOUIS, Missouri, Police Department, granted construction permit, special experimental, point-to-point police radiotelegraph system, 2,036, 2,812 kc, 500 watts.

CITY OF KANSAS CITY, Missouri, granted construction permit, special experimental, point-to-point police radiotelegraph system, 2,036, 2,040, 2,044, 2,804, 2,808, 2,812 kc, 500 watts.

CITY OF MINNEAPOLIS, Minnesota, granted construction permit, special experimental, point-to-point police radiotelegraph system, 2,044, 2,808 kc, 400 watts.

PINELLAS COUNTY, Clearwater, Florida, granted construction permit, municipal police in emergency service, 2,466 kc, 50 watts.

BOROUGH OF VERONA, New Jersey, granted construction permit, general experimental, municipal police, 30,100, 33,100, 37,100, 40,100 kc, 50 watts.

CITY OF JACKSONVILLE, Florida, granted construction permit, airport, 278 kc, 15 watts.

Broadcast Division

December 3, 1935.

SHEPARD BROADCASTING SERVICE INC., Quincy, Massachusetts, granted construction permit, general experimental, facsimile broadcasting, 31,600, 35,600, 38,600, 41,000 kc, 500 watts.

GENERAL ELECTRIC COMPANY, Schenectady, New York, granted construction permit, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 15 watts.

NATIONAL BROADCASTING CO., St. Paul, Minnesota, granted construction permit, portable-mobile, broadcast pickup, 1622, 2060, 2150, 2790 kc, 25 watts.

EDWARD HOFFMAN, St. Paul, Minnesota, granted construction permit, 1370 kc, 100 watts, unlimited time subject to Rules 131, 132, 139.

December 10, 1935.

OREGON STATE AGRICULTURE COLLEGE, Corvallis, Oregon, granted construction permit, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 5 watts.

WTAR RADIO CORPORATION, Norfolk, Virginia, granted construction permit, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 5 watts, unlimited time.

NATIONAL BROADCASTING COMPANY, New York City, New York, granted construction permit and license, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 20 watts.

RADIO STATION WSCG INC., Charlotte, North Carolina, granted construction permit, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 2 watts.

THE REYNOLDS RADIO COMPANY INC., Denver, Colorado, granted construction permit, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 1 watt.

QUINCY A. BRACKETT, LEWIS B. BREED AND EDMUND A. LAPORT, doing business as Connecticut Valley Broadcasting Company, Springfield, Massachusetts, granted construction permit, 1140 kc, 500 watts, limited time.

THE HARTFORD TIMES INC., Hartford, Connecticut, granted construction permit, 1200 kc, 100 watts, daytime.

THE OKLAHOMA PRESS PUBLISHING CO., Muskogee, Oklahoma, granted construction permit, 1500 kc, 100 watts, unlimited time subject to Rules 131, 132, and 139.

December 17, 1935.

WTAR RADIO CORPORATION, Norfolk, Virginia, granted construction permit, 31,600, 35,600, 38,600, 41,000 kc, 50 watts, unlimited time.

THE BALTIMORE RADIO SHOW, INC., granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 100 watts, unlimited time.

JAMES McCLATCHY COMPANY, granted construction permit, portable, broadcast pickup service, 1,614, 2,090, 2,190, 2,830 kc, 50 watts.

January 10, 1936.

THE EVENING NEWS ASSOC., granted construction permit, portable-mobile, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 100 watts.

WCBS INCORPORATED, Springfield, Illinois, granted construction permit, portable-mobile, general experimental, broadcast pickup, 31,100, 34,600, 37,600, 40,600 kc, 2 watts.

THE ATTALA BROADCASTING CORP., Kosiusko, Mississippi, granted construction permit, 31,600, 35,600, 38,600, 41,000 kc, 100 watts.

MEMPHIS COMMERCIAL APPEAL, INC., Memphis, Tennessee, granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 50 watts.

January 14, 1936.

WDOD BROADCASTING CORP., Chattanooga, Tennessee, granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 100 watts.

HEAD OF THE LAKES BROADCASTING CO., Superior, Wisconsin, granted construction permit, 31,600, 35,600, 38,600, 41,000 kc, 80 watts.

January 21, 1936.

WESTINGHOUSE ELECTRIC AND MFG. CO., Chicopee Falls, Massachusetts, granted construction permit and license, portable, special experimental, 31,600, 35,600, 38,600, 41,000, 55,500, 60,500, 86,000-400,000 kc, 500 watts.

