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Radio Telegraphy

Radio Telephony

Wire and Cable Telegraphy

Wire and Cable Telephony

Broadcast Transmission

Carrier Transmission

Beam Transmission

Marine Radio

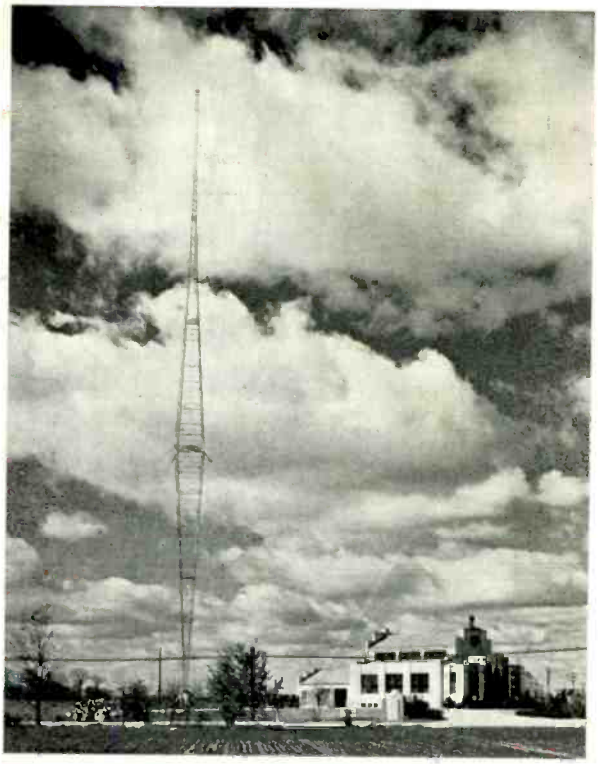
Police Radio

Aeronautical Radio

Television

Facsimile

MARCH, 1936



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Associate Editor

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COVER ILLUSTRATION

THE 733-FOOT SINGLE-MAST ANTENNA OF WJR, THE GOODWILL STATION, DETROIT, MICHIGAN

CONTENTS

FEATURES

DEPARTMENTS

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EDITORIAL

THE MULTIPACTOR TUBE

A HIGH-GAIN, low-noise tube was discussed and demonstrated at the March 4 meeting of the New York Section of the Institute of Radio Engineers by Philo T. Farnsworth, of Farnsworth Television, Inc. This tube, known as the Multipactor, employs the phenomenon of secondary emission and is similar in principle to the Multiplier tube which was announced some months ago by Dr. V. K. Zworykin, of the RCA Manufacturing Co., Inc.

Farnsworth's Multipactor tube is of the cold-cathode type, the electron stream building up as it traverses the inside of the cylindrical cold cathode and finally being collected at the anode. Amplification is controlled by the design of the tube.

Since this tube will oscillate at frequencies as high as 300 megacycles and since it possesses the features of low noise, high gain and high efficiency, it would seem to promise much, especially for the ultra-high-frequency spectrum. As a result, it may have considerable importance in the development of television transmissions and high-quality broadcasts at the shorter wavelengths.

TELEPHONE-TELEVISION SERVICE

THE FIRST long-distance telephone-television service to be made public was placed in service at the opening of the annual Leipzig Industrial Fair on March 1. This service links Berlin and Leipzig over a 186-mile cable route. The equipment is of the 180-line 25-frames-per-second variety. However, it is planned to increase both the number of lines and frames.

According to reports, a single concentric cable is used for both sight and sound. At the present time, this cable service provides eighty simultaneous transmissions, but is capable of only one series of images at a time. The number of simultaneous telephone communications can be increased to 500.

Experiments with higher definition systems have been carried out in Germany, Great Britain and the United States. The process which is employed in the Leipzig-Berlin telephone-television service has also been developed in other countries and is similar in quality to that set up by the American Telephone and Telegraph Company in New York in 1930 and operated on an experimental basis.

TELEVISION FIELD TESTS

THE TELEVISION FIELD TESTS of RCA are proceeding on schedule and will commence within a month or two, according to the annual report to the stockholders of the Radio Corporation of America. For the first time it was officially disclosed that the television transmitter will be located on the Empire State Building in New York City. The transmitter will be connected by radio with the television studio now under construction in the NBC plant, RCA Building, in Radio City. The installation is practically complete.

The test receivers will be operated by the technical personnel of the RCA organization throughout the metropolitan area.

However, these experimental tests do not necessarily mean that regular television service is at hand. It represents an essential pioneering stage to estimate and define its possibilities under actual working conditions. The experimental data gained from these field tests should prove invaluable.

DECISION ON COAXIAL CABLE

ON FEBRUARY 26, the Federal Communications Commission reached its second decision in connection with the application of the American Telephone and Telegraph Company for authorization to construct a coaxial cable between New York and Philadelphia. The commission, according to a NAB report, in its decision granted the Telephone Company permission to construct this cable for experimental purposes only and provided that before it could be used commercially further permission would have to be obtained from the Commission.

The American Telephone and Telegraph Company have notified the FCC that the decision has been accepted.

In its decision, the Commission found that it had jurisdiction over the construction of the cable . . . that it is in the public interest that it be constructed. Among the restrictions placed on this project was a statement to the effect that there shall be no discrimination between television experimenters who wish to use the cable.

It is believed that the installation of this cable will have considerable bearing on the future of television. Its importance can hardly be over-emphasized.

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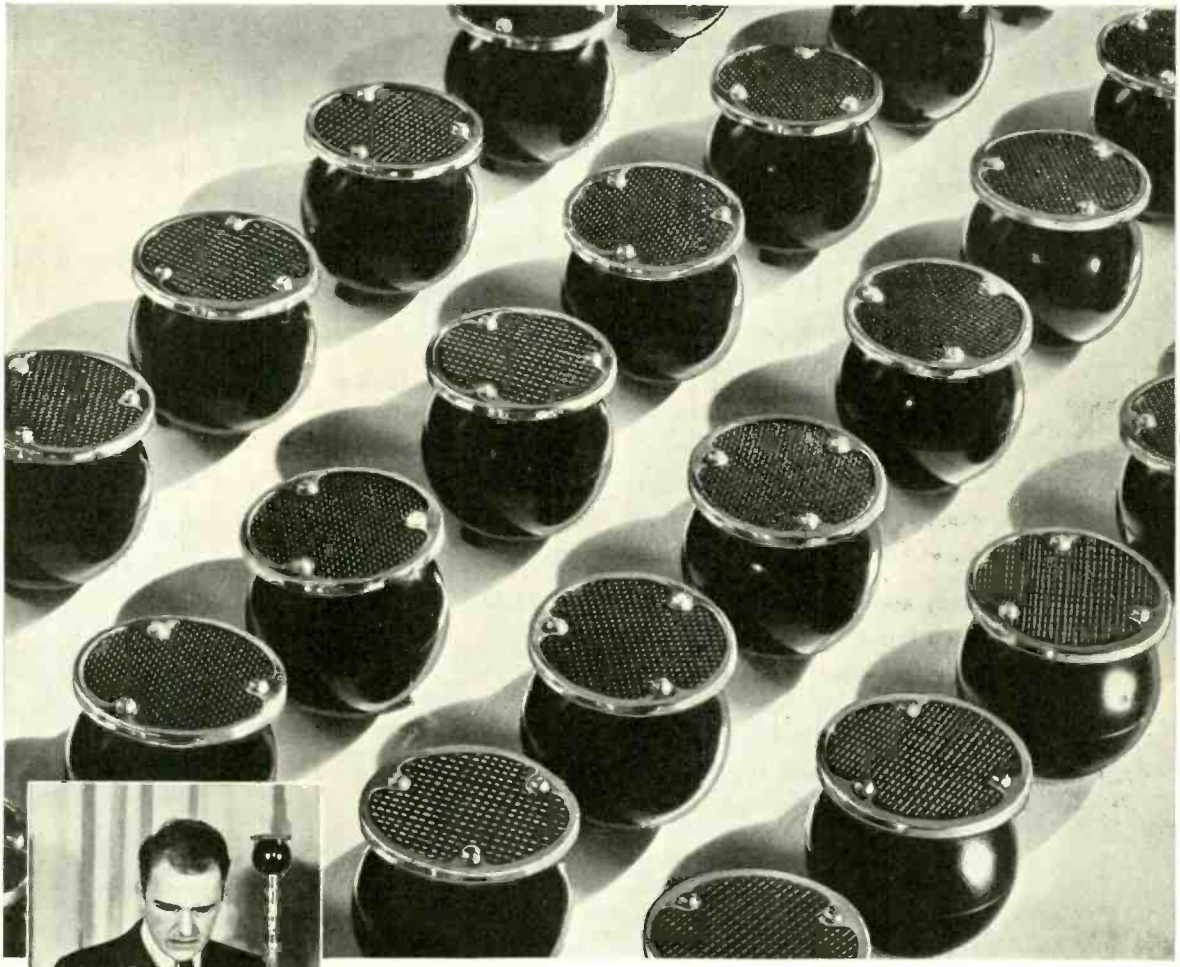

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RADIO TELEPHONE BROADCASTING EQUIPMENT

COMMUNICATION & BROADCAST ENGINEERING

FOR MARCH, 1936

"HIGH-FIDELITY" TRANSCRIPTION EQUIPMENT

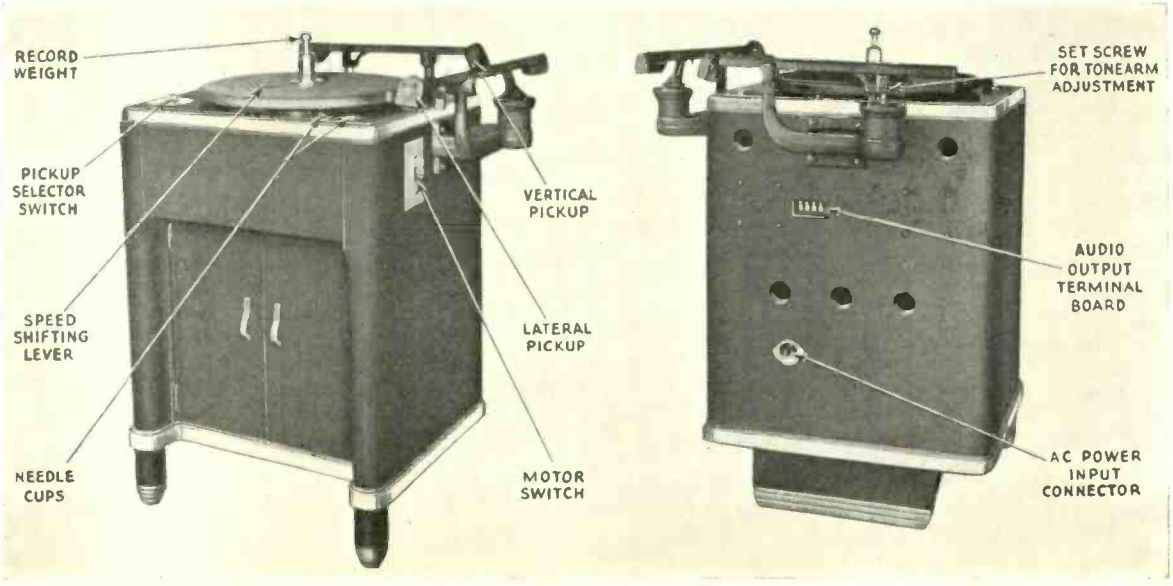
By JOHN P. TAYLOR

The Newest Equipment in this Field Discussed with Particular Reference to the Increased Fidelity Standards Necessitated By the Growing Importance of Transcription Broadcasting

BROADCASTING, in the popular sense at least, began with the record programs of Dr. Conrad's experimental transmitter 8XK—and from that early beginning until the present time, recordings, in one form or another, have continued to be an important source of program material. In the gradual evolution of the transcribed program which has occurred during this period, there have been several ups and downs—occasioned partly by the spasmodic progress of technical improvement in recording, and partly by the coincidental development of other phases of broadcasting, such as the growth of the networks. However, the latest of these resurgences—that which has occurred in the last two years—has definitely carried transcriptions to a new high in popular regard, and this new phase in their development seems certain to establish for them a permanent place in the broadcast picture.

