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EDITORIAL

BLIND FLYING

THE RAPID GROWTH of air passenger traffic and the tendency towards increased size in air transport planes are making it necessary for aircraft to operate on schedule regardless of weather. This involves two major problems, namely, blind landing and blind navigation.

Blind-landing arrangements of at least seven types have been suggested and tested. To mention a few, the Army system, devised by Captain Hagenberger, has been given an extensive field trial in this country, while the Lorenz system is now in operation at a number of airports in Europe. Although each of these systems have contributed something towards the art of instrument landing, the ideal system has not yet been devised.

In addition to the general use of radio range on all the major air routes in this country, there are some aircraft equipped with direction finders for use on range stations and broadcast stations. The possibility of more elaborate direction-finding equipment on the ground has also been suggested. Such equipments operated on short waves should be of material value to supplement other apparatus carried in the plane.

Simultaneous transmission of radio range beacon signals and voice has been tested at Pittsburgh by the Bureau of Air Commerce engineers and pilots and by airline and other pilots. Radio equipment on the new Nashville-Washington airway is being installed so as to provide for simultaneous operation. The new medium-powered simultaneous stations which are to serve this airway and which will be located at Knoxville and Smithville, Tennessee, and Bristol, Pulaski, Roanoke, Lynchburg and Gordonsville, Virginia, will permit continuous radio range operation. A brief description of the equipment will be found on page 24 of this issue.

With the advent of larger planes, it is safe to predict that added impetus will be given to the use of blind-landing and better navigating equipment.

SOUND PROJECTION

THE FIELDS of radio broadcasting and sound projection may be said to almost go hand in hand. Much of the equipments used in the two fields are nearly identical; this is especially true of speech-input apparatus, including microphones, amplifiers, and the like. Also, similar acoustical problems are encountered in regard to studios, auditoriums, and theatres. Further, many of the large up-to-date broadcast stations now have special departments that make many of the larger public-address installations.

In view of the foregoing, COMMUNICATION AND BROADCAST ENGINEERING has expanded its editorial policy to include the field of sound projection. Future issues will include practical, up-to-date articles on acoustics, as it applies to public-address as well as broadcasting, centralized sound systems, speech-input equipment, speaker and horn design, and the like. In this issue, we should like to call attention to Mr. Tower's article on sound, Mr. Duncan's article on the design of exponential horns, and to the article on resistance-pad design.

NBC ANNIVERSARY

ON NOVEMBER 9, the National Broadcasting Company observed its tenth anniversary. As a part of the ceremonies a special broadcast featured, among other things, two-way conversations between a train traveling between Boston and Providence and a German train running between Hamburg and Berlin. Other broadcasts of conversations ranged from a submarine under the sea to the top of Pike's Peak and to planes flying over San Diego.

It is only when we stop to compare the broadcasting of today with that of ten years ago that we are able to realize the tremendous advances that have been made. The radio industry has ever moved fast, and its future looks bright indeed. Having now gained a firm foothold there seems to be no reason why the next ten years should not see even greater progress.

COMMUNICATION & BROADCAST ENGINEERING

FOR NOVEMBER, 1936

A STUDIO CONTROL SYSTEM for BROADCAST STATIONS

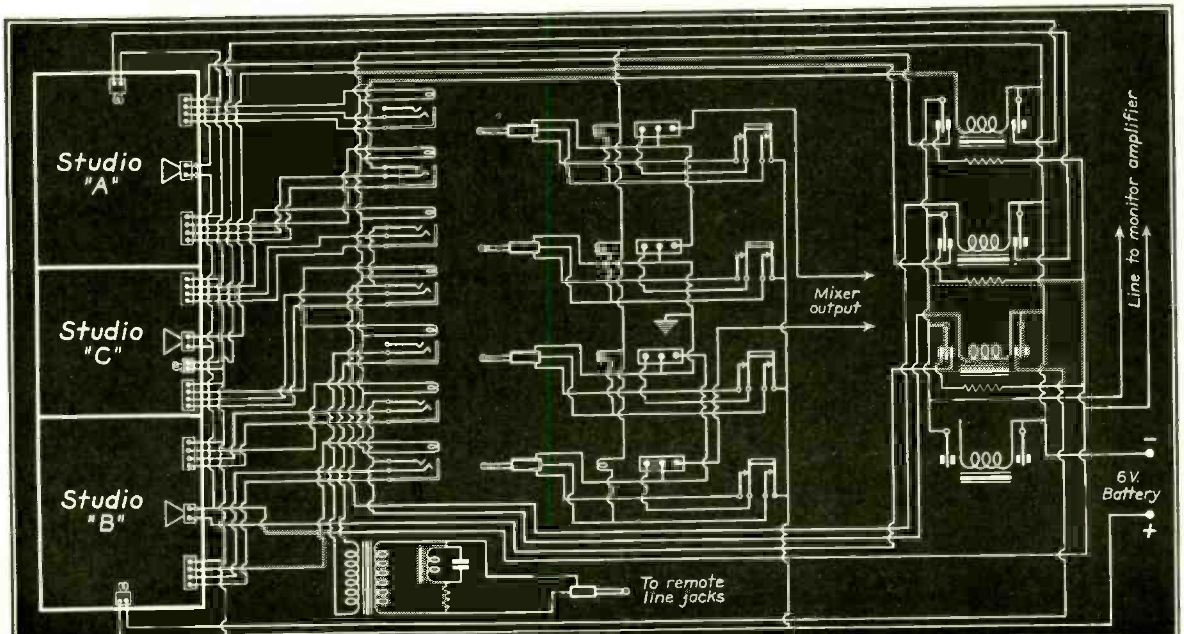
By STOKES GRESHAM, Jr.
WSGN

THE ACCOMPANYING DRAWING and explanation show a unique system for the control of several studios from a central control room. The chief advantages of the system are greater flexibility, minimum switching and patching, automatic operation, and high efficiency.

The drawing shows a four-channel mixer, three studios, and two microphone or phone outlets per studio. There can be more or less of either without affecting the fundamental design. More mixing pads would simply mean one additional switch for each added channel, more outlets in any studio would mean an additional corresponding jack on the jack strip at the control panel. It can be seen that it is very desirable to place a number of spare jacks in the original installation to take care of future station expansion. It is believed that four mixers will be sufficient for most stations since they can be used on all studios and all outlets.

It was intended that the equipment shown in the drawing be mounted on a 19 by 10 inch metal panel and in a cabinet suitable for desk or table use. The

SCHEMATIC DIAGRAM OF THE STUDIO CONTROL SYSTEM DESCRIBED IN THE ACCOMPANYING ARTICLE.



relays were to be mounted on the speech-amplifier rack or inside the desk. Each station engineer has his own ideas concerning the artistic arrangement of such apparatus, and to meet some station requirements it may be desirable to mount all equipment on a relay rack.

Again referring to the drawing, it can be seen that all voice lines, either microphone, transcription pickup, or other outlets are terminated in a jack panel over the mixer. All jacks and plugs referred to are of the three-circuit type (except those on which the remote telephone lines terminate), and all contacts are entirely independent. These three-circuit plugs and jacks are the elements that make the system so flexible and yet so simple. If it is desired, double plugs and jacks may be used instead of the three-circuit type shown, but one contact on both plug and jack of one double is not used.

In the event a microphone preamplifier, necessary for certain types of microphones, is used then the studio outlet would go to that input, and the output of the preamplifier to a control jack. The third contact of each jack and plug is for the six-volt battery circuit, or other suitable source, and completes the circuit to the relay for each studio. The fact must be kept in mind that the same contact of each jack and plug must be used for this circuit, otherwise the system will not operate.

One relay per studio is shown, and likewise one red signal light in each studio. However, it is possible to have as many signal lights as there are microphone outlets and a relay per light, thus indicating in each studio which microphone is "hot." All relays for a studio under this method would be connected in parallel with the exception of the signal-light contact. Although the requirements of the individual station will determine this, one light per studio is usually sufficient.

Now let us look at the mixer proper and the associated switches. In this particular case the mixing pads are series connected; however, that is not a necessary arrangement, but is left to the taste of the station engineer. There is a corresponding switch for each mixing pad, preferably of the "anti-capacity" type or the corresponding Western Electric variety. In the physical arrangement of the panel it is good practice to mount the switches above their associated mixing pads, and wire them so that the up position is with the speaker on (mike off) and the down position is with the mike on (speaker off). In looking at the drawing we note that the channel switch is for the completion of the six-volt battery circuit to the relay as well as the voice line to mixer. By tracing the schematic wiring diagram this becomes self-explanatory.

Here is the system in operation. Assume the plug connected to the right-hand channel (designated for this purpose as No. 1) and insert it in a jack carrying the voice line of a microphone from A studio. Note that all four patch cords are permanently connected at one end to a switch and mixer. The switch over channel No. 1 is thrown to the on position (down). The line to mixer is completed; the six-volt battery circuit through the switch, plug and jack, to relay is completed. The relay trips, causing studio A speaker to go off, and the red signal light on, indicating that the studio is "on the air." At the same instant the switch completes the voice line to mixer circuit. A red light is also on over the No. 1 mixer channel reminding the operator that this channel is in use and not to remove the plug from the jack. This operation is from studio A on channel No. 1.

Now let us see how channel No. 1 can be used elsewhere. Assume that there is to be a program from studio B. We take the same plug that was used in a jack corresponding to studio A and insert it in a jack carrying a voice line from studio B. Channel No. 1 is now ready for operation on B studio. We now throw *the same switch as before to the on position and the identical operations are accomplished on B studio as were accomplished on A studio from the same switch and mixer, and without the necessity of using additional switches, patch cords or relays* (one relay per studio), the entire change being accomplished with one manual operation, and the circuit operation on both studios from the same switch and mixer being *entirely automatic.*

Thus it can be seen that *any* channel can be used on *any* microphone, transcription, telephone or other outlet, and from *any* studio, or other program point. All operation after a jack is inserted in a plug is automatic.

Tracing out the circuits we see that the placing of a plug from any channel in a jack connects the relay of that studio to the channel switch, and at the same time the voice line of that microphone outlet is connected to the channel switch and mixing pad. When the switch of that channel is thrown to the on position the circuit to the relay is completed and the relay closes causing the red signal light to go on and the studio speaker to go off. A resistor replaces the speaker winding on the monitor-amplifier line so that the impedance remains constant. At the same time the switch completes the voice line. A spare relay is shown which may be connected to the control-room speaker, light and microphone so that announcements can be made from that point, or it may be reserved as a spare for future expansion.

At first glance it might seem that voltage might be accidentally applied to the mixing pads by inserting a plug in a jack. However, on closer inspection of the diagram it will be seen that this cannot happen as the tip of the plug and the back jack contact in the battery circuit and with the switch in the open position (as it would always be when inserting a plug) the battery circuit in this section is not complete.

Although a battery is shown in the drawing to furnish the energizing force for the relays other mediums may be used. The very important fact should be kept in mind that this source of supply should be of pure d-c and at a very low potential. If the source is not pure d-c, hum may be induced in the voice line due to its proximity to the relay circuit. And if the potential is not kept low there is danger of shock or injury to the equipment.

Another unusual arrangement is the method that notifies the control operator which microphone will be used. The writer has often had the experience of having several microphone outlets in a studio and not knowing in which one the microphone was plugged, the announcer failing to state the one to be used. Thus confusion resulted and a consequent loss of air time. To avoid this, the arrangement using a mike plug and receptacle with two extra contacts was devised.

There is a green light over each jack on the control panel with the light corresponding to the associated voice line of that studio outlet. One side of the light is connected to the negative side of the battery while the other side goes to a spare contact of the wall receptacle corresponding to the voice line it indicates. The other spare contact of the wall receptacle goes to the positive side of the battery. When a microphone is inserted in a receptacle, the spare contacts simply as a switch since the microphone plug contacts (spare ones) are shorted together. Thus a green light is caused to flash on over the jack on the control panel when a microphone is inserted in a receptacle corresponding to that voice line jack, and light.

The impedance of the various microphones, or the preamplifiers if used, must correspond to the mixer impedance, otherwise matching transformers will be necessary. Since remote lines usually have an impedance of 500 ohms it will be necessary to use a matching transformer between line and mixing pad. A transformer and equalizer for this purpose are shown. A switch may be used to eliminate the equalizer for short lines where equalization is not necessary.

HOW LOUD IS SOUND?

By C. H. TOWER

THE BRUSH DEVELOPMENT COMPANY

IN ORDER to answer this question it is necessary to carefully define what is meant by sound. Usually sound is defined as the sensation produced upon the ear by the vibrations of air particles, although vibrating solids applied to other parts of the body may also produce the sensation of sound. With this definition as a basis it is at once obvious that the loudness of a given sound will vary with the individual and that we are primarily concerned with the objective characteristics of the air particle vibrations such as frequency, amplitude, velocity, etc., only as they are effective in inducing an auditory response. A difficulty is that a given vibratory condition induces a different response in different individuals. This difficulty can be to some extent overcome by testing many different persons and determining the characteristics of the average or normal individual and relating them to the objective characteristics of air particle vibrations. These are the quantities which ultimately must be measured in determining the loudness of sound since it is difficult to measure quantitatively the intensity of sensations of the average individual even if it were always possible to have him present as a laboratory instrument.

An ideal scale would be one in which the 0 would correspond to the faintest possible sound that could be detected and in which the number of divisions corresponding to a sound would be proportional to its loudness or the intensity of the subjective sensation. Furthermore, this scale should be one to which the objective characteristics of the air particle vibrations could be easily and simply related.

Although the law of auditory response to a stimulus of constant frequency is approximately logarithmic there are substantial departures especially at the higher sound levels. Furthermore, as is well known, the intensity of a sound which can be detected by a given individual varies markedly with the frequency, the greatest sensitivity of the human ear being in the neighborhood of 1,000 cycles per second. Indeed few persons can detect a pure tone having a frequency below 30 cycles per second and the range of hearing rarely extends as high as nine octaves above this. The effect of the surrounding noise level, the condition of the listener and other factors also affect the apparent loudness of sounds so that any system based entirely upon the physiological effect becomes so complicated as to be impractical.

It is possible, however. to express the characteristics of the vibratory motion of air particles in such units that their numerical value will approximate the resulting sensation of loudness closely enough to be useful and moreover be simple enough in their derivation to be readily usable. Such units should be proportional to the logarithms of the numerical values of the corresponding characteristics since this is the simplest function approximating the relationship between sensation and stimulus. More complicated functions might express the relationship more closely at extremes of loudness and pitch but would lack simplicity and ease of use.

The American Standards Association

(*Continued on page* 23)

ACOUSTICAL LEVELS

Various Noises and Orchestral Effects	RMS Sound Pressure — Dynes per Sq Cm	RMS Particle Velocity — Cm per Sec	Total Particle Excursion — Millimeters at 1,000 Cycles	Sound Intensities — Microwatts per Sq Cm	Power Level — Decibels
Threshold	0.000204	0.0000050	2.22×10^{-8}	10^{-10}	0
	0.000363	0.0000089	3.95×10^{-8}	3.165×10^{-10}	5
	0.000645	0.0000158	7.00×10^{-8}	10^{-9}	10
	0.001146	0.0000281	1.25×10^{-7}	3.165×10^{-9}	15
Whisper 4′ from source	0.00204	0.000050	2.22×10^{-7}	10^{-8}	20
	0.00363	0.000089	3.95×10^{-7}	3.165×10^{-8}	25
Soft Violin 12′ from source	0.00645	0.000158	7.00×10^{-7}	10^{-7}	30
	0.01146	0.000281	1.25×10^{-6}	3.165×10^{-7}	35
	0.0204	0.0005	2.22×10^{-6}	10^{-6}	40
	0.036	0.00089	3.95×10^{-6}	3.165×10^{-6}	45
Bell F4 160′ from source	0.0645	0.00158	7.00×10^{-6}	10^{-5}	50
Ordinary Conversation 3′ from source	0.1146	0.00281	1.25×10^{-5}	3.165×10^{-5}	55
	0.204	0.0050	2.22×10^{-5}	10^{-4}	60
	0.363	0.0089	3.95×10^{-5}	3.165×10^{-4}	65
Bell F2 160′ from source	0.645	0.0158	7.00×10^{-5}	10^{-3}	70
	1.146	0.0281	1.25×10^{-4}	3.165×10^{-3}	75
Full Orchestra					
	2.04	0.15	2.22×10^{-4}	10^{-2}	80
Bell F4 6′ from source	3.63	0.089	3.95×10^{-4}	3.165×10^{-2}	85
	6.45	0.158	7.00×10^{-4}	10^{-1}	90
	11.46	0.281	1.25×10^{-3}	0.3165	95
	20.4	0.5	2.22×10^{-3}	1.0	100
Bell F2 6′ from source					
	36.3	0.89	3.95×10^{-3}	3.165	105
Thunder	64.5	1.58	7.00×10^{-3}	10.0	110
Hammer 2′ from source	114.6	2.81	1.25×10^{-2}	31.65	115
	204	5.0	2.22×10^{-2}	100.00	120
	363	8.9	3.95×10^{-2}	316.5	125
Threshold of pain	645	15.8	7.00×10^{-2}	1000.0	130

THE DESIGN OF EXPONENTIAL HORNS

By W. S. DUNCAN

Sound Division

BELL & HOWELL COMPANY

MUCH HAS BEEN WRITTEN concerning the exponential horn, its principles, and its action on sound waves. Much less has been written on the actual design of this horn. A few simple rules can aid materially in the design. On the opposite page is a chart which will reduce the matter of design to a few easy calculations.