CONNECTICUT STATE COLLEGE, Storrs, Connecticut, granted license to cover construction permit, general experimental, 86,000-400,000, 401,000 kc and above, 500 watts, unlimited time.

TRI-STATE BROADCASTING SYSTEM, INC., Shreveport, Louisiana, granted construction permit and license, portable-mobile, temporary broadcast pickup, 1,606, 2,020, 2,102, 2,760 kc, 50 watts.

Telephone Division

November 20, 1935.

RADIO CORP. OF PUERTO RICO, San Juan Puerto Rico, granted construction permit, fixed public point-to-point radiotelephone, 13,410 kc, 400 watts.

January 9, 1936.

THE LORAIN COUNTY RADIO CORP., Lorain, Ohio, granted construction permit, special experimental, located at WMI, 6,470, 11,370 kc, 400 watts.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

THE ELEVENTH ANNUAL DINNER-CRUISE of the Veteran Wireless Operators Association was held on the evening of February 11, 1936, at the Hotel Montclair in New York City. The Second Annual Cruise of the Boston Chapter of the Association was held simultaneously at the Hotel Bradford in Boston. San Francisco was the scene of the Second Annual Cruise of the West Coast group of the Association on the same evening. Miami held their First Annual Dinner-Cruise at the Royal Palm Club simultaneously. Honolulu inaugurated their Annual Cruise on the evening of the eleventh of February.

A complete summary of the events held on the eleventh of February has not yet been prepared. Additional details will appear in a future issue.

Messages of greetings were exchanged between the Boston, Chicago, Miami, New Orleans, Omaha, San Francisco and Honolulu Chapters and the New York Cruise. A Collins 300-watt phone and cw transmitter was installed in the banquet room of the Casino-in-the-Air atop the Hotel Montclair and operated in the Army Amateur Radio System Net as WLNA-W2PF, portable. The Collins transmitter was supplied by Fred Muller, Sales Engineer of the Collins Company in New York. The receiving equipment in the banquet room consisted of a Hammarlund Super-Pro installed through the courtesy of Mr. Jabolin, Sales Engineer of the Hammarlund Company. Mr. Butt, of Radiomarine, supplied us with an AR-60, latest RCA communications type receiver. Joseph Appel, VWOA member, brought down his National HRO receiver and the Secretary had his Hammarlund Comet-Pro there—all in all, a ham's paradise. Army Amateurs in Boston, Chicago, Miami, New Orleans and Omaha were worked direct from this station on 3497.5 kc. Messages from San Francisco and Honolulu were relayed via Washington.

Colonel Alvin C. Voris, Signal Officer, U. S. Army 2nd Corps Area, came over from Governors Island to take part in the festivities. The Army Amateur Radio System was represented by Captain David Talley, Radio Aide, 2nd Corps Area, who had direct charge of the operations of WLNA.

We take this opportunity of expressing our sincere appreciation of the cooperation of the Hammarlund Company, Collins Radio Company, Arthur H. Lynch, who supplied the aerial equipment, Radiomarine Corp. of America, Leeds Radio, and the Army Amateur personnel who took part in the exchange of greetings.

HONOLULU

GEORGE STREET, Chairman of the Honolulu Chapter of the Association, rates the highest commendation for his excellent work in instituting the formation of a real up-and-coming organization—the "Grass Skirt" Chapter. George has sent in the following applications recently: John A. Balch, President of the Mutual Telephone Company, and, as George adds, one of the real pioneers in wireless in those parts; James M. Chapple, Chief Inspector of the 21st District, Federal Communications Commission; J. P. Thornton, Engineer-in-Charge, Kahuku transmitting station of RCA Communications; W. I. Harrington, Wireless Superintendent of the Mutual Telephone Company; C. B. Andrews, Engineer-in-Charge of the Kokohead station of RCA Communications; Louis Bagley, leading amateur in those parts and a columnist on one of the local papers; Sam Slavin, Engineer at Kahuku station, RCA Communications; Webley Edwards, Manager of station KGMB of the Honolulu Broadcasting Company; E. J. Grayhack and George Spare, of the staff of RCA Communications in Honolulu; Werner W. Dietz, Secretary of RCA Communications in that city; Howard R. Belch, Engineer of the Mackay Radio Company in Honolulu; C. G. B. Meredith, Assistant Superintendent of RCA Communications in Honolulu; H. C. Kelser, a real old time radio man; Alexander McLain, operator at RCA Communications, and G. Paul Gray, Engineer of RCA Communications in the "Paradise of the Pacific." George tells us in his most recent letter that the Dinner-Cruise of the Paradise Chapter of the VWOA would be held at the Oahu Country Club where they will partake of Squid and Papaia while hoisting a few to the success of the other simultaneous cruises. We are certain that the Honolulu party was a success for with the zest with which George Street has tackled the job of organizing the Honolulu Chapter of the VWOA they should get places. We are indeed fortunate in having as Chairman and Secretary, respectively, of the "Surfboard" Chapter—George Street of RCA Communications and Arthur Enderlin of the Mackay Radio Company. An interesting article concerning the formation of the Honolulu Chapter accompanied by a photo of George Street appeared in the Honolulu Star-Bulletin.