Most important of the several factors promoting the widening use of recorded programs are: First, the much improved reproduction fidelity now possible and, second, the more general commercial sponsorship of such programs. These are of urgent interest to broadcast engineers because of the emphasis they place on the use of high-fidelity equipment. The first makes such equipment a desirability; the second makes it a necessity. The practice of making up a reproducing equipment of parts obtained from a cut-rate supply house (parts usually long since discarded as obso-

FRONT AND REAR VIEW OF A NEW UNIVERSAL-TYPE TRANSCRIPTION EQUIPMENT, WHICH OPERATES AT 33-1/3 AND 78 RPM AND WHICH REPRODUCES BOTH VERTICAL- AND LATERAL-CUT RECORDINGS.



lete by the receiver manufacturers) can no longer be tolerated. High fidelity must now be considered as much a primary requirement of transcription equipment as of any other unit of the broadcast chain.

HIGH-FIDELITY REQUIREMENTS

The general requirements for high fidelity in a transcription equipment are no different from those for other items of broadcast equipment. They include: A uniform response over a wide frequency range, a minimum distortion factor and a noise level sufficiently low to allow for accommodation of a wide volume range. These must, of course, be considered somewhat differently, in that recording is primarily a mechanical process (the "electrically transcribed" slogan notwithstanding). However, the proper design of the mechanical elements is now well understood and, if they are considered in proper relation to the electrical constants involved, it is possible to closely approach accepted standards for high-fidelity transmission. The equipment illustrated and described on these pages is of particular interest as an indication of how far it is presently possible to go in this direction.

GENERAL DESIGN

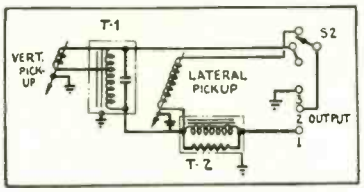
The transcription equipments in use in broadcast stations during the last year or two have varied in design and complexity from the relative simplicity of a shallow cabinet model, designed for table mounting, to the elaborate layout of an apparatus requiring fifteen or twenty feet of floor space. Of these two extremes the first has the convenient advantage of requiring a very minimum of space; but it suffers under the handicap that the turntable must be mounted directly on the motor shaft—thus making impossible the very desirable interposition of a mechanical filter for damping motor irregularity. The second, and more elaborate, while admittedly insuring good performance, requires an excessive amount of floor space and presents the usual disadvantages of an open assembly.

The new equipment illustrated here has been designed with the idea of securing the advantages of both of these earlier types of equipments, while at the same time avoiding to a large degree their disadvantages. This has been done by mounting this equipment in a console cabinet approximately 22 inches square and 32 inches high. Thus the floor space it requires is no greater than the table space required by the smallest previous models. At the same time the extra depth allows the motor to be mounted separately from the turntable driving mechanism, thus allowing use of a flexible driving system. The latter refinement makes it possible to obtain, in this relatively small equipment, regulation equal to that obtained with the more elaborate of previous equipments.

The several illustrations shown indicate the appearance of this equipment sufficiently that detailed description is hardly necessary. It will be noted that only one leg is provided in the rear, the three-point support thus provided being valuable in eliminating any possibility of rocking on an uneven floor.

LATERAL-CUT AND VERTICAL-CUT REPRODUCTION

The transcriptions in every-day use in broadcast stations include both lateral-cut and vertical-cut recordings. The pickup systems required for reproduction of the two differ considerably, and, in order to make a transcription equipment satisfactory for both, it is necessary to provide two complete and



SCHEMATIC DIAGRAM INDICATING CONNECTIONS OF LATERAL AND VERTICAL PICKUP CIRCUITS.

independent reproducing systems. In the equipment shown this provision, together with the possibility of operating at either speed, makes the equipment completely universal. Thus standard records, long-playing records, lateral-cut transcriptions and vertical-cut transcriptions can be used interchangeably.

The two reproducing systems employed are independent mechanically, and also electrically with the exception of the compensating reactor which is common to both pickup circuits.

The lateral pickup (of the magnetic type) and suspension arm are mounted on the right side of the console. The vertical pickup (of the moving-coil type with diamond-point needle) and suspension are mounted at the rear. The mountings, which are similar, consist of cast-metal brackets rigidly fixed to the cabinet. These brackets are shaped at one end into a swivel-cup in which the suspension arm support is cushion-mounted, and at the other end into a rest for the pickup arm. Long arms are used so that good tracking will be obtained on both large and small records. These are of the inertia type with the individual balances adjusted to obtain the correct needle pressures for the two types of recordings.

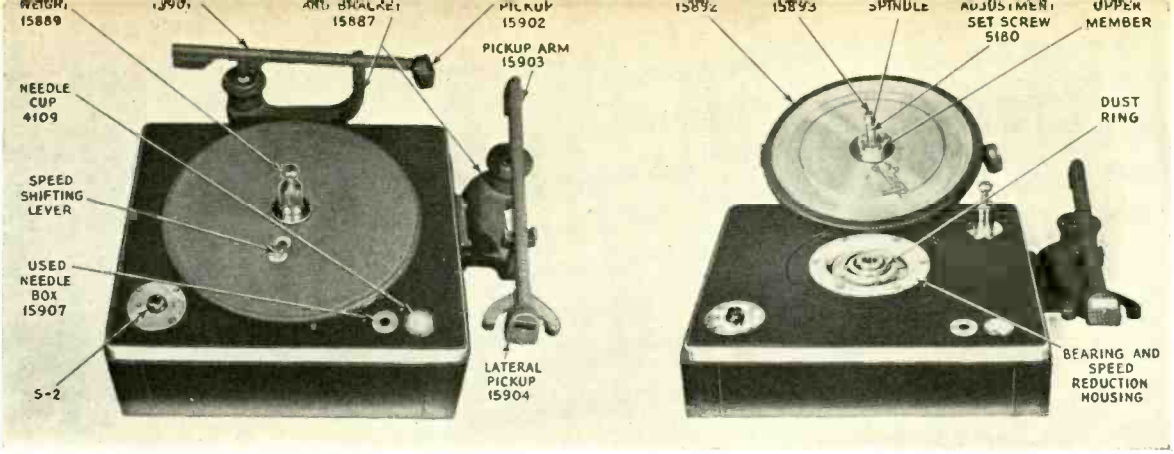
RECORDING VERSUS REPRODUCTION CHARACTERISTICS

In general the various units of a broadcast transmitting layout are designed so that each has a flat frequency characteristic. In transcription equipment, however, the rule must be deviated from, inasmuch as it is necessary to compensate at the reproducing end for the non-uniformity which is accepted practice in all recording processes. This requires a downward slope of something like 15 db in the frequency characteristic of the lateral pickup, and a corresponding, although rather less, slope in the frequency characteristic of the vertical pickup. Proper shaping of these characteristics necessitates, of course, an accurate knowledge of recording characteristics. However, when such information is available it is possible to provide compensation which will insure an overall recording-reproduction characteristic substantially uniform throughout the whole usable range. In this way the equipment shown here has been given a range of 50 to 7000 cycles on lateral-cut recordings and 50 to 10,000 cycles on vertical-cut recordings. Thus a frequency range approaching high-fidelity standards is provided.

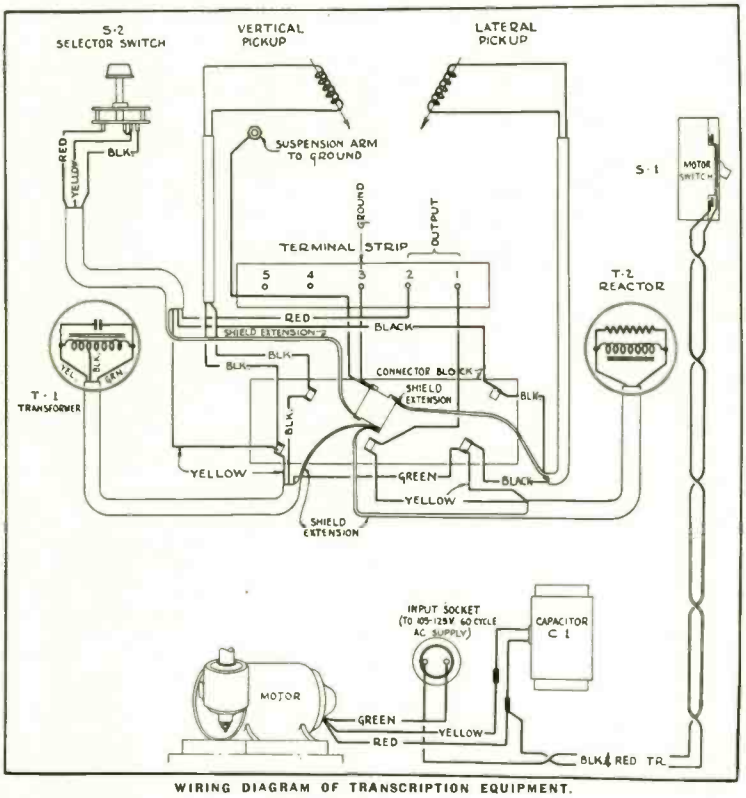
ELIMINATION OF "WOWS"

In any reproducing equipment speed-constancy is an essential requirement. Unless the regulation of the driving motor is such that variations of the load imparted by the pickup and suspension arm do not affect the motor speed, "wows" will occur on sustained notes of low frequency. This is a type of distortion which is particularly objectionable in broadcast transmission. It has been found, for instance, that speed variations as small as one percent will produce noticeable "wows." Thus, to avoid this distortion, regulation of a fraction of one percent is necessary.

In the equipment shown the problem has been attacked, first, by employing a synchronous motor of sufficient size that the torque developed is large compared to the load variation and, second, by providing a damping system capable of smoothing out the slight irregularities which occur in the motor. The inertia of this damping system is provided by the turntable itself plus a large flywheel mounted on the turntable spindle. This arrangement insures a fairly constant load on the motor. An oiled-felt filtering mechanism incorporated in the motor drive provides an additional smoothing action. The overall effect of these precautions is to limit the variations of the turntable speed to a maxi-

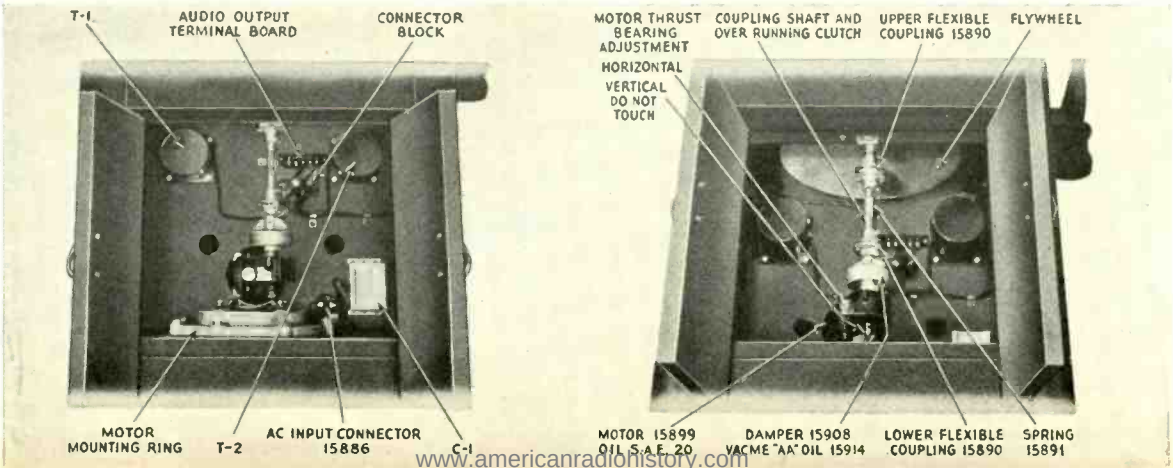


TOP VIEW OF UNIVERSAL-TYPE TRANSCRIPTION EQUIPMENT SHOWING THE SPECIAL TURNTABLE AND HEAVY-DUTY SPEED-REDUCTION MECHANISM.