The first consideration in the design of an exponential horn is the choice of the low-frequency cut-off, or the lowest frequency the horn will efficiently reproduce. This cut-off frequency determines the size of the bell, or large opening, and, consequently, the length of the horn. As in a plane baffle, the diameter of the bell should be at least ¼ of the wavelength of the cut-off frequency. Reduced to an equation for the minimum size of the bell:

$$\text{Diameter of round bell} = \frac{281}{f}$$

$$\text{Side of square bell} = \frac{249}{f}$$

where f is the cut-off frequency. Measurements are in feet.

The definition of an exponential horn is one in which the cross-section area doubles for equal increases in length. The expansion ratio is the rate at which this area increases, and is determined by the cut-off frequency. In the form of an equation:

$$E.\ R. = 2^{\frac{f}{64}}$$

where E. R. is the expansion ratio, and f is the cut-off frequency.

Thus, the diameter of the bell and the expansion ratio have been determined by the low-frequency cut-off. Next in consideration is the size of the throat, or small end of the horn. This dimension will determine the length of the horn. It is evident, that with a given expansion ratio and bell, a horn with a small throat must be longer than one with a large opening. Expressed in an equation:

$$L = \frac{\log\left(\frac{D}{D_T}\right)}{\log\ (E.\ R.)^{\frac{1}{2}}}$$

where L is the length, either total or at any point on the horn, measured along the central axis. D is the diameter of the horn if round, or one side if square, either total or at any point. D_T is the diameter or side of the throat. Measurements are in feet.

In this way the overall dimensions of the horn are calculated. In order to complete the design, it is necessary to obtain the diameter of the horn at various points, so it can be laid out. The following equation serves here:

$$D = D_T\ (\ (E.\ R.)^{\frac{1}{2}})^L$$

The meaning of the symbols has been given above.

To provide a simple means of making these calculations, the chart on the opposite page is provided. Curves are drawn for five different cut-off frequencies, which should cover most designs. In order to make the design widely applicable, a throat dimension of 0.5 inch was used in each case. All dimensions are in inches, since this unit is most easily used in layout and construction. Short vertical lines are drawn across four of the five curves at an abscissa equal to the required side of the square bell for that cut-off. The bell for a 32-cycle cut-off should be 93 inches on one side, and is not shown on the curve. The *X* on each of the four curves is drawn at an abscissa equal to the diameter of the round bell required for that cut-off. For a cut-off of 100 cycles, a square bell should be 30 inches on each side, and a round bell should be 33.7 inches in diameter.

To use the curve as it is drawn, for a 0.5-inch throat, simply follow it until you reach the short vertical line or the X. This gives the size of the bell. Reading the ordinate at this point, you will determine the total length of the horn. Thus the length of a 64-cycle round horn would be 162 inches, while that for a 192-cycle square horn would be 39 inches.

As an example of the use of this chart in an actual design problem, let us design a square exponential horn for a 12-inch dynamic speaker. This means that the throat will be 11 inches on a side. It is desirable in this instance to reproduce as low a frequency as possible, without making the horn too large. A 64-cycle cut-off would be acceptable, and so we follow the curve for this frequency until we reach the short vertical line. There we find that the bell would be 47 inches on a side.

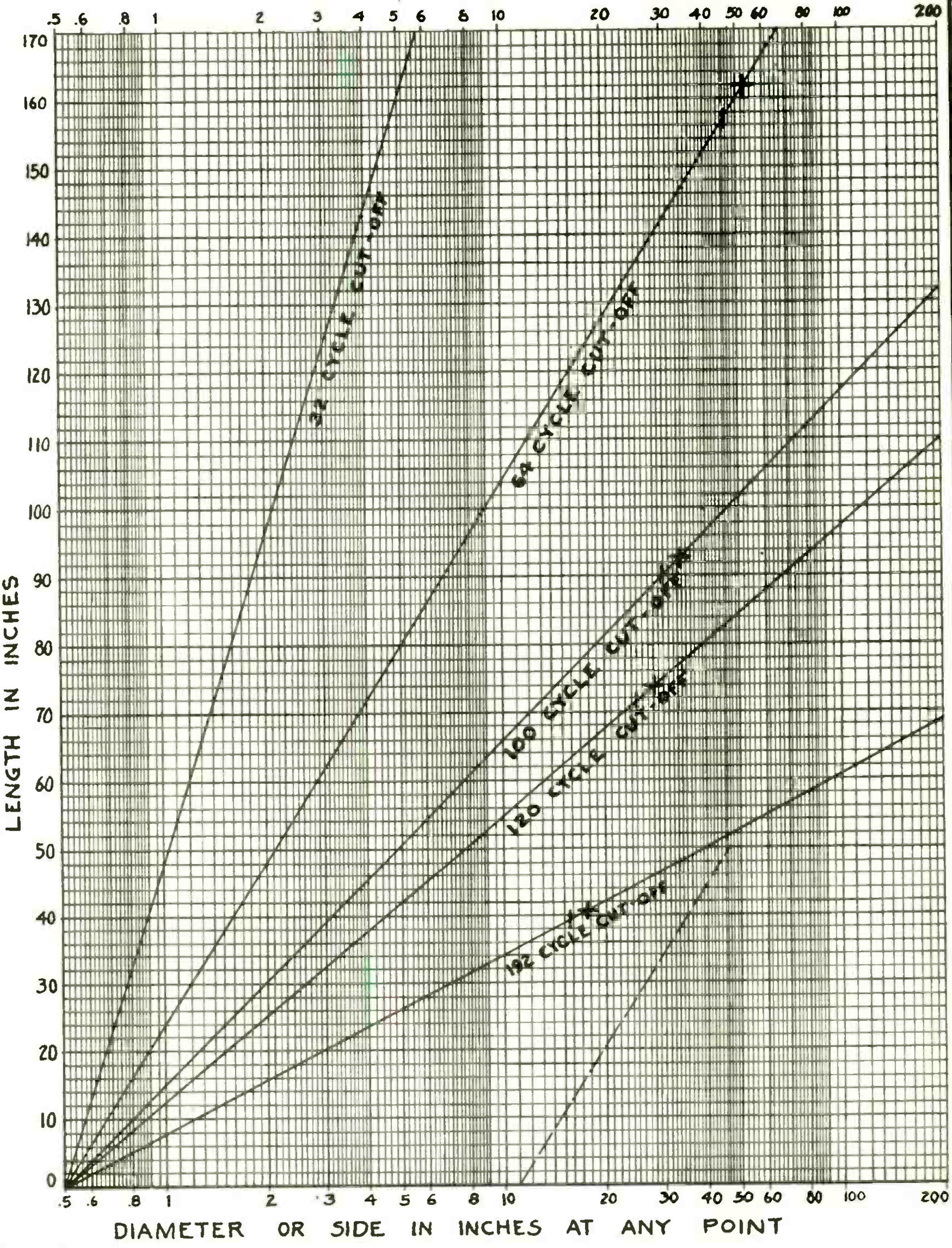
Now through the X-axis at 11 inches we draw a straight line parallel to the 64-cycle curve on the chart. The line is dotted to prevent confusion. This line is drawn only to the 47-inch abscissa, as that will be the extent of the horn. We find the ordinate at that point to be 50 inches, indicating that the horn will have a total length of 50 inches from throat to bell, measured along the axis. Thus we have the overall dimensions of the horn.

To determine the curvature of the horn for layout purposes, we take different readings along the dotted line. At a length of 10 inches from the throat, the cross-section is 14.6 inches on a side; at a length of 20 inches, the cross-section is 19.7 inches, and so on. In this way the cross-section at any length can easily be determined.

A round horn would be designed in exactly the same way, except the dotted line would be drawn to an abscissa corresponding to that of the X on the curve.

Instead of drawing the dotted line, a pair of calipers may be used to work out the design. Set the calipers on the X-axis with a spacing equal to the difference between the throat to be used and 0.5 inch. Then use this setting on the various ordinates to the right of the curve for the desired cut-off.

Curves for other cut-off frequencies may be drawn in by using the equations given above. With a given throat, and using the desired expansion ratio, locate a point for some arbitrary value of length or diameter. Draw a straight line through this point to the X-axis at the given size of throat. The once laborious task of designing an exponential horn thus becomes a simple matter of taking readings from a graph.



.5 .6 .8 1 2 3 4 5 6 8 10 20 30 40 50 60 80 100 200
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
LENGTH IN INCHES
32 CYCLE CUT-OFF
64 CYCLE CUT-OFF
100 CYCLE CUT-OFF
120 CYCLE CUT-OFF
192 CYCLE CUT-OFF
DIAMETER OR SIDE IN INCHES AT ANY POINT

A COMPACT POWER-LEVEL INDICATOR

By CHARLES FELSTEAD

Sound Engineer

UNIVERSAL PICTURES CORPORATION

TION-PICTURE sound recording
ɔjection, in radio broadcasting,
allied communication work, it is
ry to have some form of volume
ʳr, or power-level indicator, for
relative comparisons of elec-
ower in different circuits, or in
t portions of the same circuit.
ɜvice usually assumes the form
ʳacuum-tube voltmeter, and is
to the circuit under measure-
ʳ a suitable tapped input trans-
A visual indication of the
s provided by a calibrated meter
plate circuit of the tube. The
ı the secondary of the input transformer, functioning in conjunction with a potentiometer controlled in fixed steps by a key switch in the grid circuit of the vacuum tube, provide the instrument with a number of ranges, which are calibrated in decibels. Batteries are required to furnish filament and plate current to the tube. A circuit for this type of volume indicator is depicted in Fig. 1. The inductor and condenser in the plate circuit of the tube constitute a simple filter that tends to smooth out the action of the meter pointer when the device is employed on a circuit carrying speech current.

This standard form of power-level indicator is eminently suited for use in a permanent installation where the compactness of the instrument is of less importance than accuracy of calibration; but for use with portable equipment, or as a test meter where only a comparison of relative power levels is required, a more compact and less elaborate instrument is desirable. The power-level indicator for portable work should also be very rugged to enable it to stand rough usage in the field, and it should preferably be an instrument that does not require a vacuum tube or batteries for its functioning. Economy of cost is likewise an important feature, as is the availability in any laboratory of the apparatus employed in its construction. It was with these requirements in mind that the device described in this paper was designed.

As will be evident from the circuit diagram in Fig. 2, the instrument was reduced to essentials and no unnecessary parts were introduced in its construction. To provide a large power transfer to the meter circuit, so that it would be sensitive to low electrical power levels, an input transformer having a one-to-one ratio between primary and secondary windings and a primary impedance that matched the standard transmission-line impedance of 500 ohms was used.

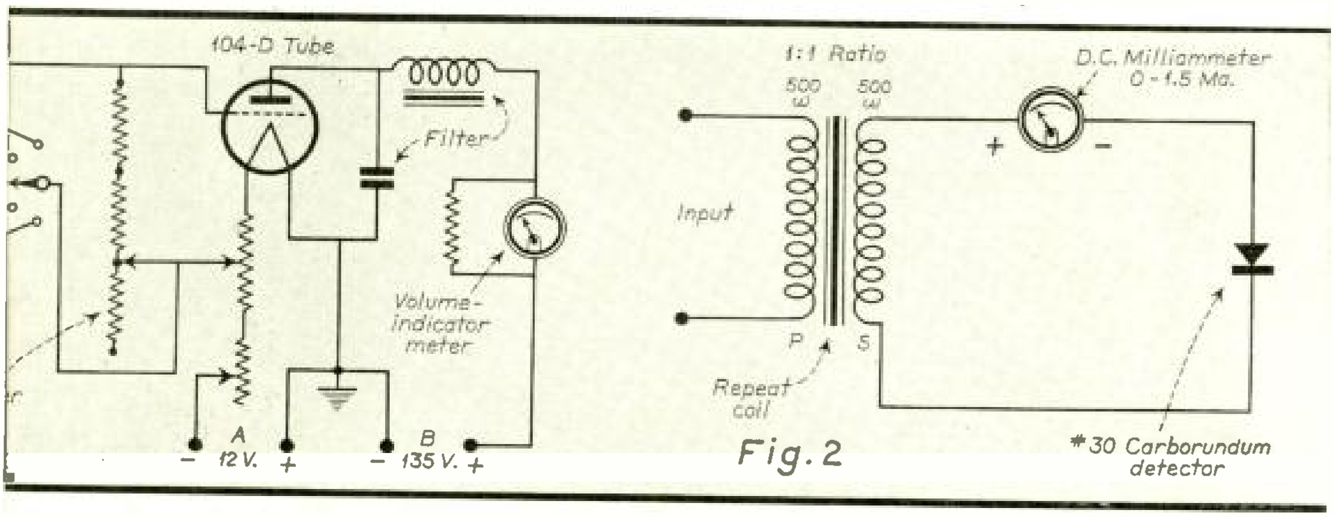


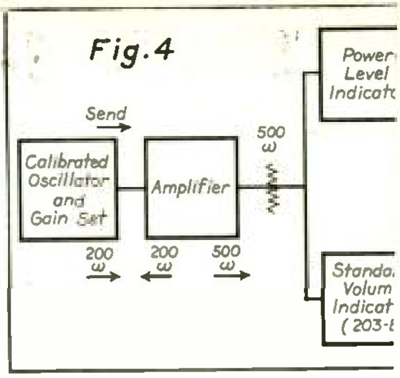
Fig. 2

...cal Level in ...elative to ...6 Watt at ...0 C.P.S.	Meter Reading in Ma. with Volume-Control Potentiometer full on
−10	0.03
−8	0.05
−6	0.08.
−4	0.14
−2	0.24
0	0.40
+2	0.66
+4	1.05
+5	1.37

Table I

The indicating meter was a high-grade d-c milliammeter with a range of 0-1.5 milliamperes. Since the instrument was intended for measuring alternating current, it was necessary to connect a rectifying unit in series with the meter so that the alternating current would be converted to pulsating direct current. A copper-oxide or other form of rectifier could be used; but in this particular instrument, a No. 30 carborundum detector, which is in the form of a cylinder about half the length of a fountain pen, was employed because of its small size. In placing the meter in the circuit, it is necessary that the proper polarity be observed. This is most easily determined by connecting the meter and applying a low a-c voltage to the input of the transformer. The leads to the meter can be reversed if it is found to be connected backward.

scribed in this article in decibels relative to 0.006 watt against milliamperes on the meter at 1000 cps. This range of the indicator was determined with the potentiometer turned to full on, and is practically the same range as obtained with the circuit shown in Fig. 1. It is not possible to measure an electric level lower than —10 decibels with this instrument, but by turning the potentiometer toward the off position, electrical levels far higher than +5 decibels may be measured. When the indicator is



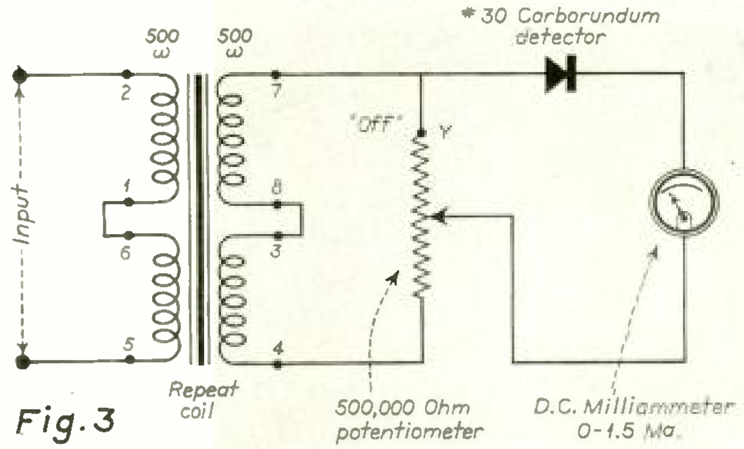
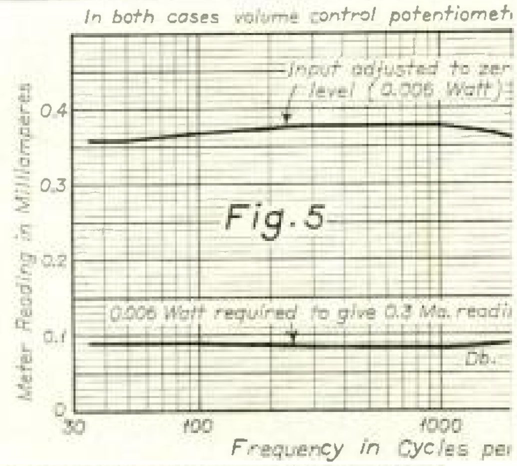


Fig.3



This original circuit proved to be unsatisfactory for general work, because the range of the indicator was too limited without the incorporation of some form of control for regulating the amount of power applied to the meter. The circuit was changed to that shown in Fig. 3, employing a 500,000-ohm potentiometer shunted across the secondary of the transformer, which was found to function perfectly. The potentiometer allowed any amount of the voltage induced across the secondary of the transformer to be applied to the meter circuit.