MIAMI

V. H. C. EBERLIN, Chairman, and C. J. Corrigan, Secretary of the Miami Chapter of the VWOA are to be congratulated on the success attending their efforts to organize the Miami Chapter and inaugurate the Annual Dinner-Cruise in the "Winter-Wonderland." Ebbie suggests that we up north attend the next cruise in Miami making their cruise a reason for a winter vacation. Not a bad idea. In a most recent letter Ebbie stated that twenty-five couples had signed up for their Dinner-Cruise at the swanky Royal Palm Club where they were to have a private dining room but to have available to them all of the entertainment facilities and dancing privileges on the main dance floor.

In promoting the work of the Miami Chapter, Eberlin and Corrigan have made numerous trips visiting NAQ, WOE, WPB, WMR and numerous other radio stations and it appears that their efforts have been well repaid for the Miami Chapter bids fair to go places and do things.

The radio setup at the Miami dinner was supplied by George P. Aldridge, of the staff of WOE, who also happens to be chief factotum of the Lake Worth Radio Club and Army Amateur Radio station in that city. It consisted of a portable transmitter set up in a truck with telescoping masts and ultra-modern receiving and public-address equipment.

C. J. Corrigan, Secretary, says in a recent letter: "It is our idea to have informal meetings at least four times a year and several of the group have advanced the idea of purchasing or renting a bungalow down here for a permanent club house to be kept open at all times. Not a bad idea at all!" We agree.

CJC has promised to keep us informed of all the doings of the Miami group and we shall be glad to include items here.

BOSTON

THANKS TO HARRY CHETHAM, Chapter Secretary, we are kept well informed concerning the activities of the Boston group. The Second Annual Dinner-Cruise of the Boston Chapter was held at the Hotel Bradford in Boston. In HC's most recent letter he anticipated a large representative gathering of old time radiomen and their wives and sweethearts.

HC tells us their publicity committee consists of Lloyd C. Greene, Samuel Curtis, Jr., R. G. Webster, J. A. Rigby and Richard J. Golden. Bart McCarthy acts in the capacity of Historian.

J. Frank Sullivan, President of the Rhode Island Radio School, traveled to Boston from Providence to attend all of the meetings last year. Bill English of West Hartford delivered an interesting talk on radio back in 1908, when he was operator at "BN," 88 Broad Street, Boston. English also served as a Colonel in charge of telegraphs during the Dominican Revolution.

OMAHA

CAPT. R. B. WOOLVERTON, Signal Corps, U. S. Army, handled the key in sending greetings to the New York Cruise from the Omaha Chapter. Right good sending it was, too. Represented by Capt. Woolverton in Omaha we should increase our mid-west representation.

PERSONALS

LIEUT. CARL O. PETERSEN, USNR, member of both Byrd Expeditions, on the first as Radio operator and the second as Paramount cameraman, delivered an extremely interesting lecture on Little America, accompanying it by the showing of motion pictures he took while down there, before 500 employees of the New York Telephone Company in the auditorium of Telephone headquarters in Brooklyn. His presentation was enthusiastically received. We highly recommend this feature to other groups. . . . Just as soon as the Secretary digs out from under our advertising campaign and dinner details he will send some of those much delayed membership cards and answer many of the recent requests received. . . . A. A. Isbell not satisfied with sending in our first advertisement received, that of RCA Communications, but he was also the first to remit for a dinner ticket. Mr. Isbell, when last seen at the Dinner-Cruise seemed to be enjoying the goings on. . . . Karl K. Baarslag, author of "S O S to the Rescue" sent a radiogram

(Continued on page 26)

OVER THE TAPE...