WIRING DIAGRAM OF TRANSCRIPTION EQUIPMENT.

INTERIOR VIEWS OF THE EQUIPMENT SHOWING THE FLEXIBLE DRIVE SYSTEM EMPLOYED TO SMOOTH OUT MOTOR IRREGULARITIES.



mum of four-tenths of one percent at 78 rpm and six-tenths of one percent at 33-1/3 rpm. This regulation insures complete freedom from mechanical load distortion.

A smooth-running and absolutely true turntable is as essential to high fidelity as good regulation—and precautions must be taken to guarantee retention of this during a long period of hard usage. In the equipment shown here a heavy-duty turntable housing of special design has been provided in order to assure this. This housing supports the main turntable spindle, the clutch mechanism and the drive-shaft on which is mounted the balanced flywheel. The main turntable shaft is well-journaled in a combination radial- and thrust-load ball-bearing at the top of the housing, and in a bronze radial-bearing at the bottom of the housing. These bearings are wide-spread and are journal-finished to insure long life and a true turntable face when revolving.

Many of the transcriptions presently used are made of very thin material and have a tendency to bend and warp, which, were further precautions not taken, would nullify all efforts to obtain a true turntable face. For this reason there are provided with this equipment a large sized turntable (16 inches) and a special weight to place on the top of the record to insure that it will lie flat. This weight—which has a soft rubber face next to the record—engages the hexagonal record spindle and thus insures a positive drive between the turntable and the record.

While most of the transcriptions now produced are for reproduction at 33-1/3 rpm, it is also usually desirable to provide for production of popular records which are recorded at 78 rpm. Speed-reduction devices of proven satisfactoriness are now available, so that there is no reason why both speeds can not be provided in the same machine. In the equipment shown here a ball-bearing reduction is utilized. This is similar to the type in use in receiver combinations for several years past, but is of special dimensions commensurate with heavy-duty use. The speed change is affected by means of a small button set in a slot in the top of the turntable disc.

The main turntable spindle revolves constantly at 78 rpm. For 78 rpm reproduction, a shifting member—which is operated from the button on the top of the disc—engages a pawl ring, and this engagement couples the driving mechanism from the motor direct to the turntable. When the control button is set at the 33-1/3 rpm position the shifting member on the turntable is disengaged from the pawl ring and engages in a slot in the bearing housing. In this clutch position the ball-bearing reduction intercepts the direct drive from the motor to the turntable, and reduces the speed of the turntable. The change-of-speed is accomplished in one revolution of the turntable, thus eliminating loss of time between successive records requiring reproduction at different speeds.

Noise in the output of a transcription equipment is often caused by pickup of the motor vibration. This may be caused by conductance of vibration through the cabinet and suspension arm to the pickup or through the cabinet or the drive shaft to the turntable and thence to the pickup. To eliminate this completely requires special cushioning at several vital points. For instance, in the equipment shown, the motor is set in a heavy cast-iron block which is fixed to a layer of felt, and the felt in turn clamped to the shelf of the cabinet. This, plus the cushioned mounting of the suspension arms at the swivel points, prevents conductance of vibration through the cabinet. The bearing-housing is cushion-mounted in the top of the cabinet, and is isolated from the motor by a specially-designed flexible coupling in the drive shaft. This consists of two semi-flexible joints, together with a secondary spring-coupling which also serves to disengage the turntable shaft whenever the turntable and flywheel are revolving at a greater speed than the motor.

The output impedances of the two reproducing circuits, and the output levels developed across these impedances, are closely the same, so that they may be used interchangeably without change of connections or gain in the succeeding speech-input equipment. The impedances are designed to match 250 ohms. Using test records XL-81 and XL-113 the output voltages developed are approximately 0.01 volt rms, at 1000 cycles—that is about minus 45 db as compared to a zero level of 6 milliwatts. These impedances and levels are comparable to those of a carbon microphone, or of a pre-amplifier used with a high-quality microphone, and thus may be fed directly to the mixers of a standard mixing system.

The switch controlling the power supplied the motor is located on the right-hand side of the cabinet at the top and toward the front. This is a mercury switch of the tumbler type, assuring noiseless operation. The pickup selector switch is located at the left in the top of the cabinet. This is a three-position switch with a detent assuring positive contact. The right-hand and center settings of this switch correspond to the relative positions of the two pickups. The left-hand setting provides for possible later addition of a third pickup system, or it may be used when the lateral pickup is placed on the left of the cabinet—as is desirable when two of these turntables are to be placed adjacent to each other. The speed-shifting control, as mentioned before, is mounted in the turntable proper. It is plainly marked in two colors as well as with the two speeds.

COMMUNICATIONS IN ETHIOPIA

THE SYSTEM of communications in Ethiopia is a Government monopoly, the postal, telegraph and telephone services being under the Ministry of Posts, Telegraphs and Telephones. This Ministry operates the postal service, the telephone service, and the two existing radio stations in the country.

No statistics are available, but it is estimated that the plant and equipment of the telephone service is valued at approximately $300,000 and that of the two radio stations is approximately $600,000.

There is no domestic telegraph service in Ethiopia, internal telegraph traffic being transmitted by telephone. There is no differentiation in classes of service, a flat rate of approximately $0.06 being charged per word. The traffic may be estimated at approximately 500 messages per day. There are no printed regulations, messenger service, tele-typewriter exchange service, or airmail in this country. There is no international telegraph or cable service.

Telephones were first brought into Ethiopia about 1895 and are entirely under the control of the Ethiopian Government. At the present time there are approximately 6,000 miles of lines and 500 telephones in service, not counting the inter-government instruments. (William M. Cramp, Addis Ababa, *Electrical Division, Department of Commerce.*)

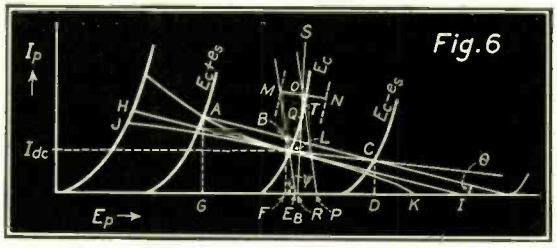
Balanced Amplifiers

PART II

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA Institutes, Inc.



V. CORRECTION FOR MID-BRANCH IMPEDANCE

In actual balanced-amplifier circuits, the "B" and "C" sources often have appreciable impedance. These are called mid-branch impedances, and usually the "B" supply impedance is the more important. We shall analyze the effects of two types of this impedance here:

(a) The case where the impedance is a pure resistance R_b to all frequencies. The resistance is usually that of the various windings in the power-supply circuit, plus that of the rectifier tube.

(b) The case where the impedance is a resistance, R_b, to d-c and zero to a-c. This is approximately the case when the filter section is terminated in a condenser of such size that its reactance to twice the lowest frequency to be amplified is negligible.

We shall take Case (a) first. We note that the resistance to $\left(\frac{I_1 - I_2}{2}\right)$ is R_L as before, but that the resistance to $2I_{dc}$ (for $e_s = 0$), and to $(I_1 + I_2)$, (when $e_s \neq 0$) is R_b. This is equivalent to a current $\left(\frac{I_1 + I_2}{2}\right)$ flowing through a resistance $2R_b$. To depict these things graphically, we proceed as follows:

From the point E_B (Fig. 6) (corresponding to the open-circuit or generated voltage of the "B" power supply) a line E_BB is drawn at an angle ψ such that

$$\psi = \cot^{-1} 2R_b \qquad (10)$$

Its intersection with the curve labeled E_c gives the no-signal d-c component of each tube. For equal grid excursions $(E_c + e_s)$ and $(E_c - e_s)$ about E_c, the simultaneous currents of the two tubes are given by AG and CD, where θ is determined by Equation (9), and B is the mid-point of AC. The position of AC can be found by sliding a rule, at the angle θ to the E_p axis, up or down along the curves. The reason for the above is that BF is evidently, from the geometry of the figure, the average between AG and CD; that is,

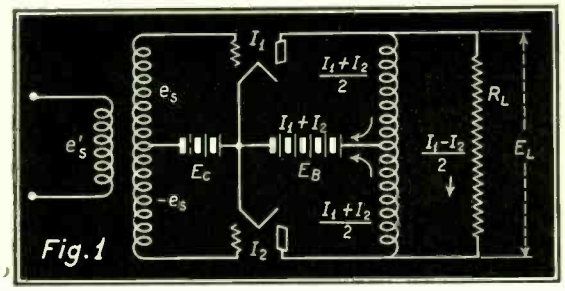
$$BF = \left(\frac{I_1 + I_2}{2}\right) \qquad (11)$$

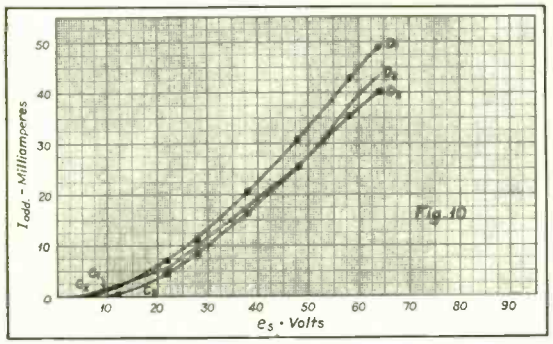
Since BF is always along the load line BE_B of $2R_b$, and $(I_1 - I_2)$ along the load line of $R_L/2$, we have satisfied the conditions stated above. Points A and C are thus two points of the load line for the tube. Other points can be found in the same manner by sliding the rule along other pairs of tube curves so that the mid-point of the segment of the rule is always on BE_B.

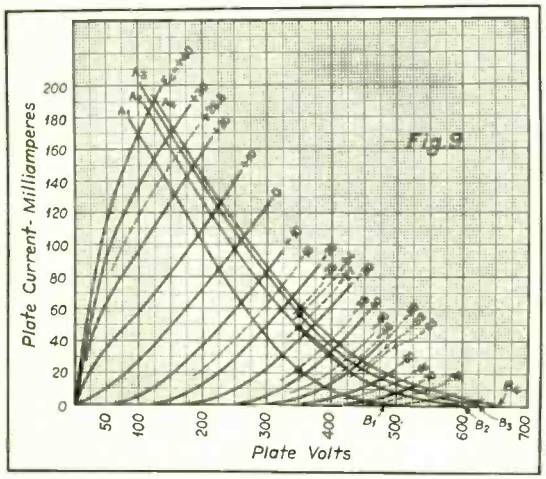
Some interesting results can be obtained for various values of R_b. In general, the load line is flatter and not as steep as for R_b equal to zero. If R_b equals $R_L/4$, the load line becomes a straight line whose slope is that for $R_L/2$ (line HI, Fig. 6). For $R_b > \frac{R_L}{4}$, the load line is concave downward (line JK). In all cases, the power output is evidently decreased since $\left(\frac{I_1 - I_2}{2}\right)$ is smaller.