Because the potentiometer was not a tapped affair, it did not permit accurate calibration of the indicator to be made at any point other than the full-on position. But as the indicator was intended primarily for reading relative power levels, this fact was of no particular consequence. The advantage accrued from the use of the potentiometer was that it provided an off position when the blade was at the bottom of the resistance element, or the point *Y*. This point was carefully marked on the panel. No matter how high the voltage induced across the secondary of the transformer becomes, there is no danger of harming the meter when the potentiometer is in the off position.

In Table I (also refer to Fig. 4) is given the range of the instrument deconnected to a source of unknown level, it is good practice to begin with the potentiometer at the off position and advance it gradually until the meter indicates a mid-scale or other convenient reading. This precaution will serve to protect the meter from burn-out due to the application of excessive power.

The frequency-response characteristic of this particular indicator is given in the curve of Fig. 5. It was obtained by applying tones of different frequency at zero level (0.006 watt) to the input of the indicator and recording the readings of the milliammeter. It will be noted that the response falls off rather rapidly at the higher frequencies. This was caused by the characteristics of the carborundum detector unit, although the transformer employed in the instrument may have augmented it slightly. For certain types of applications of the indicator, this lack of response to the higher frequencies is decidedly disadvantageous; but when the indicator is employed for the purposes for which it was designed, it is immaterial. A table of correction factors may be compiled, if necessary, by comparison with a standard volume indicator, and the factors applied to the readings obtained with this instrument.

Some of the applications of this power-level indicator are: (1) to the output of a radio-receiving set for the balancing of tuning condensers to the output of the amplifier motion-picture theatre or record stallation for the selection of tu the adjustment of apparatus to the greatest possible gain comme with stability; and (3) to balar sets of amplifiers, as in a the that they will furnish the same of gain. In each of these examp electrical input to the amplifiers be a tone of fixed amplitude of frequency. A 1000-cycle phor record or reel of film is a satis source of tone where a pickup is available. Otherwise an audi lator with a suitable impedance ing transformer should be emplc

The indicator may also be u checking the relative outputs of or condenser microphones, ph tric-cell amplifiers, and pho pickups. It may be employed to electrical levels within the ca limits, to measure the relative levels in different portions of ar fying system; and it will ser volume-indicator meter when cc in a speech circuit, thus prov constant visual check on the ar of the voice currents. Many o plications of this useful instru the measurement of power l audio frequencies will be disco practice.

DESIGN OF RESISTANCE PADS

The equations derived in this article are readily applicable to the design of almost any type of resistance pad. Actual working curves have been plotted from these equations. While the curves given here are felt to be of sufficient size, and hence accuracy, for the ordinary design requirements, greater ease of reading and added detail may be gained by replotting them to a larger scale.

By C. F. NORDICA

MUCH HAS BEEN written during the past few years on the design of resistance pads of various sorts. A number of involved formulae have been developed with the aid of hyperbolic trigonometry and transmission theory, which together with numerous graphs and charts can usually be made to yield the results required to fit any specific problem. However, it seems somewhat absurd to resort to any involved procedure to design so simple and common a structure as a resistance pad. It is proposed here to derive, with the aid of only simple algebra and the application of Kirchoff's laws, expressions for the constants of resistance pads . . . expressions which can be easily remembered and quickly solved.

SIMPLE T-PAD CALCULATION

The resistance pad must, in general, fulfill two and only two conditions. They are: First, the pad must have a prescribed loss in db when inserted between a generator of impedance A and a terminating resistance B, and the pad must match the generator impedance A on its input and B on its output when working between these impedances. These conditions are illustrated in Fig. 1 in which A and B are resistances, since this represents the usual case. Applying Kirchoff's laws to this network, there results:

$$P(I_1 - I_2) = (N + B) I_2$$

$$\frac{I_2}{I_1} = \frac{P}{N + B + P} = R.$$

Whence,

$$P = \frac{R}{(1 - R)} (N + B).$$

But,

$$A = Z_1 = M + \frac{P(N + B)}{P + N + B} = M + R(N + B).$$

Therefore,

$$M = A - R(N + B)$$

and

$$B = Z_2 = N + \frac{P(M + A)}{P + M + A} = N + \frac{R(N + B)(M + A)}{R(N + B) + (1 - R)(M + A)}.$$

Solving for M, N and P, we have,

DESIGN CURVES OF CONSTANTS FOR L-TYPE IMPEDANCE-MATCHING PAD. THE VALUES OF M AND P HAVE BEEN EXPRESSED IN TERMS OF THE GENERATOR IMPEDANCE A.

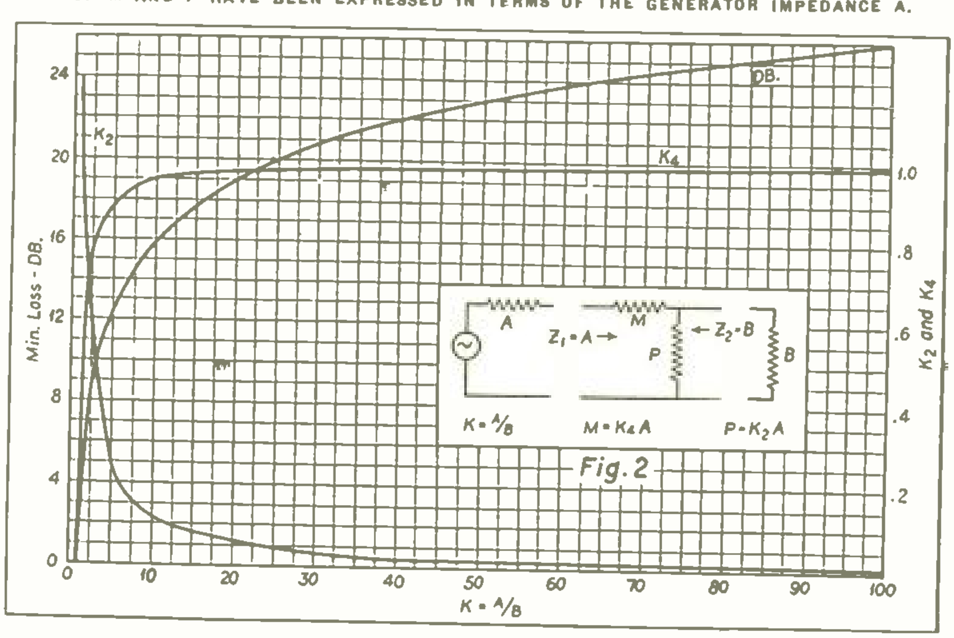


Fig. 2

THE USUAL OR T-TYPE RESISTANCE PAD WHICH IS DESIGNED TO HAVE A DEFINITE LOSS IN DB.

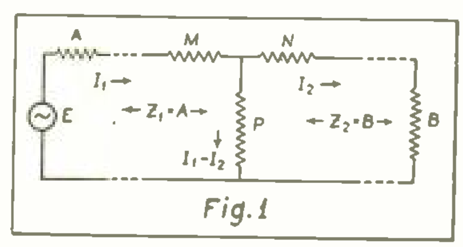


Fig. 1

AN L-TYPE PAD DESIGNED FOR LOW LOSS.

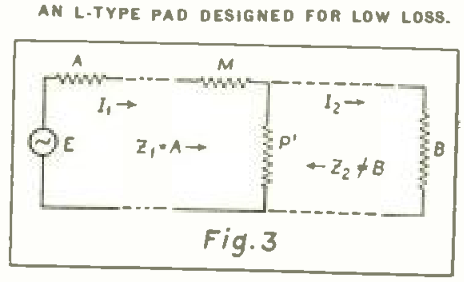


Fig. 3

$$M = \frac{A^2 - 2\,RAB + R^2\,AB}{A - R^2\,B}$$

$$N = \frac{(1 - 2\,R)\;AB + R^2\,B^2}{A - R^2\,B}$$

$$P = \frac{2\,RAB}{A - R^2\,B}.$$

While the above values express M, N and P in terms of the terminal impedances and the ratio of output to input current, it is usually more convenient to have them given in terms of the terminal impedances and the insertion loss of the pad. From the relations,

$$\lambda = \varepsilon^{-\alpha l}$$

and

$$L = 20 \log \lambda^{-1}\ \text{db}$$

it may be shown for this case that

$$R = \lambda \sqrt{\frac{A}{B}} \qquad = \lambda \sqrt{\frac{Z_1}{Z_2}}.$$

Substitution for R gives,

$$M = \frac{2\,A - 2\,\lambda\sqrt{A\,B}}{1 - \lambda^2} - A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$N = \frac{2\,A - 2\,\lambda\sqrt{A\,B}}{1 - \lambda^2} - B \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$P = \frac{2\,\lambda\sqrt{A\,B}}{1 - \lambda^2}. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

A COMMON PROBLEM

One of the most common problems is to design a pad, for impedance matching only, which will have minimum attenuation. For this case if A is greater than B, the condition of minimum attenuation will be reached when N vanishes. Whence,

$$B = \frac{2\,B - 2\,\lambda\sqrt{A\,B}}{1 - \lambda^2}$$

and

$$\lambda = \frac{\sqrt{A} - \sqrt{A - B}}{\sqrt{B}}.$$

Let

$$A = K\,B.$$

Then

$$\lambda = \sqrt{K} - \sqrt{K - 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

and the loss in db is

$$L = 20 \log \lambda^{-1}.$$

Hence

$$P = \frac{2\,\lambda\sqrt{K}}{1 - \lambda^2}\,B = \frac{2\,\lambda}{\sqrt{K}\,(1 - \lambda^2)}\,A$$

and

$$M = \left[\frac{2\,K - 2\,\lambda\sqrt{K}}{1 - \lambda^2} - K\right] B = \left[\frac{2\sqrt{K} - 2\,\lambda}{\sqrt{K}\,(1 - \lambda^2)} - 1\right] A.$$

Obviously both P and M may then be expressed as a function of either A or B and a constant which, in turn, is a function of K and λ. That is,

$$P = K_1\,B = K_2\,A$$

where

$$K_1 = \frac{2\,\lambda\sqrt{K}}{1 - \lambda^2}$$

and

$$K_2 = \frac{2\,\lambda}{(1 - \lambda^2)\sqrt{K}}$$

Also

$$M = K_3\,B = K_4\,A$$

where

$$K_3 = \left(\frac{2\,K - 2\,\lambda\sqrt{K}}{1 - \lambda^2} - K\right)$$

and

$$K_4 = \left(\frac{2\sqrt{K} - 2\,\lambda}{(1 - \lambda^2)\sqrt{K}} - 1\right)$$

MINIMUM LOSS CONDITION

Needless to say the case of interest is that for the pad of minimum loss, so that λ is fixed by this condition for any value of K, as shown in formula (4). It immediately follows that curves for K_1, K_2, K_3 and K_4 may be plotted as a function of K, or the ratio of generator and terminal impedances. Fig. 2 indicates one set of curves in which M and P are expressed as functions of A. Naturally a similar set of curves may be drawn for K_1 and K_3.

In some cases the loss resulting from the insertion of an impedance-matching pad of the type shown in Fig. 2 is greater than can be tolerated. In such cases it is customary to match impedances in only one direction, usually the higher impedance side, and to design the pad for this condition and the desired loss.

Such a pad is illustrated in Fig. 3. To arrive at the design formula for this case, let

$$R = \frac{I_2}{I_1} = \frac{P'}{P' + B} \quad \text{and} \quad Z_2 = B.$$

But

$$P' = B\,\frac{R}{1 - R}$$

and

$$M = \frac{A\,(2\,R - 1) - RB}{1 - 2\,R}.$$

If

$$B = A$$

then

$$M = A\left(\frac{R - 1}{1 - 2\,R}\right) = A\,\frac{(1 - R)}{2\,R - 1}.$$

Now if

$$Z_2 \neq B$$

but

$$Z_1 = A$$

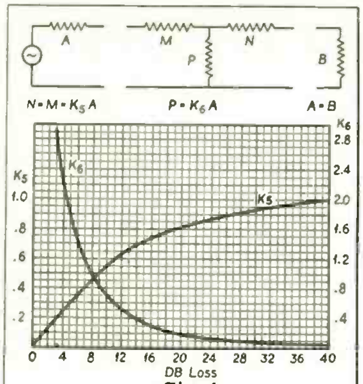


Fig. 4

CURVES OF CONSTANTS FOR SYMMETRICAL T-TYPE IMPEDANCE-MATCHING PAD.

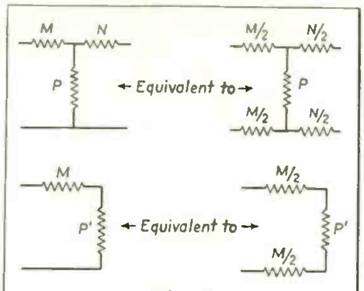


Fig. 6

THE SAME LINE OF REASONING USED IN THE DESIGN OF L- AND T-TYPE PADS MAY ALSO BE USED FOR THE DESIGN OF H AND U TYPES.

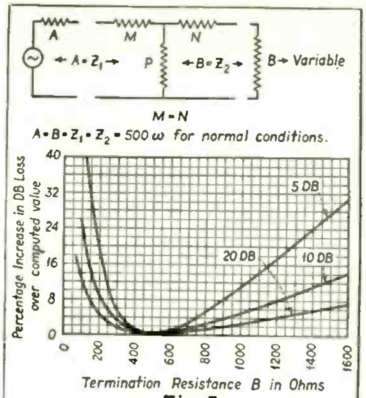


Fig. 5

CURVES SHOWING ERROR DUE TO MISMATCH OF A SYMMETRICAL T-PAD.

it follows that

$$M = A\,(1 - R$$

and

$$P' = A\,\frac{R}{1 - R} = \frac{A^2 R}{M}.$$

EQUAL IMPEDANCE CASE

Formulae (1), (2) and (3) may, of course, be simplified for the case of equality between generator and terminating impedances. For that case these formulae reduce to

$$M = \left(\frac{1 - 2\lambda + \lambda^2}{1 - \lambda^2}\right) A = \left(\frac{1 - \lambda}{1 + \lambda}\right) A = K_5\,A \quad (5)$$

$$P = \frac{2\lambda}{1 - \lambda^2} A = K_6\,A \quad (6)$$

$$N = M = \frac{1 - \lambda}{1 + \lambda} A \quad (7)$$

Curves of constants for N, M and P are shown in Fig. 4.

MISMATCHING OF T PADS

Another case of interest is that for mismatching of a T-type pad. As long as the pad has a large loss and is terminated in a pure resistance it can produce no frequency distortion. However, the loss produced by the pad will be greater for the mismatched condition than the calculated loss. The computations involved in this case are identical with those used in setting up the initial equations for pad constants. The results for a 500-ohm symmetrical, T-type pad are shown in Fig. 5. The curve parameters in this case are the computed loss of the pad under conditions of impedance match. It is assumed for this instance that the generator impedance is matched and the terminating impedance varied.

U- AND H-TYPE PADS

The above discussion has been confined to unbalanced or T- and L-type structures. Obviously the same reasoning applies to balanced or H- and U-type structures. In the H-type structure, each series arm is half the value of the similar arm of the equivalent T-type pad. This is illustrated in Fig. 6. The shunt arm, is of course, unchanged in converting from the balanced to the unbalanced type of structure.