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

W. R. G. BAKER RECEIVES APPOINTMENT

W. R. G. Baker has been appointed Managing Engineer of the General Electric Company's radio-receiver section, with responsibility for both the engineering and the manufacture of its products, according to an announcement by W. Stewart Clark, Manager of the company's Bridgeport Works. Although closely associated with General Electric's initial radio-development activities, Mr. Baker for the past few years has been connected with RCA Victor in Camden, N. J.

WIRELESS PIONEER DIES

Adam Stein, Jr., one of the pioneers of the radio industry, died on January 20 at his home at Silverlake, Mass., at the age of 54. Death was due to a heart attack. He was stricken while packing to leave for his regular weekly duties with the World Broadcasting System, in New York, with which company he was associated as Vice-president in Charge of Engineering.

Many old-timers in the organizations with which Mr. Stein served during his colorful career will learn with sorrow of his death.

THORDARSON TRANSMITTER GUIDE

Thordarson Electric Manufacturing Company, Chicago, Illinois, recently issued a 32-page third edition of their Transmitter Guide, No. 344-B. Considerable information is contained on fundamental circuits, coupling, amplifier tuning, grid-bias systems, modulation, transmitters, speech amplifiers, and the like. Numerous charts, tables and the like are provided. This guide may be obtained from the above organization. The price is 15 cents.

METAL DISC BULLETIN

Paul K. Trautwein of 58 West 25th Street, New York City, announced the contemplation of a corporation for the manufacture of a coated metal disc for all kinds of direct-recording purposes, and that a bulletin to that effect, with prices and other information, is ready to be mailed.

Upon application to Mr. Trautwein by readers interested, this bulletin will be mailed without charge and their names placed on the mailing list for future issues.

"AMERTRAN TRANSFORMER NEWS"

"Amertran Transformer News" is the title of a magazine which is published by The American Transformer Company, 178 Emmett Street, Newark, N. J. As implied by the name, this magazine covers recent developments of The American Transformer Company. Those desiring to receive this publication should write to the above organization.

A 32-page catalog on transformers for audio amplification and transmission is also available. Write for Bulletin 1002B.

NEW CORNELL-DUBILIER CATALOG

The Cornell-Dubilier Corporation, 4377 Bronx Boulevard, New York, announces

their latest catalog for the transmitting and industrial fields. Catalog No. 127 contains twenty-four pages attractively illustrated, replete with technical information, covering a complete group of capacitors for the above fields.

The newly designed Cornell-Dubilier line of Dykanol Transmitting capacitors is fully illustrated and listed.

NAME WANTED

Having perfected what is stated to be a revolutionary new system of pickup reproduction, the Audak Co., 500 Fifth Avenue, manufacturers of electrical and acoustical apparatus since 1915, is telling the world about it in current advertisements, offering a first prize of $100 and five additional prizes for the best name for this new system.

Features of the new instruments, we understand, will be elimination of the factor of moving mass which has always militated against perfect reproduction; also since there is no moving mass, damping will be unnecessary. Moreover, the vibrating armature, hitherto a decided barrier to wide range, has been made stationary.

In the words of Maximilian Weil, president of the Audak Company, "We have had such tremendous improvement in broadcasting and recording that even pretty good pickups are unable to do full justice to the new recordings. What we are after now is to make the pickup as good as the microphone . . . believing that only then will the public be able to enjoy music 100%. I honestly believe that the new Audax models will prove a revelation to the most skeptical because they give everything that went into the mike at the original recording . . . and this applies to a phenomenally wide range."

The complete catalogue of Audax models, including the new numbers, is available to members of the radio music trade, and all are invited to compete in this nation-wide contest for a name.

"VOICE OF LONGVIEW"

The story of KFRO, the "Voice of Longview," Texas, is told in an attractive brochure which has recently been released. The title of this interesting brochure is "The Story of KFRO and its Market."

BROADCASTING SERVICE ASSOCIATION

Broadcasting Service Association, Ltd., has been formed in Sydney, Australia, with Sir John Butters as Chairman.

Broadcasting stations 2GB and 2UE have cooperated to form the new organization which will coordinate the program facilities of both stations and particularly to use the stock company and transcription programs of 2GB.

According to a statement made by Sir John Butters the new company does not own or operate either station or other stations that might avail themselves of the facilities of the Association.

A. E. Bennett, Managing Director of 2GB and President of the Australian Federation of Broadcasting Stations, and C. V. Stevenson, Managing Director of 2UE, will be managing directors of the new firm.