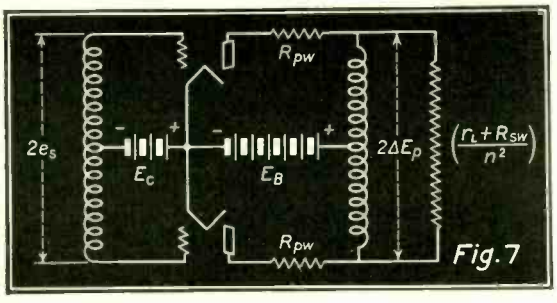
For Case (b), I_{dc} is determined by line BE_B. $(I_1 - I_2)$, however, is not determined by this same line, but by the ordinate passing through I_{dc}; i.e., through point L. The rule segment must be bisected by the ordinate instead of BE_B. When the load line is obtained, the current-time curve can be analyzed for additional d-c component. This is now added to the original I_{dc} at point L along BE_B, giving now point M. Through M the line MN is drawn parrallel to AC. As before, N represents a grid voltage as much below E_c as that for M is above. The ordinate, SR, through the mid-point, O, of MN, is the one about which equal values of ΔE_p are to be found. Points for the new load line can be found as before, and M, Q, and N are three of these just determined.

In correcting for the additional d-c component in Case (a), the same procedure is followed, except that OP, parallel to ME_B instead of the ordinate SR, through O, is the line about which equal values of ΔE_p are to be found in determining the new load line. In that case, M, T, and N are the three points of the new load line.









VI. CORRECTION FOR WINDING RESISTANCE

In actual practice, a two-winding transformer instead of a tapped choke is used. The two halves of the transformer may each have appreciable resistance, call it R_{pw}. The secondary-winding resistance, R_{sw}, may be combined with the actual load resistance r_L and reflected by the square of the turns ratio, n, to give the plate-to-plate resistance R_L. Thus

$$R_L = \left(\frac{r_L + R_{sw}}{n^2}\right) \qquad (12)$$

The primary resistances, however, cannot be disposed of so readily. The circuit of Fig. 1 may be modified to take care of this condition by the well-known transformer theory, as shown in Fig. 7. As can be seen the primary-winding resistances can be associated with the two tubes instead of with the transformer so that we may regard the tubes as generators having higher internal resistances. The situation, however, is not quite the same as in *Section V*, for there R_b acted as a common or coupling resistance between the two tubes, whereas here each R_{pw} carries only its own tube current.

This case can be handled by first re-plotting all the tube curves so as to include R_{pw} as part of the equivalent tube's resistance. This is a laborious process, and the resulting family of curves would hold only for the particular value of R_{pw} used. Another output transformer with a different primary-winding resistance would require a new set of curves. Fortunately, the construction can be simplified so as to apply to the original tube family of curves.

In Fig. 8 is shown the method of construction which is also that of the sliding rule. Line DE_B is the load line for R_{pw}. AB is the segment of the rule between curves of equal grid swings e_s. The slope of AB is such that

$$\theta = \cot^{-1}\left(R_{pw} + \frac{R_L}{2}\right) \qquad (13)$$

where R_L is given by Equation (12). Furthermore, D is the mid-point of AB, and C is the normal d-c component. Points A, C, and B are on the load line, and further points can be determined in exactly the same way that A and B were. From this, further facts and constructions clearly follow. Thus, the additional d-c component is added along DE_B and the rest follows as in the other cases analyzed.

The proof is as follows: Suppose the correct values of I_1 and I_2 were known beforehand for the grid swing e_s, and are represented by H and G, respectively. Due to R_{pw}, the instantaneous plate voltages are determined where the load lines for R_{pw} through A and B strike the E_p axis in J and K, respectively. If I_1 and I_2 are correct, then

$$JE_B = E_BK$$

and JK is the voltage across R_L.

Points H and G are the projections of A and B, over to the ordinates through J and K, respectively. The line joining H and G will make the proper slope corresponding to $\cot^{-1}\frac{R_L}{2}$. The mid-point of HG is represented by F, and its vertical projection on CE_B as D. We note that $FE_B = \frac{HJ + GK}{2}$, and that triangles AHJ, DFE_B, and BGK are similar, so that $DE_B = \frac{AJ + BK}{2}$. This

in turn means that figure $AJKB$ is a trapezoid, and therefore ADB is a straight line whose mid-point is D.

We finally note that the angle of slope of AB is given by

$$\theta = \cot^{-1}\frac{AH + JK - BG}{HJ - GK}$$

$$= \cot^{-1}\frac{(HJ)R_{pw} + JK - (GK)\,R_{pw}}{HJ - GK}$$

$$= R_{pw} + \frac{JK}{HJ - GK} = R_{pw} + \frac{R_L}{2}$$

This establishes the correctness of the construction.

This construction can be combined with that given in *Section V*. For the case of R_b a resistance to all frequencies, DE_B is drawn to represent the load line for $(2R_b + R_{pw})$, and AB so that Equation (13) is still valid. For the case of R_b a resistance to d-c, only, we draw DE_B to represent $(2R_b + R_{pw})$, and where it intersects the E_c curve at C is the normal value of d-c component. Through C a line representing R_{pw} is drawn, and the rule slid so that AB is bisected by this line rather than by the first one representing $(R_{pw} + 2R_b)$. The additional d-c component, however, is added along the load line of $(R_{pw} + 2R_b)$, but for a-c components of $(I_1 - I_2)$ and $(I_1 + I_2)$, the load line for R_{pw} is used. The rest of the work should be evident to the reader from the preceding analysis.

VII. APPLICATION TO 6F6 TUBE

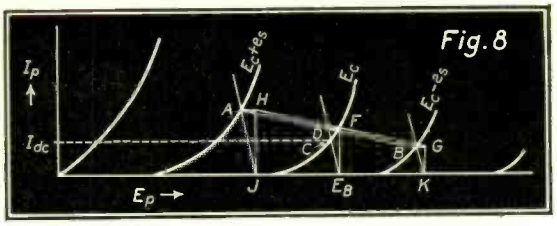
It will be of interest to apply the foregoing methods to an actual case, that of two 6F6 tubes in push-pull. Two modes of operation will be analyzed: (a) that for a zero mid-branch impedance, and (b) for a resistance to d-c of 1000 ohms; i.e., $R_b = 1{,}000$ ohms.

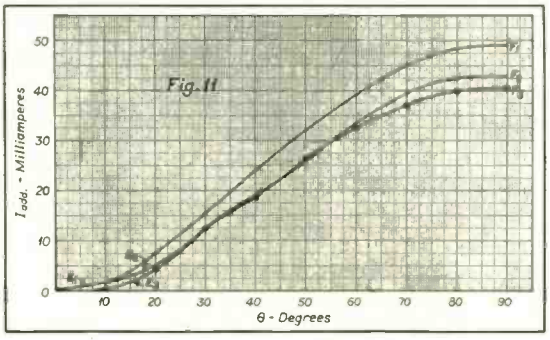
In either case the quiescent plate voltage and current are 350 volts and 22.5 milliamperes, respectively, and the plate-to-plate load resistance, R_L, is 6000 ohms. For the case $R_b = 0$, peak $e_s = 63.8$ volts, and the fixed grid bias is -38 volts. The characteristic curves are shown in Fig. 9, and A_1B_1 is the first tentative load line for either tube, obtained by sliding the rule at an angle corresponding to 3000 ohms, and bisected by the 350-volt ordinate. From this curve simultaneous values of I_1 and I_2 can be obtained for the corresponding grid swings. Thus, if e_s is 8 volts per grid, I_1 is 30 ma, and I_2 is 15 ma. Then $\frac{I_1 + I_2}{2} = 23$ ma, which is 0.5 ma greater than the quiescent value 22.5 ma. This increase of 0.5 ma will be called I_{add}. The values for grid swings up to 63.8 volts have been set down in Table I. The quantity I_{add} represents half the amount by which the power-supply current pulsates above its quiescent value.

This is then plotted against e_s, and curve C_1D_1, Fig. 10, obtained. If we now assume e_s is sinusoidal, and of peak amplitude 63.8 volts, its equation is

$$e_s = 63.8 \sin \omega t$$

We can then calculate the instantaneous values of e_s for every 10° of the cycle, or any other interval, and then find the corresponding values of I_{add} from Fig. 10. These are tabulated in Table II. From this table I_{add} is plotted against θ, and curve E_1F_1, Fig. 11, obtained. The area underneath this curve is then found in any convenient way, such as by adding up all the small squares of the graph paper below it, and dividing by





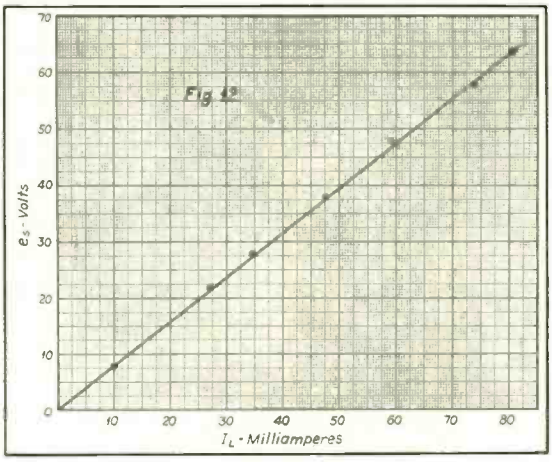
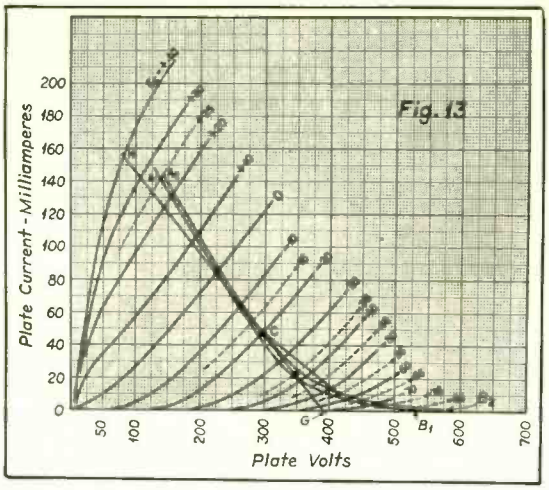


Table I

e_s	I_1	I_2	$\frac{I_1+I_2}{2}$	$I_{add.}$
8.0	31	15	23.0	0.5
22.0	53	7	30.0	7.5
28.0	63	5	34.0	11.5
38.0	85	2	43.5	21.0
48.0	107	0	53.5	31.0
58.0	131	0	65.5	43.0
63.8	143	0	71.5	49.0

Table II

θ	sin θ	e_s	$I_{add.}$
0	0	0	0
10	0.1736	11.07	1.5
20	0.3420	21.80	7.3
30	0.5000	31.90	15.2
40	0.6430	41.00	24.0
50	0.7660	48.90	32.0
60	[illegible]	[illegible]	39.5
70	0.9400	59.90	45.3
80	0.9850	62.80	48.3
90	1.0000	63.80	49.0



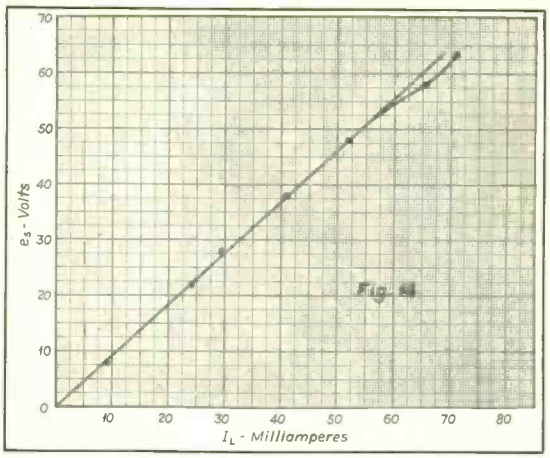
the base. The quotient, to the proper scale, represents the d-c component of I_{add}; in this case it comes out to be 26.4 ma. This is added to the quiescent value of 22.5 ma, giving a total of 48.9 ma. The latter is laid off along the 350-volt ordinate in Fig. 9. It intersects the curve for which the grid voltage is —27 volts (11 volts above —38 volts bias), hence the corresponding curve has a grid voltage of —49 volts. A line at the angle $R_L/2$ or 3000 ohms is laid off between these two curves, and through the point 48.9 ma. It intersects the —49 volt curve at 23 ma. The ordinate through 385 volts bisects this line, and intersects the —38 volt curve at 34 ma. The rule is now slid so that its segment intercepted by curves of equal grid swing is bisected by the 385-volt ordinate, and load line A_2B_2 is obtained.