It is interesting to examine a pad terminated in a complex impedance. Limited space will preclude any extended discussion of this matter which is doubtless only of academic interest to the engineer. However, the case of a complex impedance equal to the termination impedance is a matter of some interest in high-frequency work. Since loss is normally expressed as a ratio of power delivered to a termination to power supplied, it becomes meaningless here . . . particularly for the limiting case of a wholly reactive termination. In instances of this nature current ratios, rather than power, are usually the quantity of interest.

In the circuit of Fig. 7, let,

$$R = \frac{I_2}{I_1}$$

(*Continued on page* 21)

THESE CURVES GIVE THE ACTUAL CURRENT RATIO AND PERCENT REACTANCE IN THE TERMINATION RESISTANCE OF DIFFERENT VALUES OF DB IN THE T-PAD.

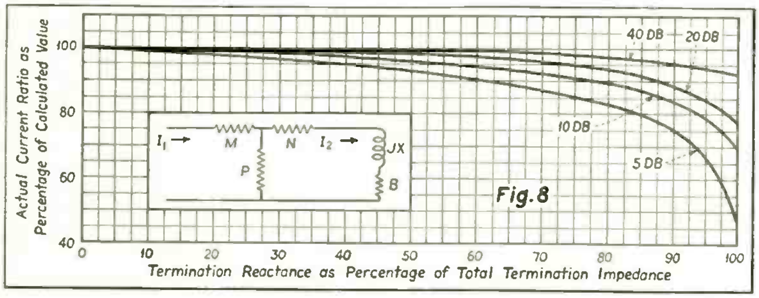


Fig. 8

THE OUTPUT IMPEDANCE IN THIS CIRCUIT HAS BOTH RESISTANCE AND REACTANCE, AND THE T-PAD DESIGN FORMULAE MUST BE DEVELOPED WITH THIS IN MIND.

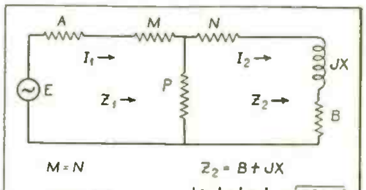


Fig. 7

Balanced Amplifiers

PART V

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA INSTITUTES, INC.

XIX. DESIRABILITY OF DRIVING GRIDS POSITIVE

OUR DISCUSSION of balanced amplifiers now leads us to the analysis of the grid circuit. If the grids were not to be driven positive then the input circuit for the balanced-amplifier stage would not differ materially from that of the single-side circuit. The only additional precaution of any consequence would be that of insuring that the two grid voltages (in the two halves of the secondary of the input transformer) were in phase opposition at all frequencies. This arises from the fact that the balanced-amplifier input transformer is essentially a three-winding transformer, and it is therefore possible for the two secondary voltages to be other than in phase opposition, particularly at the higher frequencies due to the distributed capacity of the windings and mutual inductance between the two halves of the secondary as well as between each half and the primary.

However, the power output of a balanced amplifier under the above conditions is relatively low, and while the plate-supply voltage may be increased (and the C bias also increased in order concomitantly to keep the plate dissipation within prescribed limits—especially at no signal), and thus more power output obtained, there is an upper limit to this increase which is determined by the insulation strength of the tube and the cost of the power supply, particularly the filter condensers.

Since, as has been shown in the previous article (October, 1936), balanced-amplifier operation is not limited by plate-current cut-off, it would appear equally desirable to remove the other restriction necessary for Class A operation that the grids be not driven positive. As a result, experiments were directed towards the expanding of the range of operation with the result that under proper design grid swings of amplitude sufficient to drive the grids positive have been successfully employed. The result has been a large increase in power output and also in plate efficiency, which is the ratio of a-c power output from the tube, to d-c power input from the B supply; also the obtaining of large power outputs at reasonably low B voltages. This mode of operation, i.e., plate currents driven beyond cut-off and grids driven positive, has been named—tentatively at least—Class AB_2. The letters AB refer to operation beyond plate-current cut-off; the subscript 2 to the fact that the grids are driven positive.

XX. DRIVER-TUBE CONSIDERATIONS

It is a fundamental fact in the theory of electrical circuits that when current flows in the same direction as the voltage acting in that circuit, power is absorbed by the latter. In the case of the grid circuit, whenever the grid is driven positive electron flow is from the cathode to the grid and then externally around the grid circuit back to the cathode, which means that the conventional flow of electric current is in the same direction as the grid signal voltage. Hence, it represents energy absorbed in the grid circuit, which energy must come from the source of signal voltage, i.e., the tube preceding the power-amplifier stage. We therefore see that this latter tube has been elevated from the role of a voltage-amplifier stage to that of a power-amplifier stage and due to this is usually called a driver tube; i.e., it drives the grids of the balanced-amplifier stage alternately positive and supplies the electrical power absorbed by them when positive. The driver tube must therefore have a power rating adequate for the grid requirements, and indeed, as will be shown, must have more than this rating in order that the distortion produced in the grid circuit be kept within allowable limits.

It may be well to amplify on this latter point. In ordinary power work, the rating of a generator depends usually upon its allowable temperature rise, since in most cases it is capable electrically of furnishing much more output than the above rating suggests. In the case of vacuum tubes operating Class A, however, such temperature rating does not limit its maximum power output since it actually runs cooler under maximum grid-swing conditions than at no signal, because in the former case the plate dissipation is equal to the difference between the practically constant input power from the B supply, and the a-c power output into the load. Hence, the maximum output is determined solely by the electrical characteristics of the tube, namely, by the optimum value of the load resistance which will give this maximum power output with distortion products that fall within prescribed limits. The optimum value of load resistance is determined by the equivalent internal resistance of the tube.

In the case of a driver tube, the load it feeds is the grid circuit of the balanced-amplifier stage and this circuit is very nonlinear in its characteristic. For instance, if the grids are negatively biased, no current flows until they are actually driven positive by the driver, so that they appear to the latter as an infinite load resistance for the early part of the signal cycle. Then in that portion of the cycle where they are driven positive they suddenly appear as a finite resistance, which, however, is not constant, for the grid current is not in direct proportion even to the positive grid voltage. It is therefore evident that the voltage drops in the driver and associated coupling transformer will depend upon this variable grid current, and hence, the terminal voltage across either half of the transformer will be distorted by the internal drops in it and the driver tube even though an equivalent sinusoidal voltage be generated in the tube itself.

Our problem is therefore two-fold:

(1) To determine the grid-current flow during the portion of the cycle of the signal voltage when the grid is positive; and

(2) To determine the permissible internal impedance of the driver source for a prescribed allowable distortion of the grid signal voltage.

We attack problem (1) first.

XXI. DETERMINATION OF GRID CURRENT

The instantaneous grid current is a function both of the grid and plate volages. The relative effect of the plate voltage, as compared with the grid voltage, upon the grid current has been called the "reflex factor" and while analagous to the amplification factor, is practically always of a value less than unity. However, under extreme conditions of operation it is possible for the plate voltage to have at some instant a large effect upon the grid current due to the relative division of the space current between the two electrodes, and also due to secondary emission and even possible dynatron effects occurring either at the plate or at the grid. Consequently, any attempt to determine the grid-current versus grid-voltage characteristic must take into account the plate voltage. The latter in turn depends upon the actual grid-to-cathode voltage and load impedance (as well as any regulation in the B-power supply.)

Thus, it would seem that a method of simultaneous solutions must be employed. However, it is possible first to solve the plate-circuit condition (as given in the previous articles) upon the assumption of a certain form of grid voltage (usually sinusoidal) and then determine the alteration of grid voltage permissible as far as distortion of the output of the plate circuit is concerned. This is tantamount to assuming, as a first approximation, that the driver internal impedance is zero. Hence, if the load line for the balanced amplifier has been determined for this form of grid voltage, the grid current can then be found. For this purpose it is convenient to plot the latter as a function of the *plate voltage,* with the grid voltage as a parameter. This gives rise to a family of curves which is super-imposed on the plate family as shown in Fig. 23.

It will be noted that for a very positive grid voltage e_{g3}, the grid current at any plate voltage is higher than for a lower positive grid voltage e_{g1}. It will also be noted that the curve for any one positive grid voltage rises as the plate voltage decreases. As mentioned previously, this is due to the fact that the grid, being closer to the cathode, diverts space current to itself. As a result the plate-current curve drops sharply downward where the corresponding grid-current curve rises sharply upward, hence the load resistance R_L must be chosen low enough so that its curved push-pull load line cuts the plate family of curves above the region where they thus droop sharply, otherwise excessive distortion will result.

If the grid voltage is more than twenty volts positive or thereabouts, secondary emission may occur at this electrode. This phenomenon is not very well understood as yet, although considerable research work is going on at the present time to determine its characteristics and quantitative relations. The amount of secondary emission depends not only upon the potential of the electrode, but its substance and surface condition. By suitably treating the surface of a grid, the secondary emission may be considerably reduced.

When secondary emission occurs at the grid, and the plate at that instant is more positive than the grid, secondaries may go from the latter to the plate. The result is that the grid current may cease to rise with increase of grid potential, or it may rise less rapidly than for lower grid potentials, or—in extreme cases, it may even decrease—sometimes even go negative. The latter case gives rise to a dynatron action; the grid-to-cathode variational resistance is negative, and at that moment the grid or input circuit may oscillate (depending upon the positive damping in this circuit).

The plate current will reflect these oscillations in its wave shape, and the result is distortion which is not even of harmonic frequency with respect to the fundamental. Such dynatron action may occur if the plate voltage is high when the grid swings sufficiently positive, and will be shown up in the shape of the right-hand portion of the grid-current curves.

However, due to the load resistance, the plate current increases in the tube whose grid is swinging positive, and the plate voltage is concomitantly falling, as indicated—for instance—in Fig. 23. In other words, when the grid voltage e_g is at its peak positive value, then the plate voltage at that instant is at its minimum value, hence such dynatron action can occur only if e_p is sufficiently high even when at its minimum value. This is not usually the case unless a very low value of load resistance is employed, or a very high value of B voltage. Consequently, this action may be expected more in large high-voltage tubes than in small ones used for radio receivers, etc. Of course, the surface of the grid also has an important bearing on the matter.

In extreme cases, dynatron action may occur at the plate. The result is ordinarily a flattening of the peak of the plate-current wave, although, for high values of load resistance, and large positive grid swings, the plate-current wave may show at its center a subsidiary minimum instead of a peak. This of course means that as the grid swings positive to its peak value, the plate current at first increases, but then decreases, due to the grid diverting the space current more completely to itself, and also possibly to its robbing the plate of sec-

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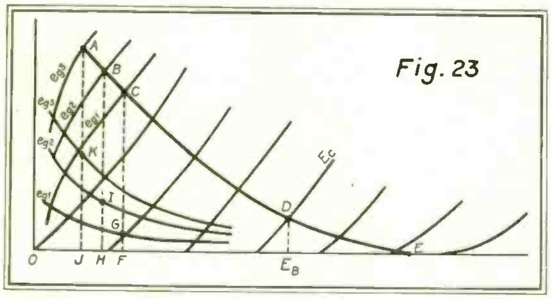


Fig. 23

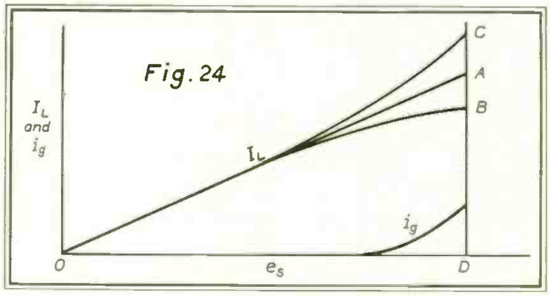
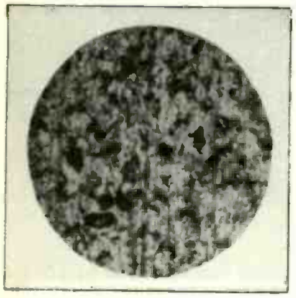
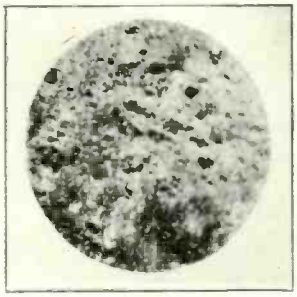


Fig. 24

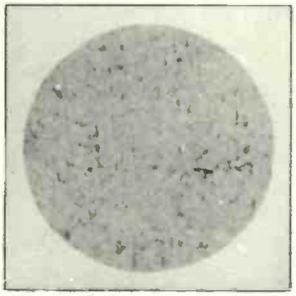
THESE ARE *Tell-Tale* PICTURES



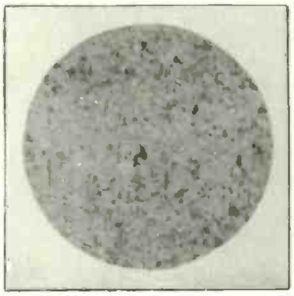
Nickel, washed only.
Not etched.
(100 x unretouched)



Nickel, after 150 hour bath in mercury at room temperature.
(100 x unretouched)



SVEA Metal, washed only.
Not etched.
(100 x unretouched)



SVEA Metal, after 150 hour bath in mercury at room temperature.
(100 x unretouched)

Photo micrographs of SVEA Metal, compared with nickel, showing effect of excessive amalgamation of mercury with nickel.

What does this mean in Mercury Rectifiers?

WE CLAIM that UNITED Svea metal mercury rectifiers will give longer and more satisfactory service than any similar type tube available.

WE EXPLAIN these superior features as follows:

1st SVEA metal instead of nickel, is employed in UNITED mercury rectifiers for anode, baffle and shield.

2nd Mercury forms an amalgam on nickel surfaces, as illustrated by photo micrographs. This amalgamation proceeds to gradually eat into the nickel during the life of the tube, ultimately uncovering unclean pockets in the nickel from which harmful occluded gasses are liberated.

In the case of UNITED rectifiers, this condition does not exist, because of the density of SVEA metal plus the fact that it does not amalgamate with mercury.

3rd UNITED processed SVEA metal is completely "cleaned" not only of surface impurities, but of internal amorphous contaminations. Therefore, no occluded gas is present within the metal structure during the exhaust and bombardment process.

Where nickel is used, residual foreign matter is released during the exhaust and bombardment process, thus poisoning the filament to a certain extent.

4th The amount of mercury used in UNITED rectifiers is kept to a minimum. This insures against arc-over when tubes are first placed in service, and adds a safety factor on pre-heating time.

5th Purity of material permits greater mass of metal — hence adequate sized shields are used in UNITED mercury rectifiers.

UNITED ELECTRONICS COMPANY

WE PROVE these points as follows:

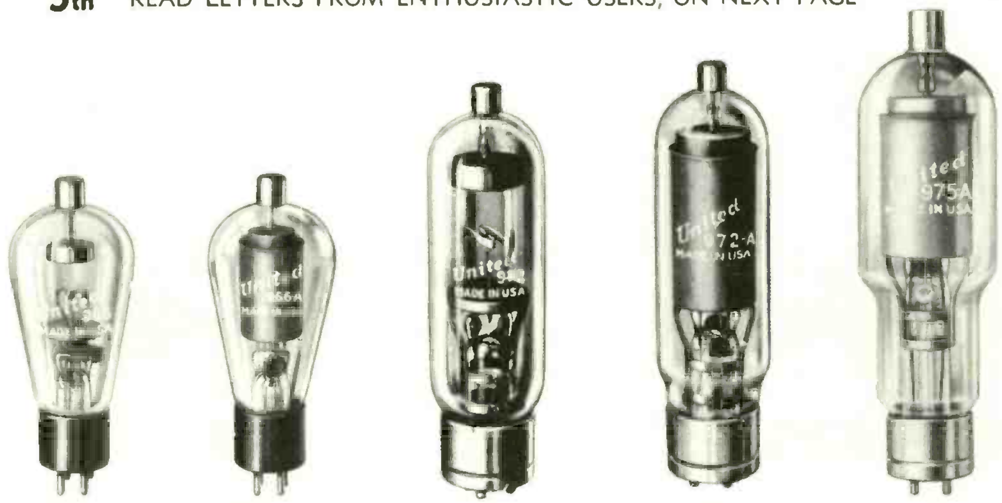
1st By service records of thousands of tubes sold over the past year. Hundreds of UNITED mercury rectifiers of different types have been furnished under contract to certain U. S. Government Departments, and other large users, without a single case of failure.

2nd The "perfect blue glow" evident in UNITED types 966, 966A, 972, 972A and 975A is proof of adequate emission, freedom from gas, and that they are designed to give proper relationship between ambient and condensed mercury temperature.

3rd Every UNITED rectifier delivered passes a pre-shipment test at the excess rating schedule tabulated below.

4th Ask any engineer or amateur who has used them.