While primarily formed to service the two Sydney stations, the new organization will make its facilities available to all stations in Australia on a regular service basis.

Dr. Ralph L. Power, Los Angeles, Calif., United States Representative for the American Radio Transcriptions Agencies, subsidiary of 2GB, will continue to purchase both transcriptions and program script in this country for the Sydney organization.

CENTRALAB PURCHASES PERFEX CONTROLS

According to information received from Mr. H. E. Osmun, Vice-president of Centralab, Milwaukee, Wis., manufacturers of volume controls, sound-projection controls and fixed resistors, this firm has purchased the Perfex Controls Co., of Milwaukee, Wis., line of wave-change switches and other radio products.

While Centralab have been working on their own switch developments this move seemed the quickest and most logical way of entering this business, so closely allied to their own business.

VWOA

(*Continued from page 24*)

to the Montclair from Coco Solo Island where he is stopping with a yachting party. . . . We hope the 1936 Year Books arrived at the various dinners in time to be distributed. . . . Why not send in fifty cents for a set of Year Books from the 1932 issne on? . . . Again we request items for use in this page, and, until the next issue, 73.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

METAL-TUBE AMPLIFIERS

Morlen Electric Company, Inc., 60 West 15th St., New York City, announces the first of a line of amplifiers with metal tubes in all stages, including the output. In addition to the basic advantages of the all-metal tubes the new line uses the Morlen "Power-Driver" circuit. This new development applied to metal tubes gives maximum power output over a wider frequency range at a lower distortion level, it is stated. Tests are said to have proven this new amplifier particularly suitable for medium-power modulator service, it having sufficient power output to modulate up to 90 watts r-f.

The MC38 amplifier uses two 6F5 and two 6C5 triodes in the voltage amplifier, two 6F6 triodes as "Power-Drivers" and four 6F6 output tubes. The amplifier will deliver 38 watts a-f normal and 45 watts in heavy-duty speech service. The overall gain is 103 db.

A bulletin giving technical data is available.

DIRECT-INDICATING AUDIO-FREQUENCY METER

A direct-indicating audio-frequency meter is a great convenience in many laboratory measurements, or in production and testing operations where a large number of measurements must be quickly made. In some cases, a continuous indication of the value of a varying frequency is required. To meet these requirements, the Type 834-A Electronic Frequency Meter has been developed. This instrument is of new design, is direct reading from 0 to 5,000 cycles per second, and operates from the a-c line.

The meter consists, essentially, of an amplifier, a gas-discharge-tube counter, and an indicator. The fundamental circuit design of the instrument was devised by Dr. F. V. Hunt in the Cruft Laboratory at Harvard University.

The instrument includes a one-stage amplifier, the gas-discharge-tube counter circuit, diode switching tube, frequency-indicating meter and power supply (with rectifier and voltage regulator).

The amplifier provides for satisfactory operation on signal inputs of three volts or less, and also provides a high-impedance input circuit (one megohm). By the arrangement of the amplifier circuit, provision is made for satisfactory operation over a wide range of signal input voltages, up to 200 volts, with no change in indication of frequency.

Five ranges are provided, each starting at 0 and extending to 200, 500, 1,000, 2,000, and 5,000 cycles. The desired range is selected by means of a multiplier switch mounted on the panel. Individual adjustments are provided for making the indication agree with the scale of the meter on each range.

The Type 834-A Electronic Frequency Meter is a product of the General Radio Company, 30 State St., Cambridge, Mass.

THE TYPE 834-A ELECTRONIC FREQUENCY METER.

CONVERTIBLE NON-DIRECTIONAL MIDGET MICROPHONE

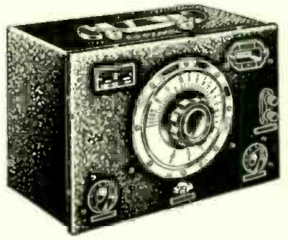
The Model 17 non-directional microphone has recently been announced by The Turner Company of Cedar Rapids, Iowa. This unit is shown in the accompanying illustration.

This crystal microphone has an output level of minus 56 db and a flat frequency response from 500 to 7,000 cycles with a rising low-frequency characteristic of approximately 5 db at 50 cycles. This is advantageous in offsetting transmission and amplifier losses at these frequencies.

The mechanical construction of the microphone has been such as to give it

sturdiness without detracting from its appearance. The microphone cord may be concealed within the stand for any position desired or it may be used on the outside to facilitate quick changes.