The analysis of this load line is the same as for A_1B_1, and the curves on the succeeding figures are all labeled with the subscript 2. The additional d-c component is now 22.3 ma, which is added to the 34 ma (the corrected operating point) and the total, 56.3 ma. *is laid off along the 350-volt ordinate.* This gives a point on the third load line, A_3B_3, which is determined in exactly the same way as the other two. This is then analyzed for additional d-c component (see curves with subscript 3), and the latter found to be 21.3 ma. The operating current for A_3B_3 is 39 ma, hence the total d-c is 60.3 ma, which does not materially exceed the previous value of 56.3 ma. Hence this is the final correction, and the fourth load line A_4B_4, may be considered the correct one. From this final curve values of $(I_1 - I_2)/2$ can be found for various values of e_s. These are plotted in Fig. 12, and the graph is practically straight. For a peak grid swing of 63.8 volts, $(I_1 - I_2)$ is 80.5 ma. The power output is then $\frac{(.0805)^2 \times 6000}{2} = 19.4$ watts, and the d-c component under full signal was found to be 60.3 ma. The experimental values are 54.5 ma and 18.8 watts, which compare favorably with the above. The latter are higher, and this is to be expected, since the experimental values include the effect of the driver tube, peak grid swing is the same in either case.

We now come to the case where $R_b = 1000$ ohms to d-c only. The tube family of curves and the successive load lines are shown in Fig. 13. Through the —38 volt curve, at 22.5 ma, a 2000-ohm load line (twice R_b) is drawn, line *GH*. It intersects the E_p axis at 395 volts, which is the open-circuit voltage of the power supply. The rule is now slid at an angle determined by 3000 ohms so that its segment is bisected by the 350-volt ordinate, and not the 2000-ohm load line *GH*. Load line A_1B_1 is obtained. This is analyzed as in the previous case, and the additional d-c component found to be 25.8 ma, or a total of 48.3 ma. This value is laid off along *GH*, giving point *C*, at a grid voltage of —20 volts. The corresponding value for I_2 is 10 ma at the grid voltage —56 volts. The new load line A_2B_2 can now be drawn around the 355-volt ordinate, on which 25 ma is the new operating point. It is evident from the figure that no further correction is necessary, since such points would lie below the tube load lines and thus give rise to a third load line below the other two, rather than above them.

From A_2B_2 the graph $(I_1 - I_2)/2$ -vs.-e_s is drawn, Fig. 14. This plot is straight up to about a 50-volt swing. From there to the peak of 63 volts it is curved. As a fair approximation it may be assumed to be sufficiently accurately represented by a power series involving e_s to the first and third powers, in which case the departure from linearity may be allocated between fundamental and third harmonic as follows: The curve reaches a peak of 71 ma, whereas if it were linear, it would attain a value of 68.5 ma. Three quarters of the difference between these two values, or 1.9 ma, may be added to the linear value of 68.5 ma (in the case of an overshot) to represent the fundamental component of the actual wave. This comes out to be 70.4 ma. The power output would then be $\frac{(.0704)^2 \times 6000}{2}$ or 14.88 watts, while the d-c component was found to be 48.3 ma. The corresponding experimentally obtained values are 14.4 watts and 45.5 ma, which are again lower than the graphical determinations, a difference to be expected.

It is felt, however, that the agreement is quite good and the methods themselves are quite easy to employ. The greatest part of the labor is the determination of the additional d-c components, which is not, in a sense, directly chargeable to the other constructions pertaining directly to the push-pull circuit. The main advantage of the graphical method over the experimental one is that the performance does not depend upon the particular tubes used, the kind of output transformer and driver input transformer.



LIEUT. CAESAR J. SCAVARDA.

MICHIGAN EXPANDS STATE POLICE-RADIO SYSTEM

By KING SAUNDERS

THAT RADIO COMMUNICATION will continue to be a vital factor in the apprehension of Michigan's criminals was seen when Lieut. Caesar J. Scavarda, chief of the Michigan State Police Communications Division, revealed details of plans for an elaborate expansion program of this method of combating crime.

The project calls for the building and equipping of two new radio-broadcasting stations in the near future, involving an expenditure of approximately $70,000. These stations will operate in conjunction with, and as adjuncts to, Station WRDS located at Headquarters Detachment in East Lansing.

Installation of the new stations will play an important part in a general expansion program of the department which will give Michigan one of the finest state police forces in the country. In addition to the two new transmitters, the program also calls for establishment of several new posts and an increase in trooper personnel at a cost of approximately $300,000.

Because of geological conditions and the fact that the upper peninsula and lower peninsula of the state are separated by the Straits of Mackinac, Station WRDS, situated in the south-central portion of the lower peninsula, has experienced considerable difficulty in establishing reliable reception in all sections of the state. While most of the "dead spots" are found in the upper peninsula, two particular portions of the lower peninsula also have provided radio engineers with a perplexing problem in their attempts to "blanket" the southern section of Michigan with reliable reception. The first of these is situated in the south-western corner of the state and is bounded on one side by Lake Michigan and on the other side by the State of Indiana. The second "dead spot" lies in the north-central portion of the state adjacent to Houghton Lake.

Geological conditions in the areas which the new stations will cover have, in the past, caused interference with the reception of signals from Station WRDS. Although squad cruisers normally receive signals without trouble, these peculiar conditions cause an uncertainty as to whether the radio can be relied upon during times of great emergency.

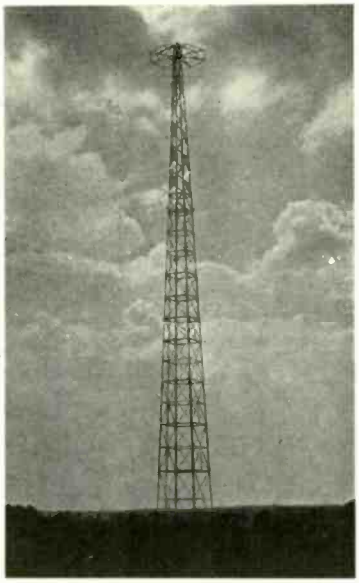
As a result, these "dead spots" cripple the efficiency of the department's ninety-seven mobile units and decrease the effectiveness of highway blockades.

Station WRDS was originally set up at an approximate cost of $45,000. It is powered with a five-kilowatt transmitter and has a guaranteed reliable reception radius of seventy-five miles. This, of course, has proven to be far below the effective range of the present transmitter, as general broadcasting is carried on regularly at much greater distances, reaching a maximum, at times, of two hundred fifty miles.

In an attempt to assure reliable reception in all sections of the lower peninsula, officials will locate one of the new radio stations near the intersection of Highway US-27 and Highway M-55 near Houghton Lake and establish the second station at Paw Paw in the south-western section of the state.

The Houghton Lake station will be powered with a five-kilowatt transmitter at a cost of approximately $45,000, while the Paw Paw station will be equipped with a one-kilowatt transmitter involving less expenditure.

Locations of the auxiliary transmitters were definitely decided upon only after exhaustive tests and a field-strength survey, covering a major portion of the state, had been conducted. This survey was started in July and extended over a period of three months. Two radio engineers, with a portable receiver and transmitter installed in a department cruiser, covered all areas where "dead spots" occurred with the greatest frequency. Their findings disclosed that the Houghton Lake and

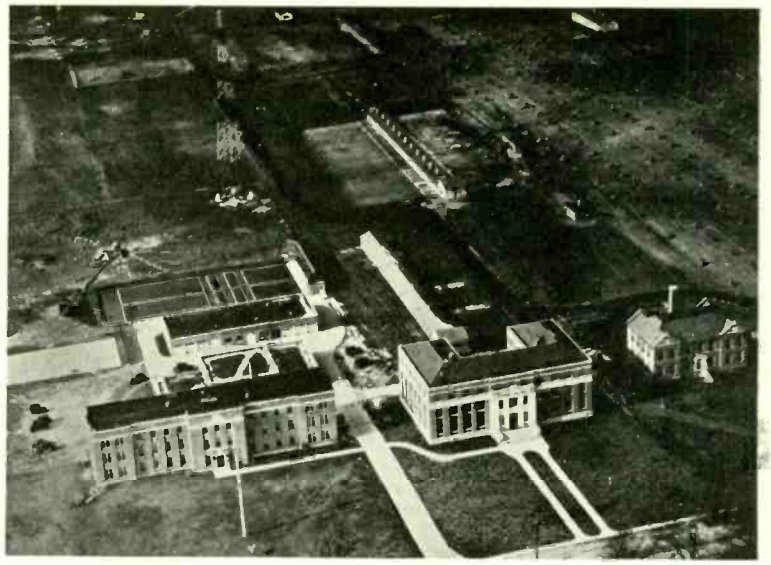


THE VERTICAL RADIATOR TOWER INSTALLED AT WRDS, EAST LANSING.

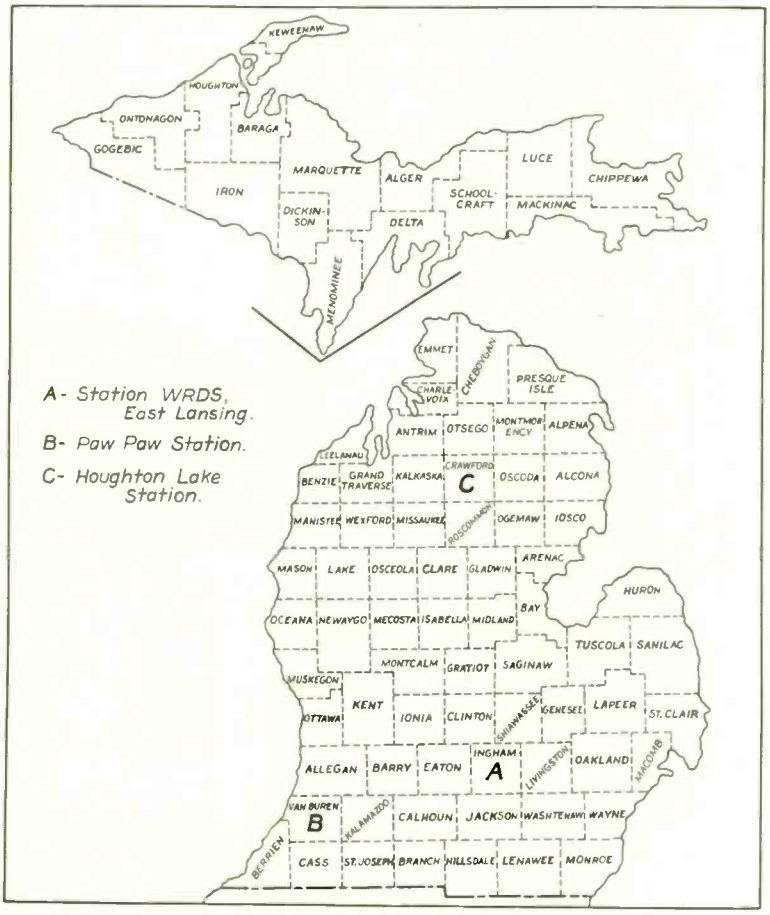
Paw Paw sites were ideal, in that broadcasting from these points will eliminate all "dead spots" and bring the entire radio system to its highest point of efficiency. The Houghton Lake station will be situated one hundred twenty-four miles north of Station WRDS and the Paw Paw station will be approximately eighty-five miles southwest of the headquarters transmitter.