5th READ LETTERS FROM ENTHUSIASTIC USERS, ON NEXT PAGE



966 966 A 972 972 A 975 A

UNITED MERCURY RECTIFIER SPECIFICATIONS, RATINGS and PRICES

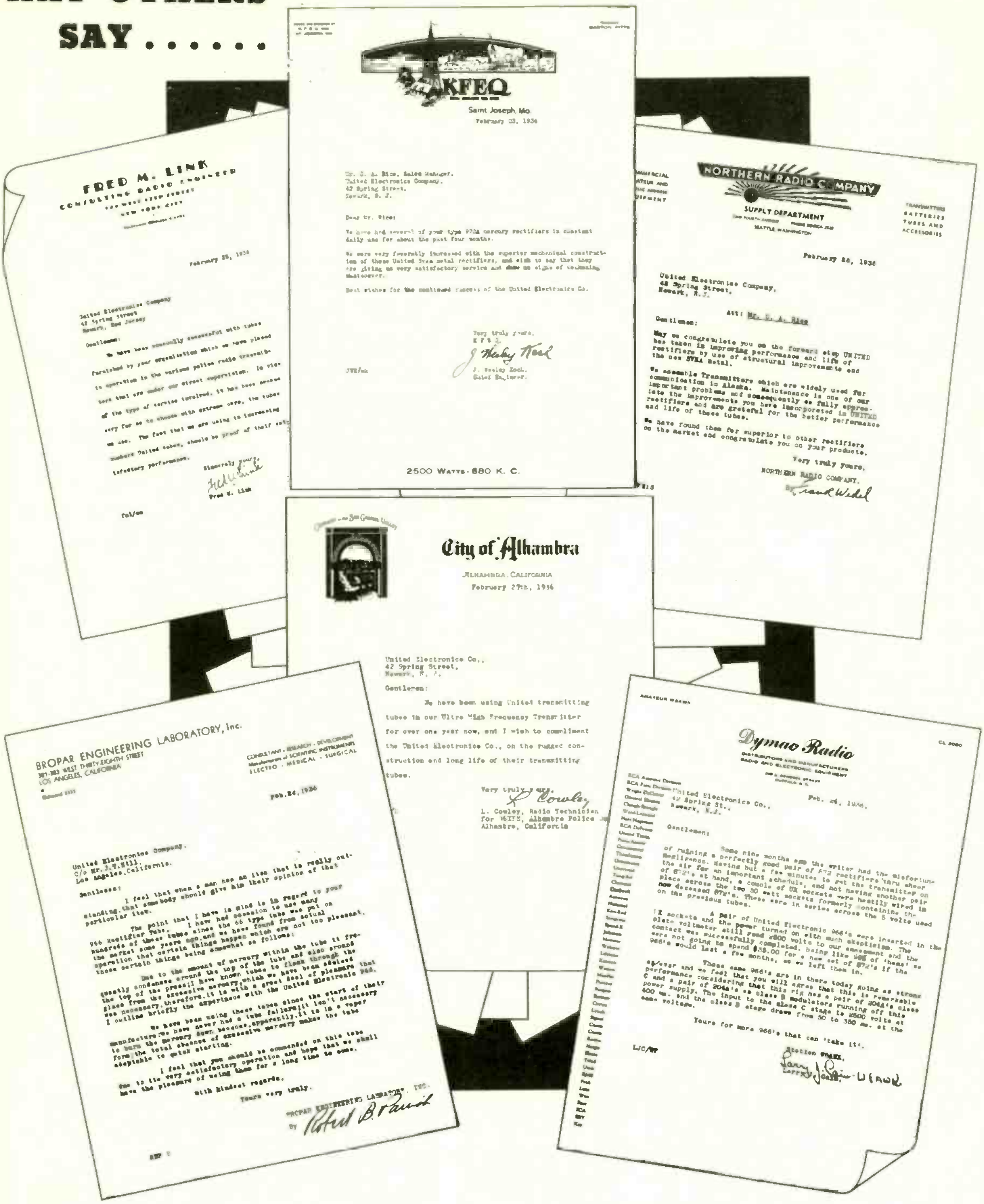
Type	Function	Fil. Volts	Fil. Amps.	Max. Peak Inverse Volts	Max. Peak Plate Current	General Description	Base Type	Filament Type	Max. Overall Dimensions Inches	Price
966	Half Wave Rectifier	2.5	5.0	7500	1.0	Mercury Vapor	Medium 4-Pin	Coated	2 7/16 x 6 5/8	$ 1.75
966A	Half Wave Rectifier	2.5	5.0	10000	1.0	Mercury Vapor	Medium 4-Pin	Shielded Coated	2 7/16 x 6 5/8	4.00
972	Half Wave Rectifier	5.0	10.0	7500	5.0	Mercury Vapor	Standard 50 Watt	Coated	2 5/16 x 8 1/2	14.00
972A	Half Wave Rectifier	5.0	6.75	10000	5.0	Mercury Vapor	Standard 50 Watt	Shielded Coated	2 5/16 x 8 1/2	16.50
975A	Half Wave Rectifier	5.0	10.0	15000	6.0	Mercury Vapor	Standard 50 Watt	Shielded Coated	3 x 10 5/8	30.00

FACTORY PRE-SHIPMENT TEST SCHEDULE

Type	D. C. Volts	Inverse Volts	Peak Amps.
966	3200	10,000	0.75
966A	3800	12,000	0.75
972	3200	10,000	3.25
972A	3800	12,000	3.25
975A	5600	17,500	3.9

42 SPRING ST., NEWARK, N. J.

WHAT OTHERS SAY......



FRED M. LINK
CONSULTING RADIO ENGINEER
NEW YORK CITY

February 25, 1936

United Electronics Company
42 Spring Street
Newark, New Jersey

Gentlemen:

We have been unusually successful with tubes furnished by your organization which we have placed in operation in the various police radio transmitters that are under our direct supervision. In view of the type of service involved, it has been necessary for us to choose with extreme care, the tubes we use. The fact that we are using in increasing numbers United tubes, should be proof of their satisfactory performance.

Sincerely yours,
Fred M. Link

FML/em

KFEQ
Saint Joseph, Mo.
February 23, 1936

Mr. C. A. Rice, Sales Manager,
United Electronics Company,
42 Spring Street,
Newark, N. J.

Dear Mr. Rice:

We have had several of your type 972A mercury rectifiers in constant daily use for about the past four months.

We were very favorably impressed with the superior mechanical construction of these United Svea metal rectifiers, and wish to say that they are giving us very satisfactory service and show no signs of weakening whatsoever.

Best wishes for the continued success of the United Electronics Co.

Very truly yours,
K F E Q
J. Wesley Koch,
Chief Engineer.

JWK/mk

2500 WATTS · 680 K. C.

NORTHERN RADIO COMPANY
SUPPLY DEPARTMENT
SEATTLE, WASHINGTON
TRANSMITTERS
BATTERIES
TUBES AND
ACCESSORIES

February 26, 1936

United Electronics Company,
42 Spring Street,
Newark, N.J.

Att: Mr. C. A. Rice

Gentlemen:

May we congratulate you on the forward step UNITED has taken in improving performance and life of rectifiers by use of structural improvements and the new SVEA Metal.

We assemble Transmitters which are widely used for communication in Alaska. Maintenance is one of our important problems and consequently we fully appreciate the improvements you have incorporated in UNITED rectifiers and are grateful for the better performance and life of these tubes.

We have found them far superior to other rectifiers on the market and congratulate you on your products.

Very truly yours,
NORTHERN RADIO COMPANY.
By Frank Wedel

City of Alhambra
ALHAMBRA, CALIFORNIA
February 27th, 1936

United Electronics Co.,
42 Spring Street,
Newark, N. J.

Gentlemen:

We have been using United transmitting tubes in our Ultra High Frequency Transmitter for over one year now, and I wish to compliment the United Electronics Co., on the rugged construction and long life of their transmitting tubes.

Very truly yours,
L. Cowley
L. Cowley, Radio Technician
for W6XYZ, Alhambra Police
Alhambra, California

BROPAR ENGINEERING LABORATORY, Inc.
301-303 WEST THIRTY-EIGHTH STREET
LOS ANGELES, CALIFORNIA
CONSULTANT · RESEARCH · DEVELOPMENT
Manufacturers of SCIENTIFIC INSTRUMENTS
ELECTRO · MEDICAL · SURGICAL

Feb.24,1936

United Electronics Company.
C/o Mr.J.T.Hill.
Los Angeles,California.

Gentlemen:

I feel that when a man has an item that is really outstanding,that somebody should give him their opinion of that particular item.

The point that I have in mind is in regard to your 966 Rectifier Tube. I have had occasion to use many hundreds of these tubes since the 66 type tube was put on the market some years ago,and we have found from actual operation that certain things happen which are not too pleasant. those certain things being somewhat as follows:

Due to the amount of mercury within the tube it frequently condenses around the top of the tube and also around the top of the press;I have known tubes to flash through the glass from the excessive mercury,which we have been advised was necessary,therefore,it is with a great deal of pleasure that I outline briefly the experience with the United Electronic 966.

We have been using these tubes since the start of their manufacture;we have never had a tube failure;it isn't necessary to burn the mercury down because,apparently,it is in a vapor form;the total absence of excessive mercury makes the tube adaptable to quick starting.

I feel that you should be commended on this tube due to its very satisfactory operation and hope that we shall have the pleasure of using them for a long time to come.

With kindest regards,

Yours very truly.
BROPAR ENGINEERING LABORATORY, INC.
By Robert B. Brand

Dymac Radio
DISTRIBUTORS AND MANUFACTURERS
RADIO AND ELECTRONIC EQUIPMENT

Feb. 26, 1936.

United Electronics Co.,
42 Spring St.,
Newark, N.J.

Gentlemen:

Some nine months ago the writer had the misfortune of ruining a perfectly good pair of 872 rectifiers thru sheer negligence. Having but a few minutes to get the transmitter on the air for an important schedule, and not having another pair of 872's at hand, a couple of UX sockets were hastily wired in place across the two 50 watt sockets formerly containing the now deceased 872's. These were in series across the 5 volts used on the precious tubes.

A pair of United Electronic 966's were inserted in the UX sockets and the power turned on with much skepticism. The plate voltmeter still read 2800 volts to our amazement and the contact was successfully completed. Being like 99% of 'hams' we were not going to spend $33.00 for a new set of 872's if the 966's would last a few months, so we left them in.

These same 966's are in there today going as strong as ever and we feel that you will agree that this is remarkable performance considering that this rig has a pair of 204A's class C and a pair of 204A's as class B modulators running off this power supply. The input to the class C stage is 2500 volts at 400 ma. and the class B stage draws from 50 to 350 ma. at the same voltage.

Yours for more 966's that can 'take it'.

Station W8AWL,
Larry J. Jones W8AWL

LJC/

Originals of above and many other similar letters are in our files.

UNITED ELECTRONICS COMPANY

42 SPRING ST., NEWARK, N. J.

BALANCED AMPLIFIERS

(*Continued from page* 16)

ondaries—if at that instant, the grid is actually at a higher potential than the plate, with respect to the cathode. This latter condition would indicate a very large grid swing and high load resistance—a condition not usually encountered in audio amplifiers, particularly if operation is confined to the region mentioned in the previous articles.

The author has found that a fair empirical rule is that the plate-voltage minimum must be at least twice the positive grid-voltage maximum (occurring at that same instant), in order that the plate-current wave shape be not flattened. For larger tubes this ratio may be even as high as four times.

It is then possible, by using this ratio, to calculate for a *linear* tube, the value of load resistance, B-supply voltage, and the amount by which the grid must be driven positive, for a desired power output. However, since many tubes are very non-linear and even considerably variable in their mu, it is preferable to obtain these values graphically in the manner explained previously.

With this brief discussion we are now ready to plot the grid current per tube for a given plate load resistance. Referring once more to Fig. 23, ABCDE is the load line presented to each tube by a load resistance R_L (plate-to-plate). It intersects the plate-current curves for successively higher positive values of the grid parameter in C, B, and A, respectively, as shown. The corresponding instantaneous values of plate current and plate voltage are CF, BH, AJ, and OF, ON, OJ, respectively. Thus, at *maximum* grid swing e_{g3}, the plate voltage has dropped to its *minimum* value OJ from its normal value at no signal of OE_B. For that value of plate voltage, OJ, and for that grid voltage e_{g3}, the grid current at that instant is evidently KJ. Similarly, for the grid swing, e_{g2}, and plate voltage OH, the grid current is IH, and for e_{g1} and OF, it is HF. Thus, the actual grid current i_g for different grid voltages and given value of R_L can be found. We now plot i_g versus e_g, or i_g against the signal voltage e_s (either grid to cathode) as shown in Fig. 24. On this same graph the load current $I_L \left(= \dfrac{I_1 - I_2}{2}\right)$ through R_L, can also be plotted, as detailed in the previous articles. It is necessary to plot only one-half cycle of e_s, as the other half cycle gives identical results (Part III, September 1936).

DESIGN OF RESISTANCE PADS

(*Continued from page* 14)

Z_0 = input impedance of pad when it is terminated in a pure resistance equal to A or B.

Then

$$Z_1 = \frac{Z_0\,[(Z_2 + Z_0) + R^2\,(Z_2 - Z_0)]}{(Z_0 + Z_2) + R^2\,(Z_0 - Z_2)} = \frac{Z_0\,(\alpha + J\beta)}{\alpha' + J\,\beta'}$$

$$Z_1 = \frac{Z_0}{\alpha'^2 + \beta'^2}[(\alpha\,\alpha' + \beta\,\beta') + J\,(\alpha'\beta - \alpha\,\beta')].$$

Where

$$\alpha = (1 - R^2)\,Z_0 + (1 + R^2)\,B$$
$$\alpha' = (1 + R^2)\,Z_0 + (1 - R^2)\,B$$

and

$$\beta = (R^2 + 1)\,X$$
$$\beta' = (1 - R^2)\,X.$$

Let

$$\theta = \tan^{-1}\frac{\alpha'\beta - \alpha\,\beta'}{\alpha\,\alpha' + \beta\,\beta'}.$$

Now θ is maximum at

$$Z_2 = 0 + J\,X \text{ for a given } R.$$
$$|X| = Z_0.$$

If

$$R_1 = \frac{I_2}{I_1} \text{ for } Z_2 = \text{any impedance}$$

and

$$R = \frac{I_2}{I_1} \text{ for } Z_2 = Z_0$$

then

$$R_1 = \frac{P}{P + 2M + Z_2} = \frac{2\,Z_0\,R}{(Z_0 + Z_2) + R^2\,(Z_0 - Z_2)}$$

$$= \frac{2\,Z_0\,R\,\alpha'}{\alpha'^2 + \beta'^2} - J\,\frac{2\,Z_0\,R\,\beta'}{\alpha'^2 + \beta'^2}$$

$$|R| = \frac{2\,Z_0\,R}{\sqrt{\alpha'^2 + \beta'^2}}.$$

Where

$$\alpha' = (1 - R^2)\,Z_0 + (1 - R^2)\,Z_2$$
$$\beta = (1 - R^2)\,X.$$

Hence

$$P = \frac{2\,Z_0\,R}{1 - R^2}$$

$$M = \frac{Z_0}{2}\left(\frac{1 - R}{1 + R}\right)$$

The difference in current ratio when a pad is terminated in a complex impedance and in a pure resistance is illustrated graphically in Fig. 8. In this case the results hold for only a single frequency at which the termination impedance is equal to the nominal termination resistance. The parameters are calculated line losses in db assuming a pure resistance termination equal to the image impedance of the pad.

THE ECONOMICS OF VERTICAL RADIATORS

By VICTOR J. ANDREW, Ph.D.

Chief Engineer

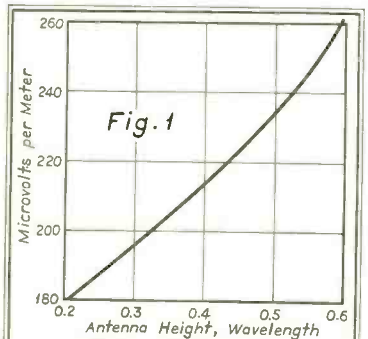
DOOLITTLE & FALKNOR, INC.

A HIGH vertical radiator gives high signal strength, but is also high in cost. Many broadcast-station owners are confronted with the question: "How high an antenna is justified for my station?"