Primarily the Model 17 has four positions of mounting, each adapted to a particular requirement. The utility of such universal application can best be appreciated in a studio, where the grouping of artists about the microphone has always been a problem. When the microphone is placed in a horizontal plane upon a stand, a true non-directional effect is said to be secured. Placing the microphone in a vertical plane upon the stand, gives it a semi-directional effect.



PORTABLE AUDIO OSCILLATOR

A new, compact, portable beat-note audio oscillator has been announced by the Clough-Brengle Company, 1134 W. Austin Ave., Chicago, Illinois.

The Model 79 is continuously variable from 0 to 10,000 cycles per second. From 50 to 10,000 cycles, the output voltage is uniform within 2 db and contains less than 5 percent distortion, it is said.

An output potential of 27 volts is developed at 5,000 ohms impedance. Two type 76 heterodyne r-f oscillators generate the audio voltage which is demodulated in a type 76 tube and amplified by an additional audio-stage employing a type 76 tube.

Full information may be secured by writing the manufacturer.

ALUMINUM RECORDS

Superfine aluminum records of a special alloy heat treatment and with a highly polished surface finish are finding a varied market among recorders for making records of speech, voice, music, languages and other uses, according to information from the Inglewood, Calif., factory of the Universal Microphone Co.

Universal's Superfine line of blanks is a composition coating of special alloy aluminum material that is not subject to deterioration from age. Speech, music and other programs or messages can be placed in storage and kept for years without frequency loss or the accumulation of background noise, it is said.

NEW ELECTRIC GENERATING PLANTS

D. W. Onan and Sons, Minneapolis, Minnesota, have announced their new line of light-weight, 110-volt, 60-cycle alternating-current generating plants.

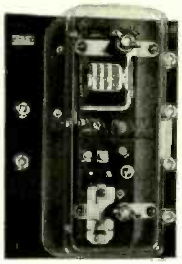
These machines are fully enclosed, streamline in design, built with four-cycle engine of one horsepower capacity, and operate at 1,800 rpm. The engine features magneto ignition, float feed carburetor, governor, pressure lubrication through the crankshaft to connecting rod.

These plants are furnished complete, ready to run. They are designed for operating sound-car, public-address, and radio-communication systems in places where a-c current is necessary.

Onan a-c generating plants are offered in sizes up to 3,000 watts capacity. There are 10 distinct sizes and 15 models.

CONTROL FOR CRYSTAL HEATING OVEN

In radio broadcasting, it is necessary that the station keep as close as possible to



its assigned wavelength to prevent interference with stations working on adjacent wavelengths. To keep the wave constant, many stations use a crystal oscillator. The crystal must be kept at a constant temperature and this is usually done by means of an electrically-heated oven whose temperature is controlled through a thermoregulator. Since the contacts of the thermoregulator are delicate, and will handle only very small currents, it is necessary to connect a relay between the thermoregulator and the load.

Struthers Dunn, Inc., of Philadelphia, have recently furnished relay equipment for the control of crystal ovens. This equipment consists of a sensitive relay and a front contact relay. The thermoregulator controls the coil of the sensitive relay, whose contacts in turn control the coil of the front contact relay. The contacts of the front contact relay control the heating circuits. With this arrangement, the contacts of the thermoregulator need only carry a current of a few milliamperes to control the load circuit.

CONTROLLED RECTIFIERS

Ward Leonard Electric Co., Mt. Vernon, N. Y., announces Controlled Rectifiers, Bulletin 8602, to provide d-c power from an a-c power supply for small public and private telephone systems.

Controlled Rectifiers on an a-c line varying ± 10%, supplies a d-c voltage maintained constant to a ± 1½ volt accuracy from no load to full load.

These rectifiers are designed for 60-cycle, 3-phase. 208-220-240 nominal line volts input and for 50 ± 1½ volt, 5- and 10-ampere outputs.

RANGERTONE DEVELOPMENTS

According to Rangertone, Inc., of 201 Verona Ave., Newark, N. J., there are three main factors in producing good blanks for instantaneous recording: The materials used, the application of the materials, and the proper delivery of the blank.

Rangertone has spent the last two years in developing the answer to these requirements.

The most popular form of blank at the present time consists of an aluminum disk coated with a material which, at the time of the recording, is soft enough to take an impression and becomes quickly hardened. The aluminum disk must be polished flat and free from blemish. The coating must be applied as uniformly as possible with no dirt or air bubbles present. The thickness of the coat must be such as to make the chances of cutting through practically negligible.