In conducting the survey the test car was "spotted" at every point throughout those particular areas which had caused trouble when attempting to cover the state with reliable reception. The two-man crew covered several hundred square miles in their efforts to determine the best locations for the auxiliary stations and tested their receivers and transmitters under varying conditions, both day and night, before the Houghton Lake and Paw Paw sites were selected.

With a post already established at Paw Paw, it will be necessary to construct only the radio station building, while at Houghton Lake an entire new post will be established in addition to the setting up of the radio unit.



AERIAL VIEW OF MICHIGAN STATE POLICE HEADQUARTERS DETACHMENT AND STATION WRDS AT EAST LANSING.



MAP SHOWING THE LOCATION OF STATIONS.

With these two stations in operation the department will be able to throw out, at a moment's notice, a complete highway blockade throughout the entire area of Michigan's lower peninsula and increase by at least one-half the reliable coverage territory in which mobile units operate.

These improvements, coupled with the installation of the vertical radiator tower and considerable new equipment at Station WRDS, will eliminate practically all difficulty which the department has experienced in the past three years.

The vertical radiator tower was erected at Station WRDS in the early fall to replace the old two-tower system which had been in use since the station was established. According to Lieut. Scavarda, this installation has increased the efficiency of the central station greatly by providing a more even pattern throughout the operating radius. This same type of tower will be erected at the Paw Paw and Houghton Lake stations.

In the past it has been necessary, because of the "dead spots" throughout the state, for Station WRDS to contact Station WMP at Framingham, Mass., and ask for rebroadcasts to portions of Michigan which the local station could not reach, but which WMP reached with little or no difficulty. This system was utilized a few years ago when a Michigan bank was looted and proved satisfactory, but, of course, made for delay in getting vital information to mobile units in Michigan.

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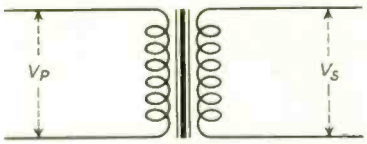


Fig. 1

LEFT: IDEAL POWER TRANSFORMER

RIGHT: ACTUAL PRACTICAL TRANSFORMER.

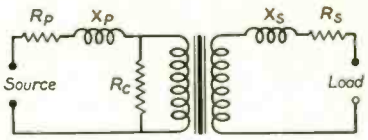


Fig. 2

DESIGN AND APPLICATION OF POWER TRANSFORMERS

By I. A. MITCHELL

Chief Engineer

United Transformer Corporation

WHEN A COMMERCIAL ORGANIZATION purchases components for broadcast or other communications equipment, the first factor which must be considered is the dependability of the apparatus. A two-hour shut-down on a broadcast schedule may be worth many times the cost of an inferior component used. Since the actual functional operation of broadcast and similar equipment is greatly dependent upon the transformers used, considerable care should be taken in the choice of these units, particularly the power supply, units which are most susceptible to overload and misuse.

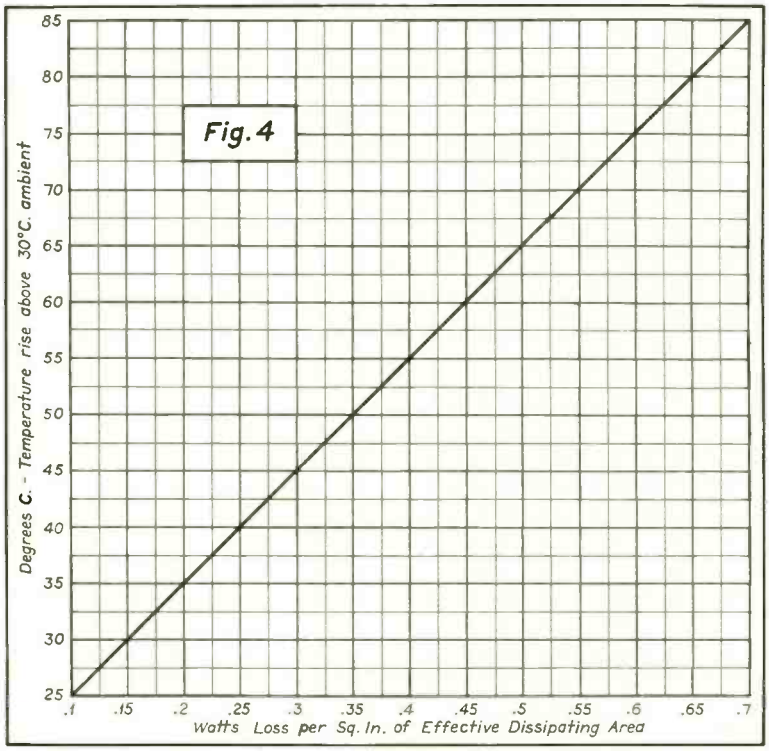
In analyzing the design or choice of a transformer, it helps to first summarize the factors which make up an ideal transformer. These may be enumerated as follows:

(a) Low temperature rise (heating).
(b) Low losses (efficiency).
(c) Good regulation.
(d) High safety factor in insulation.
(e) Rugged mechanical construction.
(f) Insulation impervious to high humidity, etc.

Before going further into the analysis of these factors, it is desirable to consider the actual operating characteristics of a power transformer.

Fig. 1 illustrates the ideal power transformer which is inherently a device designed to transfer power from one circuit to another with no direct connection, and generally with a change in voltage from the input to the output circuits. In an ideal transformer the input and output power is identical and the ratio of secondary voltage to primary voltage is directly proportional to the ratio of secondary to primary turns.

However, it is impossible to produce an ideal transformer. Fig. 2 illustrates the actual equivalent circuit of a commercial unit. Here R_p and R_s are, respectively, the primary and secondary resistances; X_p and X_s are, respectively, the primary and secondary leakage reactances; and R_c represents the losses of the magnetic core material. This may be simplified still further to the form of Fig. 3, where the leakage reactances are lumped in L and the winding resistances lumped in R. Using this T equivalent it is immediately apparent that the voltage developed across the load will be the theoretical value less



ILLUSTRATING THE EFFECT ON FINAL TEMPERATURE RISE CAUSED BY DIFFERENT RATIOS OF TRANSFORMER LOSS TO TRANSFORMER HEAT-DISSIPATING SURFACE.

the drop in L and R caused by the load current. In addition, it will also be seen that an actual power loss takes place in R and R_c. It is this power loss which governs the available output from a transformer.

TEMPERATURE RISE

A conservatively designed transformer should not have a temperature rise exceeding 40 to 55 degrees Centigrade above ambient temperature. This is due to the danger of injury to the coil insulation when exposed to final temperatures of 85 degrees and above. This maximum temperature which the coil insulation can withstand forms the definite limit to which the temperature rise and the consequent available power output must be held. Similar to most other electrical apparatus carrying power, it is found that the final temperature rise of a transformer is dependent on the total transformer losses, which produce heat, and the rate at which this heat is dissipated. As the heat-radiating surface area is increased, the rate of dissipation of heat is also increased and the internal transformer temperature is decreased. Radiation of heat is also dependent to some extent on the color of the surface, and it has been found that a black surface may reduce the temperature of a transformer 5 to 10 degrees Centigrade. Fig. 4 illustrates the effect on final temperature rise caused by different ratios of transformer loss to transformer heat-dissipating surface.

This curve is frequently useful in determining the temperature rise of a transformer when operated under abnormal or overload conditions. When a transformer is used under no-load condition a considerable portion of the time, as in testing apparatus or distribution transformers, it is customary to make the iron losses small so that a minimum of power is wasted in the idling condition. However, most transformers used in the communications field are operated at full load continuously. Under this condition it has been found that the best proportions are obtained when the iron and copper losses are approximately equal.

To analyze overload conditions let us call the iron loss 0.5 and the copper loss 0.5. If the output power is brought above normal, only the copper loss will be effected. Let us assume that we start with a transformer having a normal rise of 45 degrees or having approximately 0.3-watt loss per square inch of active surface. Now let us take the case where the transformer is overloaded 50 percent; for example, a 200-mil plate transformer operated at 300 mils. As the copper loss is proportional to the square of the current, we have a condition where the new copper loss equals 0.5 x 1.5 squared or 1.13. Adding this to the iron loss of 0.5, which has not been altered, we obtain a total loss of 1.63. Multiplying our 0.3 watt per square inch by this figure a ratio of 0.49 watt per square inch is obtained. An examination of the curve shows that this will result in a final temperature rise of 62 degrees.

As one becomes accustomed to the idea of lower temperature rise in a transformer being made possible by better heat dissipation, one begins to question the advantage of placing transformers in enclosing castings or sheet-metal cases which apparently reduce ventilation. This has been eliminated in some transformers by the use of a special insulating compound which is poured into the case. This compound, which has a large Gilsonite content, has a very high coefficient of heat transfer with the result that the transformer heat is quickly carried to the outer case. As this outer case has a larger exposed area than the transformer itself, it is found that the final temperature with the case will be less than that of an open unit.

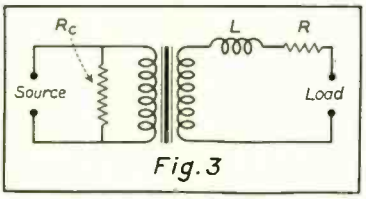


Fig. 3

SIMPLIFIED TRANSFORMER EQUIVALENT.

LOSSES—EFFICIENCY

As previously stated, the main losses in a transformer are the iron losses and the copper losses. In large transformers, and particularly in transformers operating at higher frequencies than 60 cycles, some additional loss is caused by eddy currents in the copper conductors. The iron losses in a transformer can be kept at a proper point by the use of low flux densities. The use of low flux densities also decreases the magnetizing or no-load current of the transformer very appreciably and tends to reduce extraneous fields. This is an important point in modern high-gain amplifiers. Copper loss is naturally kept low by the use of large conductors.

It is frequently assumed that a large transformer will be superior from the angle of losses, efficiency and heating as compared to a smaller unit of equivalent rating. Care must be taken in the application of this statement. The use of large quantities of material if coupled with poor engineering may be a detriment. A large quantity of steel operated at the same flux density as a small unit will have an iron loss in direct proportion to the bulk of the cores. In addition, the larger bulk of copper made necessary may have greater losses than that in the smaller units. Much care must be taken to obtain the optimum balance between sizes so that the greatest efficiency and safety factor is effected.

REGULATION

The regulation of plate transformers is becoming an exceedingly important factor in modern amplifiers using Class B or Class AB tube operation. Referring to Fig. 3 it is seen that the loss in voltage sustained with an increase in transformer load current is caused by L and R, the leakage reactance and d-c resistance of the transformer windings. In small transformers R is by far the larger effect. The resistance of the windings can be kept down by the use of large wire sizes, but more important than this is the question of getting as much copper in a given space as possible. In large transformers, particularly plate transformers which require considerable spacing between layers and windings for insulation, the reactance loss L becomes a more important factor than R as respects regulation. This effect can be reduced to a minimum through the use of interleaved windings.

INSULATION

The insulation used in a transformer must have a high safety factor, taking into consideration the most severe conditions which may be encountered in service. Many materials used for insulation purposes will deteriorate with age or heat. Considerable care must be taken in the use of these materials. As previously stated, temperature has a decided effect upon most insulating materials. The dielectric strength of some materials is cut to less than half by a change in temperature from 50 to 100 degrees Centigrade. Mica is an ideal insulating material to be used at points of high-voltage stress. This transformer insulation material, while costly, is unequalled in dielectric strength and is practically unaffected by temperature, age, or the presence of ozone caused by high-voltage corona.