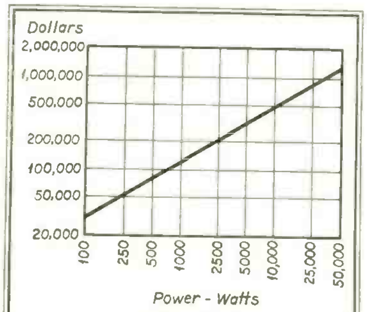
To determine whether a certain radiator will be worth the cost, three things must be known: (1) what the improvement in signal strength will be; (2) what this improvement will cost the station; (3) what this improvement will be worth to the station.

In order to obtain some general conclusions, assumptions are made hereafter on each of these three subjects. These assumptions are a low order of accuracy, and of course particular circumstances will greatly alter individual cases. It is therefore urged that when the reader must make a decision on the height of an antenna he shall use the procedure outlined below, but shall re-examine the basic assumptions rather than fully accepting the numerical data offered here.

The relation between antenna height and performance, is a purely engineering subject, and is known more accurately than the other two. Fig. 1 gives the field strength at one mile for one-kilowatt power as a function of height. The antenna height is expressed in wavelengths. To convert this height into feet, multiply it by 985,000, and divide the product by the station frequency in kilocycles. For example, a 0.2 wavelength antenna for 1200 kilocycles has a height of 0.2×985,000/1200 = 164 feet.



Field Strength of 1000 Watt Station at One Mile



Value of a Broadcast Station

Fig. 4

Since power is the usual measure of the size of a station and consequently the value of the station, we will convert field strength into equivalent power. To do this we will assume that the station has normal power when the antenna is 0.2 wavelength high. This is approximately the minimum height conforming with Rule 131 of the Federal Communications Commission. Fig. 2 shows equivalent power as a function of antenna height for a 1000-watt station. The ordinates may be multiplied to give the equivalent power of stations of different actual power.

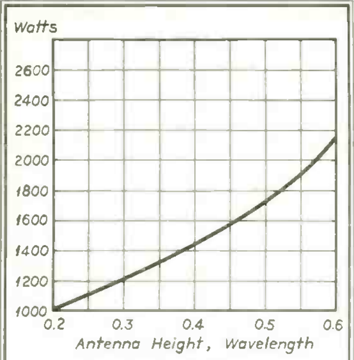
The second relation, between cost and antenna height, is shown in Fig. 3. This cost includes land, ground system, erection, etc., since all of these factors vary with antenna height.

The greatest uncertainty is in the third relation between the power of a station and the value of the station.

The curve of Fig. 4 is drawn from various sales prices of stations reported recently. It is assumed that the value of a station increases continuously with power, and that a given increase in signal strength has the same value, whether it is due to increased power or to a better antenna. It is particularly important that the reader reconsider the assumption of values shown in the curve, making allowance for the peculiar circumstances of his station. For in-

TABLE 1—COST ANALYSIS FOR INCREASING HEIGHT OF ANTENNA OF 100-WATT 1500-KC BROADCAST STATION

Antenna Height Wavelengths	Feet	Equivalent Power Watts	Antenna Cost Dollars	Station Value Dollars	Incremental Cost Dollars	Incremental Value Dollars
0.2	131	100	1350	29,400	....	....
0.3	197	118	2500	32,000	1150	2600
0.4	262	142	4500	36,500	2000	4500
0.5	328	170	7200	41,000	2700	4500
0.6	394	217	10,500	46,500	3300	5500

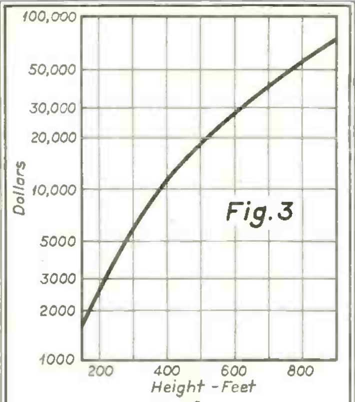


Equivalent Power of 1000 Watt Station

Fig. 2

Table II—Recommended Antenna for Various Powers and Frequencies

Power Watts	Frequency Kilocycles	Recommended Antenna
100	1200 to 1500	Optional
100	1510 to 1600	High
250	500 to 900	Low
250	910 to 1140	Optional
250	1150 to 1600	High
500	500 to 760	Low
500	770 to 990	Optional
500	1000 to 1600	High
1000	500 to 620	Low
1000	630 to 800	Optional
1000	810 to 1600	High
2500	500 to 660	Optional
2500	670 to 1600	High
5000	500 to 540	Optional
5000	550 to 1600	High
10000 up	500 to 1600	High



Cost of a Broadcast Antenna System

stance, a station operating part time or reducing power at night is of less value. One on a low-frequency channel is of greater value; station values vary greatly in different cities. If the owner has an opinion of the value of his station, he can plot the point on Fig. 4, and, to determine variation in value with power, he can draw a line parallel with the line given.

Now let us use this data to determine what height antenna a 100-watt station on 1500 kilocycles is justified in erecting. In Table I, the fourth column shows the cost of the antenna, obtained from Fig. 3. the value of the station, taken from Fig 4, is shown in the fifth column. Column six shows the increments of differences of cost as the antenna height is increased in steps, and column seven shows the corresponding incremental value of the station. In this case the incremental value is approximately twice the incremental cost, indicating that it will be profitable to build an antenna of 0.5 to 0.6 wavelength height.

Both the value and the cost increase more rapidly between 0.4 and 0.6 wavelength than between 0.2 and 0.4 wavelength. The cost rises more rapidly than the value, which means that in a borderline case an antenna of about 0.4 wavelength (or 3/8-wave) is justifiable. In most cases, however, one extreme or the other, either the shortest antenna permitted, which is about 0.2 wavelength, or the best obtainable, which is 0.5 to 0.6 wavelength, is shown to be economically justified.

By repeated analysis of the foregoing type, the conclusions regarding economical antenna shown in Table II are obtained. Where a low antenna is recommended, the value is less than the cost. Here a low antenna in the order of 0.2 or 0.25, a medium height such as 0.375 or 0.4 wavelength, or a high antenna such as 0.5 or 0.6 should be chosen, depending on individual economic factors. Where a high antenna is recommended, the calculated value is more than twice the cost.

A high antenna has been loosely referred to as 0.5 or 0.6 wavelength. The exact height for optimum operation means maximum signal strength (which is the case with a low-power station) or means maximum area free from fading (which is the case with a high-power station). The optimum height also varies with tower construction. When the owner has decided to build a high radiator, he must rely on a qualified engineer to specify just what is optimum height. In nearly all cases it is between 0.5 and 0.6 wavelengths.

HOW LOUD IS SOUND?

(Continued from page 7)

has proposed the use of 1×10^{-10} microwatts per sq cm as the unit of sound intensity. At 1,000 cycles per second this is close to the average threshold of hearing, being a trifle below if anything, although perceptible to many people under good conditions of hearing. Intensity is a characteristic of sound waves which can be measured without great difficulty and is related to most other characteristics of sound waves such as pressure, velocity, amplitude, etc., by simple equations.

Since the decibel scale is essentially logarithmic, if the sound intensities are expressed in decibels referred to the preceding proposed standard as a base the results correspond sufficiently well to the auditory sensations produced to be practically useful. The effect of frequencies outside the audible range can be overcome by limiting the frequency range of response of the measuring apparatus.

Since the unit "microwatt per sq cm" has the dimensions of power, any value W will be converted to decibels by the formula:

$$\text{Decibels} = 10 \log_{10} \frac{W}{W_o} = 10 \log_{10} \frac{W}{10^{-10}} = 10\,[\,(\log_{10} W) + 10]$$

where $W_o = 10^{-10}$ microwatts per sq cm.

Values of microwatts per sq cm corresponding to various decibel levels are given in the fifth column of the table.

In the design of acoustical apparatus or in undertaking the measurement of sound intensities it is often desirable to know the difference of pressure in the medium caused by the sound waves or even the actual length of the excursion or travel of a vibrational particle of the medium.

The excess pressure or difference in pressure is proportional to the particle velocity and is connected to the sound intensity by the equation $W = P^2/rv$ where p is the pressure in dynes per sq cm, r is the density of the medium in grams per cu cm and v is the velocity of sound propagation in the medium. The particle velocity U in centimeters per second is related to the pressure by the equation $U = P/rv$.

Substituting in the above equations the physical constants of air we obtain

(Continued on page 27)

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

CHICAGO-NEW YORK FACSIMILE TELEGRAPH CIRCUIT

TRANSMISSION of telegrams by the facsimile method of telegraphy was inaugurated between Chicago and New York recently, when service over the second facsimile circuit was placed on regular commercial operation by The Western Union Telegraph Company. In the future a portion of the regular telegraph traffic between the two cities will be handled by the new method.

The first facsimile circuit used in regular telegraph service in America was opened November 14, 1935, when Western Union inaugurated service between Buffalo and New York. Western Union engineers, under the stimulus and encouragement of Mr. White, in 1933 began to develop a facsimile method of transmission which would be fast enough and simple enough for regular commercial telegraph use. The Western Union facsimile system, which now has been placed in regular operation, is the outcome of their work.

No announcement was made as to how rapidly the new system of telegraphy will be extended to other cities, nor as to when the facsimile transmission of drawings, designs, tabulations, manuscripts, etc., will be available. It is understood, however, that such a service can be supplied when rates and conditions are determined.

Telegrams to be transmitted by facsimile are mounted upon a cylinder which, revolving on a horizontal axis, rapidly passes under an electric "eye." As the characters comprising the message pass under the beam they reflect a greater or lesser amount of light. These gradations of light produce minute signals which are amplified billions of times in their telegraphic transmission to a machine at the other end.

At the receiving end in the distant city there is a machine similar to the one at the sending end, except that instead of an electric "eye" it is equipped with a tiny stylus which passes over the surface of a receiving blank mounted on a revolving cylinder. The electrical impulses, or signals, coming over the telegraph line, are received on this stylus and, as the variations of the current pass through it, an immediate color change is produced upon that portion of the paper which is in contact with the stylus. The received message requires no processing and is ready for delivery as soon as the message comes from the receiving machine.

SIMULTANEOUS RADIO RANGE AND TELEPHONE TRANSMISSION

RADIO RANGES and radio telephones which have been installed by the Department of Commerce have contributed a great deal toward the safety of air navigation; however, it has become evident that there are definite limitations in the method of operation of this equipment . . . limitations which greatly restrict its usefulness in practical application. According to W. E. Jackson and D. M. Stuart of the Bureau of Air Commerce, the major limitation is that neither range nor broadcast service is continuous due to the fact that the range has to be shut down while the broadcast is made and vice versa.

While continuous radio-range operation is at times of greater importance to the pilot than the weather broadcasts, the rapidly increasing air-traffic conditions and the need for instantaneous communication between air-traffic-control ground stations and all aircraft will cause the weather-broadcast stations to take over a more valuable function than ever before.

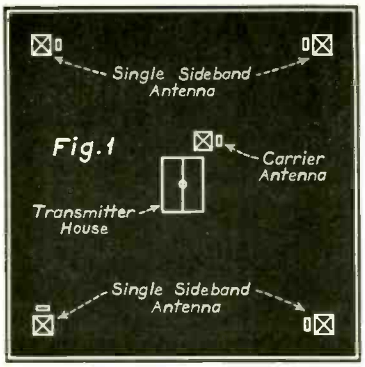
The general method of attack has been to transmit weather broadcasts and radio-range signals simultaneously on the same r-f channel and separate them by means of a-f filters in the receiver output. In order to accomplish this, two separate antenna systems are used. A single tower radiates a circular carrier-frequency (f_c) field pattern which is modulated by speech during weather broadcasts and which at all times heterodynes with a fixed-frequency single sideband (f_c+1020) radiated directionally from four towers, symmetrically disposed about the broadcast tower and keyed in the conventional A-N manner to produce the range courses. (See Figs. 1 and 2.)

THE NEW WESTERN ELECTRIC EXPERIMENTAL ULTRA-HIGH FREQUENCY PUSH-PULL PENTODE. ONE OF THE TUBES HAS HAD THE ENVELOPE CUT APART TO DISCLOSE THE ELEMENTS MORE CLEARLY.

The a-f selected for the range is 1020 cycles which appears to be best from several considerations. It has a minimum masking effect due to engine noises and static, is easily readable, and may easily be produced by means of synchronous machines, if required. The 1020-cycle a-f difference between carrier and single sideband may be obtained either from a single-sideband generator modulated by a synchronous alternator or a tuning-fork, or by means of two matched A-cut quartz plates which excite two separate r-f channels. In order to avoid interference between the 1020-cycle heterodyne and the speech frequencies during weather broadcasts, a filter which eliminates the band of frequencies between 830 and 1252 cycles is inserted in the line which carries the speech input to the modulator of the carrier transmitter.

A similar filter is used in the output of the aircraft receiver to pass the voice frequencies and eliminate the range signal, in conjunction with a band-pass filter which passes only the range signal and eliminates the voice frequencies. This combination permits optional reception of either range or weather broadcasts or the simultaneous reception of both if one pilot flies the range while the other receives the weather.

The filter unit consists of a single-section band-pass and a single-section band-elimination filter connected with parallel inputs. The band-pass section is designed for minimum attenuation at 1020 cycles with cut-off frequencies at 919 and 1132 cycles. The characteristic impedance is 300 ohms at the frequency of minimum attenuation. The band-elimination section is designed for maximum attenuation at 1020 cycles with cut-off frequencies of 830 and 1252 cycles. The characteristic impedance is 300 ohms at 2000 cycles and remains substantially constant over the non-attenuation range. In Fig. 3 is



LAYOUT OF RADIO-RANGE PLOT AND ANTENNA SYSTEM.

shown the schematic diagram of the aircraft filter.

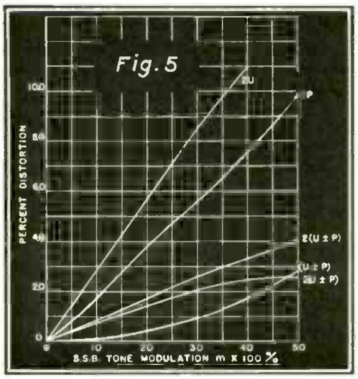
The band-elimination filter which is used in the microphone circuit at the transmitter consists of two sections of the same type as are used in the aircraft. The cut-off frequencies are 830 and 1252 cycles with maximum attenuation at 1020 cycles, and the characteristic impedance is made 600 ohms at 2000 cycles to match the impedance of the line and line-amplifier equipment.

The method of detection used in the reception of a simultaneous range and telephone transmission is an important phase of the development. If a linear detector is used the distortion is not excessive provided the single-sideband modulation does not exceed 30 percent and the speech modulation does not exceed 70 percent. The most serious type of distortion is that which gives rise to frequencies of

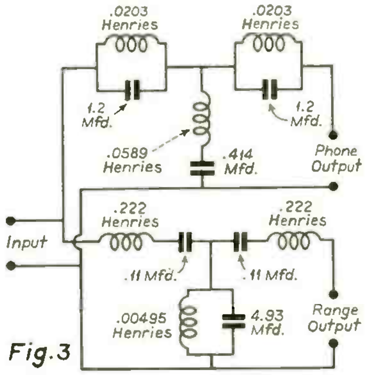
$$\frac{P \pm U}{2\pi} \quad \frac{P \pm 2U}{2\pi} \quad \frac{2P \pm U}{2\pi} \quad \frac{2P \pm 2U}{2\pi}$$

etc., all of which may be of such a value as to pass through the aircraft band-pass filter and cause interference with the range signals in addition to their deleterious effect on the quality of the voice.

LINEAR DETECTION OF A SINGLE-SIDEBAND TONE FOR A FIXED SUPERIMPOSED SPEECH MODULATION OF M = .50. DISTORTION EXPRESSED AS PERCENT OF S.S.B. TONE FUNDAMENTAL.

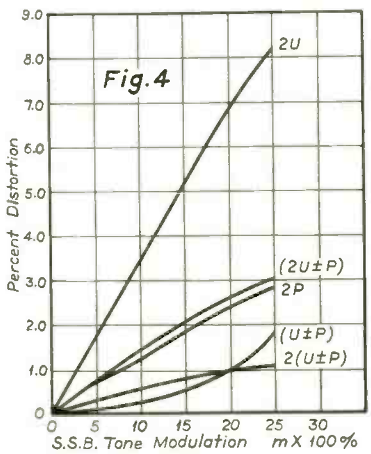


Also harmonic distortion of the range signals passes through the band-elimination filter and interferes with the speech; however, this type of interference is much less serious than the former. From the curves of Fig. 4 it may be seen that no serious distortion of any kind occurs if the percentage of single-sideband modulation does not exceed 30. In Fig. 5 it may be seen that the distortion increases if the voice percentage modulation is decreased to 50 percent



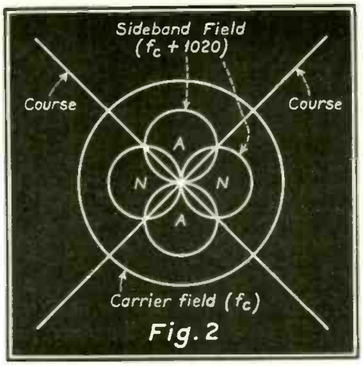
SCHEMATIC DIAGRAM OF AIRCRAFT FILTER UNIT.