The matter of delivery requires as much consideration as either of the first two factors. Rangertone has endeavored to meet the situation by handling record blanks in much the same manner as dated coffee or photographic film. The records as purchased from the plant, are furnished in sealed cans which maintain the original softness for a period of at least a month. After this time, it is possible to recondition the records by a special conditioner which is available.

The cutting needle is an especially important item in reducing the noise ratio in records, and the actual cutting materials are equally important. By repeated trials the combination has been realized which makes phonographic recording equal to the very high standard which radio has commonly experienced in broadcast work, it is stated. A recent test is said to have shown that in a setup which before the introduction of the record gave a —95 db level for the noise, the introduction of the record only brought this down to —86 db.

NEW HEAVY-DUTY VIBRATORS

A new line of heavy-duty vibrators, designed especially for police-radio and transceiver work, has just been announced by Electronic Laboratories, Inc., of Indianapolis.

The outstanding feature of these new vibrators is their unusually large contact points, these being approximately twice the diameter of the contacts used in vibrators of the standard types, it is stated. These larger contacts, Electronic engineers advise, greatly increase the current-carrying capacity and life of the heavy-duty vibrators.

The non-synchronous models in Electronic's heavy-duty line are plug-in units on a four-prong base, while the synchronous types are on a standard five-prong base. However, any of the heavy-duty units will be built to order for police radios in which the vibrator base wiring is not standard.

NEW OIL-PROCESS HIGH-VOLTAGE CONDENSERS

Something new in a compact high-voltage condenser for use in the filter and audio-coupling circuits of transmitters and public-address systems has been placed on the market by the Tobe Deutschmann Corporation, Canton, Massachusetts.

The condensers have a working voltage of 2,000 volts d-c, and are tested at 6,000 volts d-c.

The 1-mfd size comes in a container 3⅜ inches by 2½ inches in diameter. The

2-mfd unit is 3⅜ inches high by 3¼ inches in diameter.

A bulletin describing these units is sent free upon request. Ask for Form No. EC-1.

COMMUNICATION BOOTH

A new type of telephone booth, built on the principle of absorbing extraneous sounds rather than blocking them, has been designed by the Acoustic Division of the Burgess Battery Company, Madison, Wisconsin. While the use of Burgess Acoustic Treatment in telephone booths is new, the principle of absorbing sound in this manner has long been applied by Burgess engineers in air ducts, airplane cabins, motor-truck cabs, auditorium walls and ceilings, automotive mufflers, and in other places requiring acoustic treatment.

This new type of booth differs from wood booths in that its interior is faced with a perforated metal sheet backed with balsam wool. The perforated metal facing may be washed easily.

One of the new features is the absence of the door, which is made possible by the fact that the lining deadens extraneous noise more effectively than a closed door, and the speaker's voice is not transmitted beyond the booth, it is stated.

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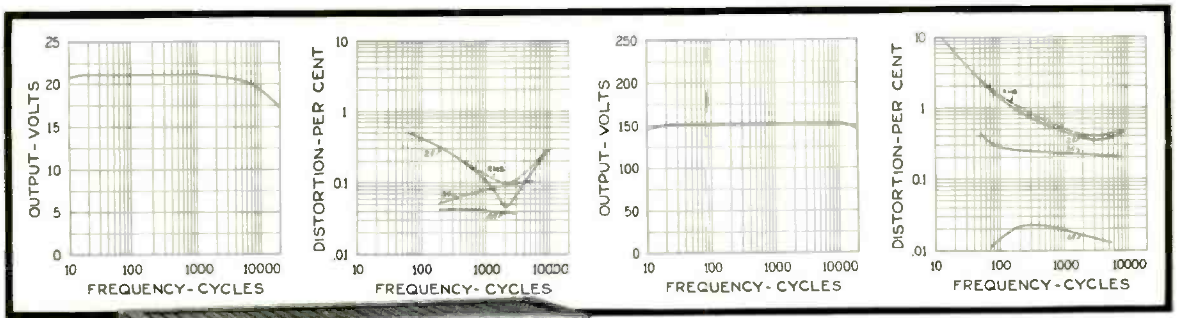