In addition to mica, some of the insulating materials used in transformers are pressboard, bakelite, paper, enamel, cotton, varnished cambric, etc. The effect of moisture on practically all of these materials is highly detrimental. This can be overcome by proper impregnation. In a typical high-quality impregnating cycle the coils are first given a 14-hour drying in special

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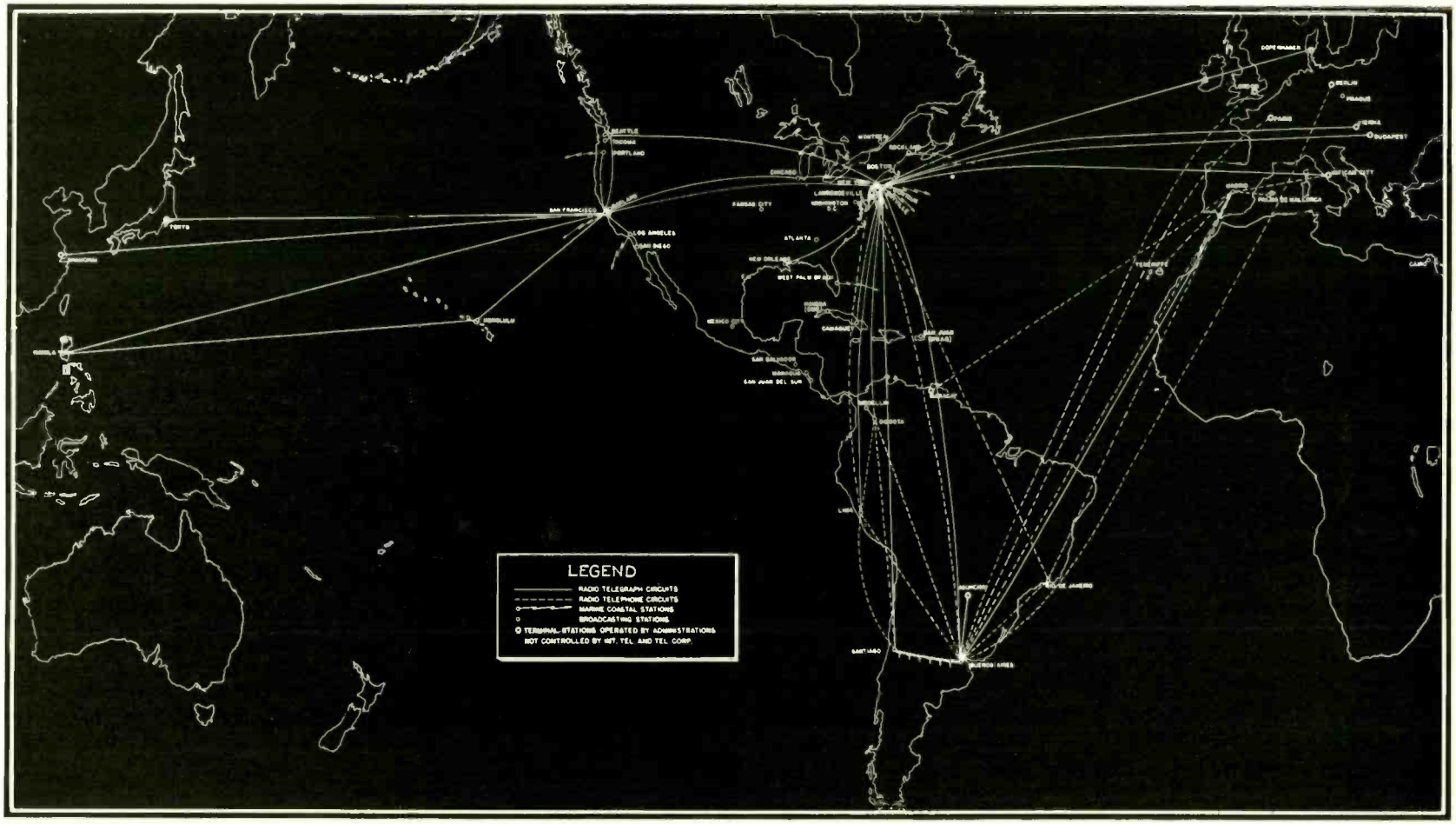
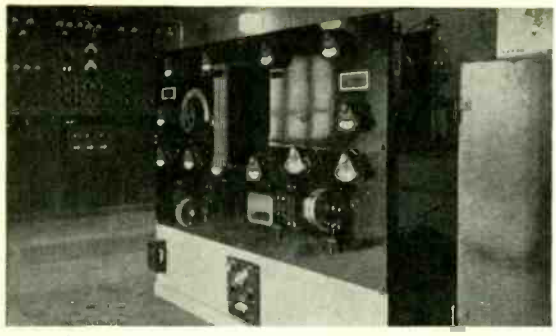


MAP No. 16 -- Radio Telephone and Telegraph Circuits of the I. T. & T. Corporation

STUDIO.



TRANSMITTER.

THE EIFFEL TOWER TELEVISION INSTALLATION

By ANDREW W. CRUSE
Chief
Electrical Division, U. S. Department of Commerce

THE EIFFEL TOWER television studio is equipped with a powerful source of light, which illuminates the persons or scenes to be televised. The reflected rays pass through a rotating Nipkow disk with 2 spirals (each with 90 holes) and are projected on a photoelectric cell, from whence the current variations are amplified and transmitted to the radio-broadcasting station.

The photoelectric cell used is in the form of a valve with two outlets. It has the property of transforming the fluctuations of luminous rays received into variable electric current. The light rays strike a layer of photo-sensitive metal inside the valve. When connected to an external circuit the cell sets up an electric current proportional in intensity to the amount of light it receives, and the current variations follow instantaneously the variations of light.

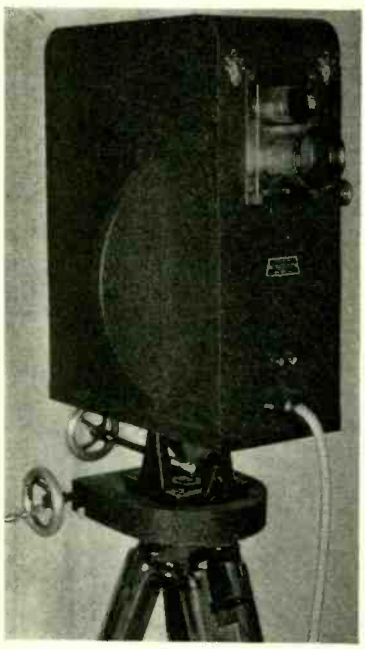
Electric oscillation is thus received in proportion to the light reflected from each point of the scene to be transmitted. As the reflected rays pass through the perforations in the Nipkow disk, a very thin and very mobile ray of light strikes the sensitive surface of the cell. The displacement speed at the end of the luminous ray, may, in certain cases, reach a speed of 1,000 meters per second.

SCANNING

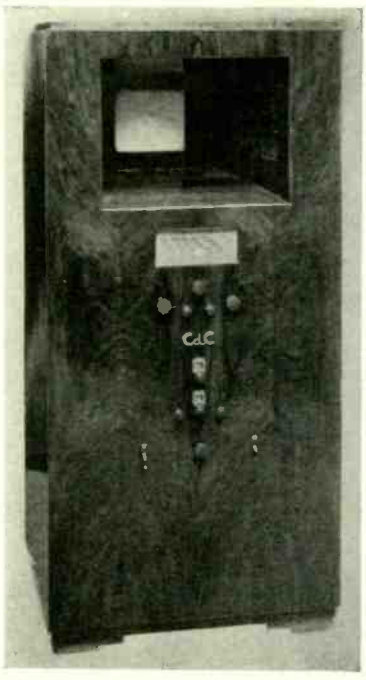
The difference existing between direct vision and television, even with a steady picture, resides in the necessary division of the picture, in the case of television, so that all the consecutive parts may be transmitted consecutively. Thus it appears that improvement of television can never bring it to equal direct vision, since the scanning must of necessity be of a definite speed.

An increase in the number of lines is possible, but this does not appear to give further improvement, increasing difficulties; numerous experiments have been conducted with regard to this aspect, 180 lines and 25 pictures per second have therefore been chosen, which make it possible to employ films in ordinary use for telecinema.

The same receiving apparatus can receive, without any change, either tele-



CAMERA.



RADIO AND TELEVISION RECEIVER.

vision or telecinema broadcasting; but the apparatuses sending out the two are distinctly different. For telecinema a ray of light is used which penetrates transparent portions of the film and then encounters the cell; while in the case of direct television, the light furnished by the projectors, or the sun, floods the person or the scene to be televised and is reflected on the photoelectric cells through the mobile perforated disk.

The essential part of the receiver is the cathode-ray oscillograph, the introduction of which marked a turning point in the history of television. Its use when receiving television has abolished the revolving apparatus, synchronous disks and motors, which previously was the weak spot in the system.

At the present stage of technical progress, the cathode-ray tube is the only possible solution for a receiver. Even for broadcasting, an oscillograph seems necessary.

SYNCHRONIZATION

The problem of synchronization has been solved in a satisfactory manner and patents have been taken out in France and abroad which places the Cie. des Compteurs in an excellent position.

The result to be obtained is as follows: The centering must be absolutely stable, without any adjustment of the animated picture on the fluorescent screen, whatever the shape and intensity of modulation.

This result is obtained by an arrangement of relays of ionized gas, known as "thyratrons", and by the evident fact that there is a simple relation between the horizontal movement of the luminous spot and its vertical displacement. In fact, the quotient of time of the vertical displacement by the time of horizontal displacement is equal to the number of lines, which defines the quality of the analysis.

By means of reflecting plates in the oscillograph, the luminous spot is made to trace horizontal lines in juxtaposition on the fluorescent surface at a constant speed in proportion to the analysis speed of the picture when viewed through the Nipkow disk.

Also, the brightness of the spot is derived from the modulation arising from the exploration of the broadcasting apparatus, the "black" and "white" in the scene to be transmitted are therefore reproduced in synchronization at the proper places on the screen. This entire reconstitution of the picture should be effected in 1/25 of a second.

The two factors of the movement of the luminous spot are two movements of constant speed. One, very rapid in the horizontal plane, furnishes the line; and the other, much slower, displaces the line from top to bottom in order to give the vertical dimension of the picture. The two deviations of the cathodic screen are obtained by applying to the deflecting plates of the perpendicular parts two tensions increasing lineally as a function of time.

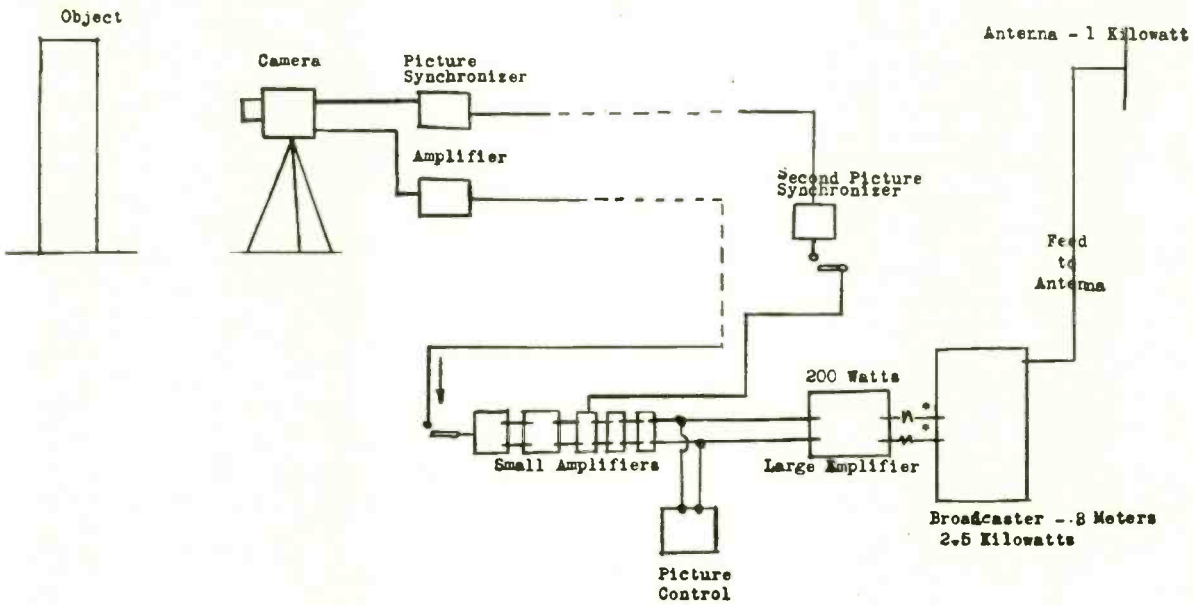
Generally the tension for causing the spot displacement is created by charging a condenser with current of constant intensity; in this instance, the potential across the condenser increases with the time during the period of charging. When the value which corresponds to the maximum desired deflection of the spot has been reached, the latter is brought back to its initial position by a sudden discharge from the condenser. This backward movement of the spot must be effected in less than one-hundred-thousandth of a second.