LINEAR DETECTION OF SINGLE-SIDEBAND TONE FOR A FIXED SUPERIMPOSED SPEECH MODULATION OF M = .70.



and the single-sideband percentage modulation is increased to 50 percent.

The chief advantages of the single-sideband system, as employed here, lie in the simplicity of the equipment required and the fact that variation in phase between the carrier and the single sideband has no effect. Two transmitters, one of which can be modulated by speech, together with the antenna and coupling apparatus which is used at all ranges is all of the r-f equipment that is necessary for simultaneous transmission. Perhaps the most objectionable

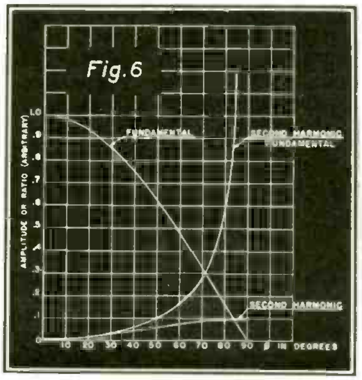


FIELD PATTERN OF SIMULTANEOUS RADIO-RANGE AND BROADCAST STATION.

feature of the single-sideband system is the necessity for operating the single sideband at moderate percentages of modulation in order to avoid high detector distortion when the voice and range signals are transmitted simultaneously.

It is possible to obtain distortionless reception at considerably higher levels of modulation if two sideband frequencies symmetrical with respect to the carrier are transmitted from the corner towers, and the receiver detector characteristic is essentially linear. Square-law detection of this type of transmission will cause excessive distortion which will render the range and telephone signals unsatisfactory. In order to provide for double-sideband transmission it is necessary that both transmitters be excited from a common r-f source and that the sideband transmitter be of the balanced-modulator suppressed-carrier type. Also means must be provided for adjusting and maintaining the phase of the carrier so that it is of the proper value to combine with the sidebands in the receiver detector. While the carrier phase is not very critical some distortion will be present unless it is maintained within ± 30° of the correct value (see Fig. 6).

RELATIONSHIP BETWEEN FUNDAMENTAL AND SECOND-HARMONIC OUTPUT FROM LINEAR DETECTION OF DOUBLE-SIDEBAND TRANSMISSION AS CARRIER PHASE IS VARIED.



BOOK REVIEWS

TELEVISION WITH CATHODE RAYS, by Arthur H. Halloran, published by the Pacific Radio Publishing Co., San Francisco, Calif., pocket size, loose leaf, price $2.75.

This handbook should provide the answers to many of the questions which will soon be asked about television. Without going into any serious engineering discussions, Mr. Halloran has managed to tell concisely and clearly how the different systems of television function.

The engineer will not be especially interested in this book unless he happens to be one of those mortals who likes to keep abreast of what the other fellow is doing, but the book is by no means a thorough technical treatise on television. Such a book is still to be written.

ELECTRON DIFFRACTION, by R. Beeching, published by the Chemical Publishing Co. of N. Y., Inc., pocket size, 106 *pages, price* $1.25.

This book, on a subject which is comparatively new in the scientific field, is by the author's admission an attempt to interest more research workers in the study and investigation of electron diffraction.

Starting out with a discussion of the wave properties of electrons, the book then progresses through a description of the early experimental work to discussions of research technique and the practical applications of the study of electron diffraction.

It is interesting to note that this book originated in Great Britain. In the opinion of this reviewer, American book publishers might well follow this means—i. e., small, inexpensive monographs—of getting scientific material into book form while it is still new.

TELEVISION, published by the RCA Institutes Technical Press, 75 *Varick Street, New York, N. Y., price* $2.00.

This book, evidently the first volume of a series, is a compilation of addresses and technical papers from RCA. All of these have appeared elsewhere—addresses by RCA officials at different times and places, reports to the FCC and technical papers in the Proceedings of the Institute of Radio Engineers, the Journal of the Franklin Institute and Proceedings of the Radio Club of America. The subject of television is covered in great detail, although just how recent the material may be we are unable to say due to the omission of nearly all dates in connection with those papers reprinted from the above societies.

THERMIONIC EMISSIONS, by T. J. Jones, published by the Chemical Publishing Co. of N. Y., Inc., pocket size, 108 *pages, price* $1.25.

This is a concise little volume purporting to give the latest information on the principles of thermionic emission. It is addressed particularly to those engaged in experimental work in this field, and as such it may be regarded as an excellent pocket companion. The inclusion of a fairly comprehensive bibliography further enhances the book's value.

RADIO ENGINEERING HANDBOOK, second edition, 850 *pages, flexible covers. Published by McGraw-Hill Book Co., New York, N. Y. Price* $5.00.

We note a great improvement in this second edition as compared with the first. There is more engineering—which, after all, is what one expects to find in a handbook—and less textbook material.

The greatest difficulty about handbooks is exemplified here—much of the material is obsolete before the book goes to press. But the basic material—which doesn't change like fashions—is sound and as pertinent today as yesterday. However, we could use more of these unchanging fundamentals. For instance, the subject of equalizers and filters is awkwardly handled; there is very little discussion of the principles of high-fidelity r-f circuits; and, much to this reviewer's surprise, the section on sound pictures still occupies space in a radio engineering handbook.

On the other hand, we find it difficult to find a suitable comparison between the new section on audio circuits and that tritely-done attempt in the previous edition. The chapter on broadcasting has been expanded to the point where it is of real value; similar remarks might be made of the sections on antennas, aircraft radio and receiver design.

If for no other reason than that it provides a quick reference to a great many subjects in radio, the handbook should be welcomed by the profession.

INDUCTIVE COORDINATION OF ELECTRIC POWER AND COMMUNICATION CIRCUITS, by L. J. Corbett, E. E., published by The J. H. Neblett Pressroom, Ltd., 500 *Sansome Street, San Francisco, California, first edition,* 161 *pages, price* $3.00.

The general aims of this book are to discuss briefly the factors involved in the problem of inductive coordination, and to point out methods by which detrimental effects can be remedied or obviated. It includes the results of original researches, amplified by a broad survey of the whole field.

The treatment is not mathematical, the physical relations being emphasized in this subject in which the constants of apparatus and circuits have wide variations. It presupposes on the part of the reader only a general knowledge of the principles of electrical engineering.

Considerable space is given to power-system wave shape and the harmonics which affect it, particularly to those which become residuals.

Although this book was written mainly from the standpoint of the power engineer, the author has also attempted to adequately cover the problems of the communications engineer.

HOW LOUD IS SOUND?

(*Continued from page* 23)

the pressure $P_o = 0.000204$ dynes per sq cm as the value corresponding to a sound intensity $W_o = 10^{-10}$ microwatts per sq cm and $U_o = 0.000005$ cm per second (actually 0.00000497) as the corresponding particle velocity.

Since the power (microwatts per sq cm) or intensity of a sound level in a given case is proportional to the square of these quantities. the decibel relationship is given by the following equation:

$$\text{Decibels} = 20 \log_{10} \frac{P}{P_o}$$

$$= 20 \log_{10} \frac{P}{0.000204}$$

$$= 20\, [(\log_{10} P) + 3.6904]$$

The values corresponding to various decibel levels are given in column 2 of the table.

Similarly the relationship between decibels and particle velocity is given by:

$$\text{Decibels} = 20 \log_{10} \frac{U}{U_o}$$

$$= 20\, [(\log_{10} U) + 5.3010]$$

and corresponding values are given in Col. 3 of the table. These values are rms values and if maximum values are desired the figures should be multiplied by 1.414.

The actual amount of movement (excursion) of the air particles may be obtained by multiplying the average particle velocity by the time and is expressed by equation $d = 1.414\ U/\pi f$ where d is the total excursion, U is the rms particle velocity and f is the frequency in cycles per second. The particle excursion for a frequency of 1,000 cycles is given in the fourth column of the table.

In order to aid in forming a mental picture of the values involved and to assist in relating them to various familiar sounds some sound effects are listed in the first table opposite the corresponding characteristics and decibel values.

For most of these sounds, the values, in the very nature of the case, will vary over quite a wide range. The loudness of a "whisper" will vary and different people might disagree on the "softness" of the music of a violin. "Ordinary conversation" varies in loudness with the surrounding noise level so in general the value of a sound in the table may vary in actual practice by ten decibels from the values given.

Looked at subjectively, then, a sound is as loud as you hear it. The same objective sound may appear of different loudness to different persons. Objectively a sound may have an energy intensity or a vibrational amplitude or a pressure, or a particle excursion of a certain amount. If any one is known, for a given medium, all the others may be obtained and the sound is accurately defined.

The actual figures, however, would be misleading in comparing two sounds, for a given numerical difference would not be proportional to the difference in the auditory effect. If, however, these quantities are expressed in decibels above a given base level then the resulting values are at least an approximation to the loudness of a sound as the average person hears it.

In conclusion it might be interesting to consider the physical magnitude of the disturbances which will just affect the human ear and gain some idea of its absolute and relative sensitivity. According to the table the minimum variation of pressure which can just be perceived is 0.0002 dynes per sq cm (rms value) or say 0.0003 dynes per sq cm for an approximate maximum value. This is equivalent to 2.25×10^{-7} millimeters of mercury.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

FREQUENCY-CONTROL UNIT

The FC-2 frequency-control unit is a combination heater oven and crystal oscillator unit that has been approved by the Federal Communications Commission.

Designed for relay rack mounting, the FC-2 is small, compact and complete in itself. The panel dimensions are 10½ inches by 19 inches, the depth behind the panel being 12½ inches.

The tank circuit of the oscillator tube is enclosed within the heater oven, thus avoiding plate-circuit detuning effects often caused by room-temperature changes. Heat insulation is balsa wood. An aluminum heat chamber and distributing unit, good quality resistors, and proper placement of parts is said to have reduced the heat cycle of the crystal chamber to a negligible amount as well as the oven-temperature variation to approximately 0.1° C for every 10° F change in ambient temperature.

For further information write to Commercial Radio Equipment Co., Box 7023, Country Club Station, Kansas City, Mo., for Bulletin B-14.

MAGNAVOX SPEAKER

The Magnavox Company, Fort Wayne, Indiana, have announced their Model 305, a heavy-duty speaker designed to eliminate the necessity for dual speakers and to handle the power output developed by the new 6L6 output tubes.

The increased cone area afforded by the 15-inch diaphragm makes possible cone resonances below 40 cycles and results in a pronounced improvement in low-frequency response characteristics, it is said.

Increased voice coil travel allows the low frequencies to be reproduced with a minimum of harmonic distortion.

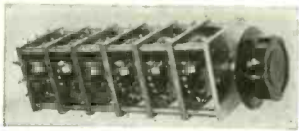
The Model 305 is adapted to public-address as well as receiver applications.

Magnavox Model 305 has a frequency range covering a band from 40 to 6000 cycles, and the high-frequency response can be extended to meet high-fidelity requirements as desired.

Cone distortion is minimized through the use of a curvilinear diaphragm.

ROTARY SWITCHES

In response to the demand for rotary switches, Tech Laboratories, 703 Newark Avenue, Jersey City, N. J., have developed an interesting line of products. One switch is a 24-pole, triple-throw, non-shorting type, designed for rough use, easy replacement of parts, etc. Based upon the results of the Tech Lab Attenuators, other switches have been produced with a noise level that is said to be better than minus 140 decibels, contact resistance of 0.0005 ohm and zero thermal emf. Switches for constant use are now made from a new Beryllium Bronze of durable qualities.

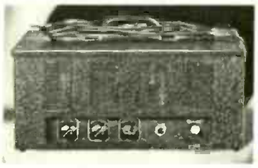


Switches have also been made with low reactance to ultra-high frequencies such as used in diathermy.

MICROPHONE PREAMPLIFIER

The unit shown in the accompanying illustration is an instrument made to mix two microphones of either the velocity or grille type of crystal. It has an overall gain of 65 db, incorporates electronic mixer and also tone control for "shading." The hum level is said to be exceptionally low.

Two of these units may be used together to form a four-postion electronic mixer and



preamplifier. This is a two-stage amplifier with first-stage tube mounted on cushioned mountings to decrease microphonics. A steel carrying case with provision for plug-in connections at input and output is provided.

If you wish a complete description, write Operadio Manufacturing Company, St. Charles, Illinois, for Catalog 10-B.

PORTABLE SOUND-LEVEL METER

The Type 759-A sound-level meter has been designed to meet a wide range of

applications in the general field of sound-level measurement.

The performance characteristics are based on the specifications recently adopted by the American Standards Association. The sound-intensity range covered by this meter is from 24 to 130 decibels above the standard reference level of 10^{-16} watts per square centimeter at 1,000 cycles. The microphone is non-directional and can be used with an extension cord and tripod, if desired.

The calibration is stable, and provision is made for recalibration by a simple method. All three frequency-weighting networks accepted by the ASA are included. Power requirements are small, and batteries are self-contained. Mechanically, it is rugged, light in weight, easily portable and attractive in appearance. Provision is made for the use of accessories, such as a vibration pickup.

The Type 759-A sound-level meter is a product of the General Radio Company, 30 State Street, Cambridge, Mass.

QX-CHECKER

The growing Q consciousness of the radio art and industry is reflected by the QX-Checker just introduced for the production testing, grouping and adjusting of coils and condensers at radio frequencies.

A product of the Boonton Radio Corporation, Boonton, N. J., the QX-Checker provides a simple and stable method of comparing Q, as well as L or C with a given standard. The Q of coils is directly read in percentage variation from the given standard rated at 100 percent. The instrument comprises a power supply, r-f oscillator (100 kc to 25 mc), tuning circuit and a specially-designed vacuum-tube voltmeter, housed in a metal cabinet with sloping panel. The dial may be read in mmfd for capacitance and, indirectly, for inductance variations from the standard.

POWER UNITS

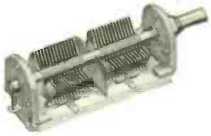
Ferranti Electric, Inc., have announced their line of hum-free plate-filament transformers and filament chokes to electronics and communications field. These units embody a self-shielding core-type construction with hum-bucking windings. This construction is said to eliminate hum at its source, resulting in a minimum of interference. The new units are designed for low regulation, high efficiency and low core and copper losses. Complete descriptive literature gladly sent upon request to the manufacturer at 30 Rockefeller Plaza, New York City.

HIGH-FREQUENCY CONDENSERS

A series of ultra-high-frequency variable condensers, known as the HF micro condensers, have been created by the Unit Development Division of the Hammarlund

Mfg. Co., Inc., 424 W. 33d Street, New York City.

The group includes single and dual models in a variety of sizes. Both types have



cadmium-plated soldered brass plates with B-100 Isolantite, for insulation.

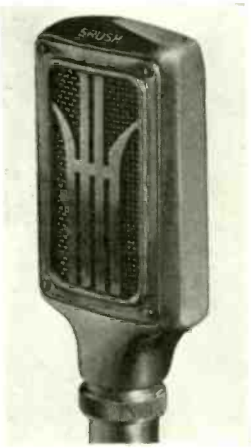
In the single unit any one of three different mounting methods may be used. One is a bracket or base mounting; another is a single-hole panel mount, and the third is a panel mounting employing spacer bushings which permit complete insulation of both rotor and stator sections. The dual model has single-hole panel mounting and base mounting features.

Single models are available in sizes from 15 mmfd to 140 mmfd. A double-spaced 30-mmfd model has also been designed. The dual sizes range from 50 mmfd to 140 mmfd.

The 140-mmfd single style is 1 9/32 inches high, 1 5/16 inches wide, and 1 13/16 inches long (behind panel), while the 140-mmfd dual is 1½ inches high, 1 inch wide, and 3¾ inches long (behind panel).

PUBLIC-ADDRESS MICROPHONE

A new public-address microphone, known as the B-1, has been placed on the market



by The Brush Development Company. It offers at a lower price, though somewhat lower output, many of the operating features found in the Brush sound-cell microphones.

Internal spring mounting, eliminating external shock absorbers and permitting the stand or even the microphone itself to be handled while it is in use . . . non-directional pickup . . . and the ability to run long leads with only slight loss . . . are some of the features built into this model.