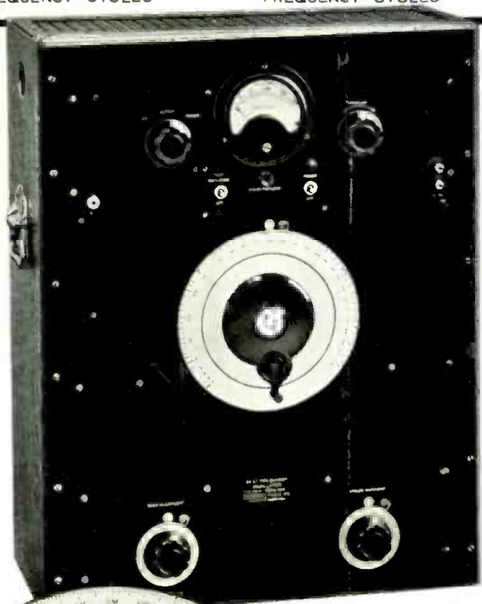

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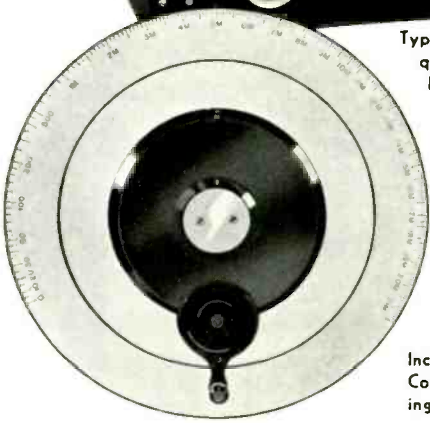

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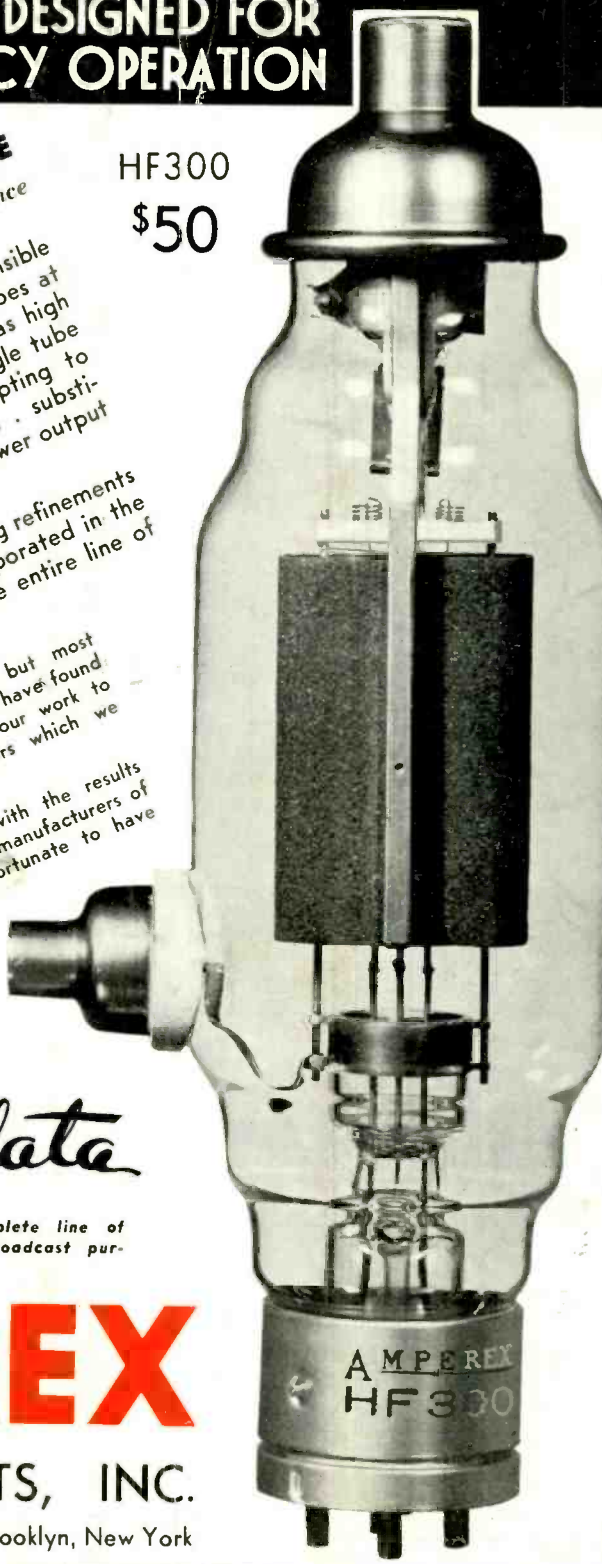

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