The Brush B-1 microphone is 3½ inches long, 1⅞ inches wide, 3¾ inches thick. Weight, complete with the locking-type plug and socket, is 11 ounces. Output level, minus 72 db. Full details, prices, etc., can be secured from The Brush Development Company, Cleveland, Ohio.

RCA-807

The RCA Manufacturing Co., Inc., RCA Radiotron Division, Harrison, N. J., have made available a new transmitting beam power amplifier designated as RCA-807. This tube is shown in an accompanying illustration.

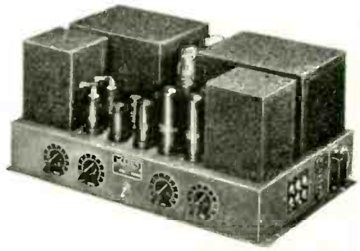
The 807 incorporates the beam power features of the receiving type RCA-6L6 but is designed particularly for r-f transmitting applications.

To meet r-f power service requirements, the 807 has been provided with ceramic base, top cap connection for high insulation and low interelectrode capacitances, and improved shielding to minimize the need for neutralization.

This new tube has a maximum plate dissipation of 21 watts, and high power sensitivity (very low driving power). The high power sensitivity of the 807 makes it especially suited for use as a crystal oscillator, frequency multiplier, and buffer amplifier. In the output stage, two 807s in Class C telegraph service are capable of giving a power output of 50 watts or better.

MORLEN BEAM POWER AMPLIFIERS

The Morlen Electric Co., 60 W. 15th St., New York City, announce the MC60 and



MC120 amplifiers using the 6L6 beam-power tubes.

The MC60 and MC120 amplifiers incorporate universal, dual channel input, with full mixer control, a main gain control, and tone control. The output is a dual winding transformer having 500 ohms impedance across one winding and 8 ohms tapped at 4 and 2 ohms across the second winding. Practically any combination of speakers or other load devices can be operated from the MC output. All MC amplifiers are complete on one chassis, from input to output and in power ranges from 19 to 120 watts.

Additional information can be obtained from the manufacturer.

CATHODE-RAY TUBE

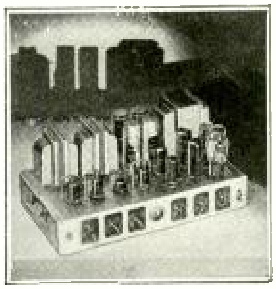
The RCA Manufacturing Company, Inc., RCA Radiotron Division, Harrison, N. J., have announced a new low-voltage cathode-ray tube of the high-vacuum electrostatic type. This new tube, designated as the RCA-913, is of practical importance to radio engineers and amateurs, and in experimental laboratories.

In appearance the 913 is quite different from other cathode-ray tubes. It is constructed like the all-metal receiving tubes except that the end of the metal shell is replaced by a fluorescent viewing screen approximately 1 inch in diameter.

The 913 is designed for operation with an anode voltage as low as 250 volts and as high as 500 volts. It is provided with two sets of electrostatic plates for the deflection of the electron beam. The luminous spot produced by this tube has a greenish hue.

ANTI-HOWL 6L6 AMPLIFIER

The Amplifier Company of America, 37 W. 20th St., New York City, offers a new development in high-fidelity audio amplifier design. This amplifier features



such facilities as howl suppression, cathode-ray indication for howl suppression action or degree of level expansion, automatic constant output for reproduction of speech, volume level expansion for reproduction of recorded programs, tone compensated volume control and high- and low-frequency gain control. Reverse phase degeneration is optional for special applications requiring less than 1 percent total harmonic content. Provisions are available for operating one or two crystal, ribbon, dynamic or electrostatic microphones.

Write to the manufacturer for a free brochure illustrating and describing in detail the complete line of Citation Series Gold Medal Amplifiers.

PORTABLE SOUND SYSTEM

The accompanying sound schematic gives the characteristics of the amplifier in the new Webster-Chicago sound system Model PA-417C. The full system consists of a 17-watt amplifier, crystal microphone in combination floor and banquet stand, and two 12-inch permanent-magnet speakers in bias cut case. All equipment is assembled in two carrying cases.

The crystal microphone is the new directional type with 25 feet of rubber-covered shielded cable. The microphone floor stand is the full size. When demounted it

packs in same case with amplifier and microphone. The weight is 41 lbs.

System PA-417C is furnished complete with all tubes, cable and other necessary accessories. Complete information may be secured from the Webster Company, 3825 West Lake Street, Chicago.

MEETING

THE MEETINGS of the New York Chapter of the VWOA will be held on the first Monday of each month at Bonat's Restaurant, 330 West 31st Street, New York City, at 6 p. m. A delicious dinner, including a cocktail, is available at 75 cents. The next meeting (December) will be held Monday, December 7, 1936. Nominations made by the Board of Directors or submitted by petition by the membership for Officers and Directors for 1937 will be announced at the December meeting.

ANNUAL CRUISE

REMEMBER FEBRUARY 11, 1937, SIMULTANEOUS CRUISES OF CHAPTERS OF VWOA THROUGHOUT THE WORLD. CONTACT YOUR LOCAL OFFICERS.

HONOLULU

REPORT ON VWOA—"Hoomalimali Chapter" picnic held Saturday afternoon (and evening—and on and on) at the RCA Communications transmitting station at Kahuku, Oahu (forty miles from Honolulu to you), October 24, 1936. ("Hoomalimali" is a Hawaiian word and means just about what it sounds like—Hooey!)

A delightful picnic was enjoyed by 38 members and friends of the "Grass Skirt" Chapter of the VWOA at Kahuku, Oahu, T. H., under the leadership of George Street, Chairman, and Arthur Enderlin, Secretary, on Saturday, October 24. Activities commenced at about 3:30 p. m. when the caravan arrived from Honolulu. Sides were immediately chosen and a game of baseball ensued on a field of "Marconi Daisies" (a local wildflower that grows with the encouragement of supercharged raindrops, falling through the myriad antennae). Umpire George Street called "batter-up" and the "Gadgets" brought in four runs in the first half inning against Captain Roberts, of the U. S. Army Signal Corps, in the pitching box. The latter half of the first inning, with the Statics at bat, was retired without scoring by pitcher Bowen of the U. S. Navy. When the umpire couldn't see the pitched ball he relied on intuition, and, since the pitcher hadn't thrown it where he could see the ball, he figured the batter encountered the same difficulty and therefore called a "ball."

The game lasted four innings and in the last of the fourth the score was Gadgets 9, Statics 3, at which time the umpire (slightly partial to the Army, perhaps) forgot how many outs had been made and permitted the Statics to have four outs, during which the Statics ran their total up to 7. Final score: Gadgets 9, Statics 7.

The only errorless play of the game was made by Williams, who happened to catch the only fly ball of several.

Refreshments were served on a wide lawn underneath shade trees. When the Gadgets and the Statics had recovered their wind along with their respective rooting sections all hands were taken on a tour of inspection by Joe Thornton and showed much interest in the several transpacific radiotelegraph and radiotelephone transmitters.

The inspection trip was followed by more refreshments and a picnic supper, story telling and renditions by a male chorus under the Hawaiian moon.

Secretary Enderlin made the most of his opportunity and signed up several new members from among those present. As usual at all Honolulu Chapter functions, all communication agencies were represented on this occasion. We are looking to February 11 for a bigger and better Annual Cruise. Geo. Street, Chairman.

PERSONALS

OUR HEARTFELT APPRECIATION to Mr. W. A. Winterbottom, Vice-President, and Arthur A. Isbell, Commercial Manager of RCA Communications, Inc., for their splendid assistance in our Year Book activity. Again this year they are first with pre-payment for a full-page advertisement in the '37 Book. Each year they provide the stimulation needed to launch our advertising campaign and in a large measure assure its success—for which we again say, thanks!

Harry J. Styles, a real oldtimer on the Pacific Coast is engaged at present as Director of Public Relations of the KMTR Radio Corporation in Hollywood. . . . A long interesting letter from Gilson Willets, charter member, who by this time has taken unto himself a bride. October 18 was the date and we extend sincere wishes and congratulations. He is "rarin'" to go towards a bigger and better San Francisco Chapter. . . . Karl Baarslag informs us that his first book, "SOS to the Rescue," ran through three editions in this country; the British Empire edition will go on the presses the first of next year; Fischer Verlag is publishing a German edition very shortly; it is now running serially in Great Britain by the Amalgamated Press; it was published in a Braille edition for the blind by the Clovernook Braille Press for the Congressional Library. Such recognition given a first literary effort is high tribute to the thoroughness and sincerity of the author. Congratulations and best wishes, Karl. . . . Charles D. ("Jerry") Guthrie was recently appointed Radio Supervisor with the Maritime Commission with offices at 45 Broadway, N. Y. C. All of Jerry's friends will be delighted to learn of this appointment and we extend heartiest wishes and 73 to a most deserving veteran.

V. H. C. Eberlin 2nd, Chairman of the Miami Chapter, reports renewal of activity in that sector among veteran wirelessmen leading to what will probably be a bigger and better cruise on February 11th, next. We glean from his stationery that he has recently been elected Secretary-Treasurer of the Chamber of Commerce of the City of Opa Locka, Fla., his place of residence. True to C. of C. ideals he invites all to come down and look the place over. Maybe we will, just as soon as another cruise has been completed.

LETTER

A MOST INTERESTING LETTER from Leslie H. Jenks, Manager for the New York Telephone Company at Carthage, N. Y. He writes:

"After reading your newsy letter of September 10, which awaited my return from a recent vacation, I am not certain that my service and experience qualify me for membership in the VWOA.

"It appears that I was too busy in active service for Bell Telephone, Western Union, and New York Central Railroad to have time for payroll employment as radio operator. I therefore hit and missed assignments, taught in a vocational school, worked a little ARRL as No. 37, and kept up air contacts as time would permit and browsed around with others of the clan when a station was to be erected.

"Of course, I have been a commercial Morse op since 1889, when I got on Western Union payroll and was retired with alimony after 35 years of activity. I am still one of the Telephone Pioneers still employed with 47 years of service. My railroad service in charge of communications is concurrent. I used to do some talking at sessions of the Am. RR Association, Tel. & Tel. Dept. of which I was a member. I joined the AIEE as member in 1913 and still seem to be in good standing.

"Otherwise I pioneered the first electric clock systems, built too many complicated pieces of mechanism to detail, still have a lab. and once every so often contribute to advancement of art of communication.

"Have held quite a flock of amateur radio licenses and acquired some station licenses both amateur and experimental. Mixed into Government relay work at one time, have had charge of communication in the big Army camp—Pine Camp—and variously conducted tests for the FCC.

"I retrospect to the happy days of long ago and have a very kindly feeling for the radio fraternity afloat and ashore and number quite a few friends in each and every class.

"Time moves along, conditions change and no matter how we now serve, we will soon join the shadows of the past. Morse is out of the picture and with progress of current events some machine will come along and bump all the OM's off the job. But as long as there is a language of dots and dashes, there will be a sentiment among the fraternity that has no equal in any other line of business."

OVER THE TAPE...

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

BROADCAST EQUIPMENT CATALOG

The Gates Radio and Supply Company of Quincy, Illinois, manufacturers of broadcast-station equipment, announce the release of a new catalog, No. B-21, pertaining to speech-input equipment, remote-control apparatus, transcription turntables, power-supply equipment, microphones, recording devices and accessories. This catalog is available to the engineering profession.

"THE SOUND ADVISOR"

"The Sound Advisor" is a monthly publication issued by the Operadio Manufacturing Company for those engaged in sound and public-address work. Those interested may receive this publication free of charge. Address all communications to Editor, "The Sound Advisor," care of the Operadio Manufacturing Company, St. Charles, Illinois.

"PICKUP FACTS"

A brochure entitled "Pickup Facts" has just been released by the Audak Company, 500 Fifth Avenue, New York City. This booklet contains a discussion of relayed-frequency pickups which is said to be of interest to broadcast and sound engineers. Illustrations and details of the entire Audax line of pickups are also included. Audak will mail a copy of "Pickup Facts" upon request.

NEW QUARTERS FOR TURNER

The Turner Company, Cedar Rapids, Iowa, announce their removal to a new factory building at 909-17th Street, Cedar Rapids. A steady growth during the past four years has made necessary the removal to larger quarters.

TRANSCRIPTION, RECORDING SERVICE

Radio Station WOR has announced the opening of a recording and transcription service for advertising agency program checking, artists' self-criticism, commercial auditions, program department references, legal files, speeches, etc. Complete facilities are available for making masters and hard pressings of programs for radio broadcasting. For further information communicate with Ray S. Lyon, development engineer, Radio Station WOR, 1440 Broadway, New York City.

U. S. TRANSMITTER CORP.

Rocke International Electric Corporation, 100 Varick Street, New York City, have announced the formation of the U. S. Transmitter Corporation, an organization which will manufacture many types of communication apparatus. Transmitters, receivers and amplifiers for the government and export market are now being manufactured at their plant at 75 Crosby Street, New York City, it is stated. A. Pleasanton is plant manager and Frank Edmonds is chief engineer.

SHURE CATALOG

A new six-page 1937 catalog of microphones and accessories has just been issued by Shure Brothers, 225 W. Huron Street, Chicago. Copies are available on request.

Among the latest additions to the Shure line shown in this catalog are the new "Ultra" wide-range crystal microphones, in spherical, swivel and "grille-type" models, the Model 85A high-fidelity sound-cell type crystal microphone, and a series of crystal and carbon microphones with 4-way utility features.

KFRO NEWS

Radio Station KFRO, Longview, Texas, is mailing out 19 by 24-inch desk blotters to advertising agencies and national advertisers. The desk blotter contains a map showing the coverage of KFRO as well as a number of other interesting facts. Copies of these desk blotters are available for distribution to anyone requesting them.

Jack Hopkins, formerly of KLMB, Monroe, Louisiana, has been added to the technical staff of KFRO as press operator and assistant engineer. Sid Parks, formerly news operator of KFRO, has resigned to take the position of technician with Police Station KACU. John McDonald is now KFRO's news announcer and studio technician. Mr. McDonald hails from WLEU, Erie, Pennsylvania.

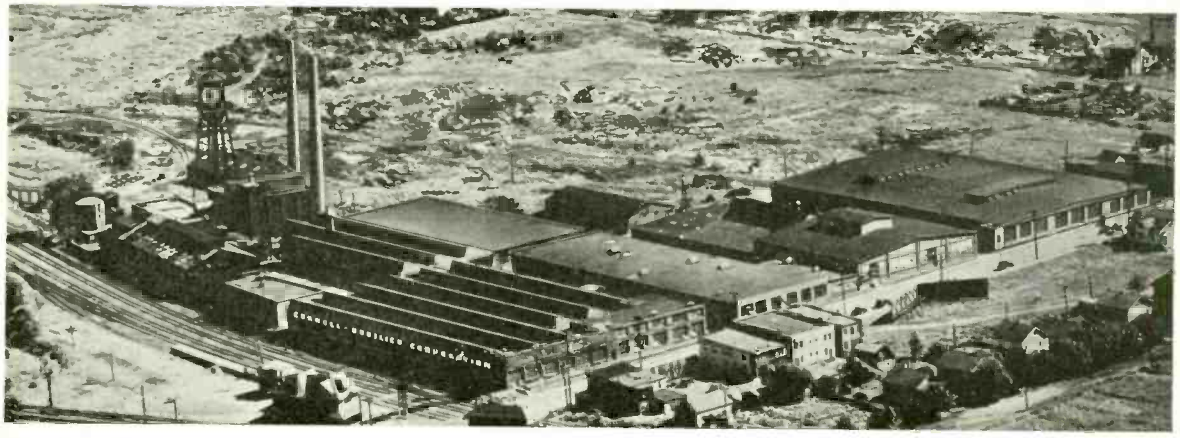
ACA BOOKLET

A booklet illustrating and describing the "ACA Citation Series Gold Medal" amplifiers has been prepared by the Amplifier Co. of America, 39 West 20th St., New York City. It is said to contain interesting data for public-address and sound engineers. Copies may be secured by writing to the manufacturer.

EASTERN MIKE-STAND CATALOG

The Eastern Mike-Stand Company, 56 Christopher Avenue, Brooklyn, N. Y., have just issued a new set of catalog sheets illustrating and describing their complete line of microphone stands and accessories. A feature of the new line is a modernistic stand especially designed for use with instruments similar in type to the Western Electric "eight-ball" microphone. This unit is said to appeal basically to broadcast stations. These catalog sheets will be mailed upon request.

THE NEW PLANT OF THE CORNELL-DUBILIER CORPORATION AT SOUTH PLAINFIELD, NEW JERSEY.



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