This condition is easily achieved by discharging the condenser through an ionized gas tube, where the internal resistance, at the moment of commencing the discharging, is very low, owing to a high positive voltage on the grid.

These periods of discharge should correspond with absolute precision to the ends of the lines of analysis, in rhythm with the broadcasting. It should be noted here that there is a noticeable difficulty in the use of "thyratrons", since the discharge tension applied to the grid does not always produce exactly the same potential when starting, with a resulting uncertainty in time, and it is then noted in the picture that the straight lines become broken lines. However, this inconvenience has been remedied.

Another difficulty, encountered more especially in slow movement, is the lack of linearity in the charging of the condenser which causes the vertical deflection. Some foreign constructors have compensated this defect with the aid of an amplifying lamp giving in inverse deformation. The C. D. C. has been able to obtain a satisfactory result without any additional lamp.

Finally, and this is the most important question, the Cie. des Compteurs has obtained control of the picture or verti-



BLOCK DIAGRAM OF EIFFEL TOWER TELEVISION INSTALLATION.

cal deflection by means of the line or horizontal deflection, so that the picture change is effected when the exact proper number of lines has been inscribed and automatically the last line forms the base of the picture when it is broadcast, which brings about the instant upward movement of the spot to the top of the picture.

The signals inserted in the carrier wave for this purpose do not take more than 1/100 of a second for transmission. The picture is thus defined when it is received, as the analysis lines, dimension and phase are fixed without any adjustment by the operator.

The direction of the oscillograph by a signal which practically does not interfere with the time, which is so essential in the analysis of a television scene, constitutes an indispensable progress for future industrialization of cathode-ray radiovision.

With the introduction at the end of each broadcast analysis line, save one, of a very brief signal, of suitable strength and frequency, the automatic establishment of the two synchronous sweeping movements is made possible in a receiver with a cathode-ray tube, with the certainty of a complete synchronization of the television modulation.

STUDIO EQUIPMENT, AIR CONDITIONING

The Rue de Grenelle studio, equipped in the same manner as all radio-broadcasting studios, is sound-proof and has several microphones. There is also a direct camera for television and several rows of projectors which may be moved in any direction. This makes it possible to concentrate the light from the projectors to throw sufficient light on the actors or the scene to be televised so that the reflected light will be sufficient to affect the photoelectric cell of the camera.

Although the amount of light employed is much less than that used for cinema filming, the quantity of heat given out by the projectors might incommode the actors; it is therefore absolutely necessary to protect them by a veritable screen of fresh air, but at the same time it is necessary to avoid too strong a movement of air and too cold air on the scene.

The problem is as follows:

1. To protect the persons from the effects of the rays of this source of heat by enabling them to maintain their normal body temperature with a humidity appropriate to the resultant temperature.
2. To avoid all movement of air which is too strong or too cold which might hinder or blow materials or clothes.
3. To avoid all transmission, either of noises from the ventilation machinery, or from air rustling from the ventilators, which would be registered by the microphone.
4. To avoid hindering the lighting as well as the filming by placing the air distributors sufficiently far from the scene and projectors.
5. To facilitate an easy control of the air movement in the different planes.
6. To constitute a mechanical equipment sufficiently elastic to meet all requirements, both as regards heat and the quantity of air distribution.
7. To constitute an automatic installation which will reduce manual labor to a minimum.

By means of the air-conditioning process of the Ets. Tunzini, protection from the heat of the projectors is obtained by means of a screen of air diffused on the scene at a temperature sufficiently low to absorb the heat given off and to maintain a temperature equal to that of the premises outside of the region of activity of the projectors.

The air thus distributed at a proper temperature and a proper degree of moisture, avoids all physiological discomfort and action on the skin through evaporation, and as soon as the apparatus is put into operation, the thermometer registers around twenty degrees Centigrade.

The air speed coming out of the ventilators is low enough so that it is not more than sixty centimeters per second in the vicinity of the actors.

The climatic preparation of the air is effected in two apparatuses, known as "Climatoblocs", Tunzini patent.

Air from the exterior, or a mixture of exterior air and air from the television room, is filtered by passing through a metal filter and an oil filter. It is then passed through a refrigeration battery. Upon contact with this battery, the air takes on the temperature of dew fall at a constant level. The regulation of this temperature is effected automatically by a regulating device which varies the mixture of frozen air and recirculated air, according to requirements.

The water supply in the refrigeration battery is maintained by a motor-pump group. The "Climatobloc" machines are covered outside with a sound-proof material. Anti-vibration apparatus, called "Silentbloc" renders the monobloc motor-ventilator pump group independent of the air pipes and it has no rigid contact with the partitions.

Besides the control of each apparatus for air distribution, the flexibility has been increased by using two independent conditioning systems which can feed each ventilator separately. These have capacities of 1000 and 500 liters per second, respectively, with variable control on each, which allows a large number of combinations.

The studio for the French Government television station is situated at the Rue de Grenelle which is exactly 2.5 kilometers from the broadcasting station, situated on the north side of the Eiffel Tower. This broadcasting station works on a power of 2,500 watts high-frequency current, and operates with emitting lamps powered by rectified current of 6,000 volts. The 37,500 kilocycles alternating current is transmitted to the antenna located at the top of the Eiffel Tower by means of a rigid copper-tube feeder approximately 10 centimeters in diameter. This feeder goes up to the second floor of the Tower by way of one of the elevator pits and from the second to the third along the stairs. It then joins the antenna by the intermediary of a transformer, the power at the antenna then being 1,000 watts. The aerial is made up of 4 wires each 8 meters long placed two together symmetrically to the Tower and two in rectangular design.

The broadcasting proper is linked up with the studio by means of a modulating cable 2500 meters in length and especially built to transmit electrical current up to a frequency of 1 megacycle per second. The pictures are broadcast on a wavelength of 8 meters while the sound is broadcast on a wavelength of 206 meters.

MICHIGAN POLICE RADIO

(*Continued from page* 14)

Present plans call for three operators to be assigned to each of the new stations in addition to the six men constituting the regular post personnel. Station WRDS has three operators and a maintenance engineer on its present staff. In addition to establishing the new radio stations, the expansion program calls for the setting up of new state police posts at New Buffalo, Romeo, Brighton and Houghton Lake in the lower peninsula, and at L'Anse and Wakefield in the upper peninsula. The personnel of the department will be increased by approximately forty troopers.

Within two years the Michigan State Police short-wave radio-communication system will cover every section of the lower part of the state and will rapidly extend north of the Straits of Mackinac.

Already considered one of the best in the country, the Michigan State Police radio-communication system will reach its highest peak of efficiency within the next two years, during which time further alterations and additions are contemplated until the radio-controlled highway blockade will be practically escape-proof.

ELECTRON MOTION IN PLASMA

By E. G. LINDER

RCA Manufacturing Co., Inc.

An abstract of a paper presented before the February 22 meeting of The American Physical Society in New York. The paper was chiefly concerned with a new formula for the behavior of the recalcitrant electrons

AN EQUATION for electron motion in a plasma is developed which is more general than previous ones, in that electron pressure is not neglected. The resulting expression is

$$\frac{d^2\xi}{dt^2} + \frac{4\pi ne^2}{m}\xi = \frac{kT}{m}\frac{d^2\xi}{dx^2}$$

where ξ is electron displacement, n electron density, T electron gas temperature, and x the equilibrium electron position. From this it is found that the possible frequencies of free vibration form a series given by

$$f_i = \sqrt{\frac{kT}{\lambda_i^2 m} + \frac{ne^2}{\pi m}}.$$

The lower limit corresponds to the Tonks-Langmuir value $(ne^2/\pi m)^{1/2}$, while the other frequencies depend upon the possible standing waves which may exist. If $T = 0$ the equation reduces to the Tonks-Langmuir equation; if $e = 0$ (uncharged particles) we get the equation for sound-wave propagation; and if $d\xi/dt = 0$, the equation yields the Debye-Hückel expression for the variation of potential near a charged plane in a plasma under equilibrium conditions.

If it is assumed that the shortest possible wavelength is $\alpha\lambda D$, where $\lambda D = (kT/4\pi ne^2)^{1/2}$, the "Debye distance", and α is a small numerical factor, which according to Langmuir is 3.31, the above theory is found to agree better with the experimentally found relation between f and n, than the simpler theory, which neglects electron pressure.

DESIGN AND APPLICATION OF POWER TRANSFORMERS

(*Continued from page* 16)

dehydrating ovens. They are inserted into a heated vacuum tank for a number of hours. When the coils and tank are at a uniform temperature a vacuum-draining pump is used for two hours, which quickly evaporates any moisture left in the coils and withdraws it. Heated varnish is then admitted into the tank and forced into the coils under pressure. Continuing the cycle, the coils are placed in baking ovens for 14 hours, at the end of which time the coils are removed thoroughly impregnated and both filled and covered with a flexible, clear varnish coating impervious to moisture. As a double precaution, some units go through another identical cycle after being laminated. In addition to the impregnating process some smaller transformers are sealed in their cases with an insulating compound having a moisture absorption of less than 6 and a melting point (ball and ring) of about 250 degrees. Larger transformers are frequently oil-filled. This tends to keep the insulation in good condition and moisture-free, and also helps conduct the transformer heat to the tank surface for dissipation to the surrounding air.

Within normal limits of weight, small transformers should be produced in enclosing casings which have a high dissipating area. In larger units, end castings are generally used which completely enclose and protect the coil but which leave the laminations directly exposed to the air to obtain maximum radiation. While both poured and open units should be well clamped to prevent vibration, wherever possible, the bolts should be kept outside of the laminations as this has been found to produce a considerable reduction in iron loss. Where the bolts must pass through the laminations they are frequently insulated so that eddy effects are not produced.

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

THE DOHERTY AMPLIFIER

A NEW high-efficiency circuit for radio-frequency amplification, which is particularly applicable to broadcast transmitters and which greatly excels anything that has been achieved before, has been perfected for the Western Electric Company by engineers of Bell Telephone Laboratories. Whereas in the past 30% to 35% efficiency has been the maximum that could be expected of the linear power-amplifier stage in a high-quality transmitter, efficiency as high as 60% to 65% now is a reality with this outstanding improvement in design. From this same standpoint, it is also said to be superior to systems employing high-level modulation.

This accomplishment is the result of applying to radio transmitters the Doherty high-efficiency circuit, which effects a large reduction in the power consumed. The new form of amplifier operates at constant high efficiency, which does not vary with the percentage of modulation. Previous designs approached this performance only during momentary rises of the audio input, caused by extra-loud portions of the program such as musical climaxes, but during the greater part of the time on the air while the program was carried along at normal volume, the efficiency was considerably below this maximum level.

Other outstanding advantages of the Doherty high-efficiency circuit are simplification of circuits with the consequent use of smaller and fewer circuit elements, greater ease of adjustment and increased stability of adjustment; also reduction in plate dissipation, which minimizes the tube-cooling requirements. The overall results of these improvements are savings in space for equipment, reduced initial outlay for auxiliary equipment, economies in operation and maintenance and, above all, a marked saving in power purchased.

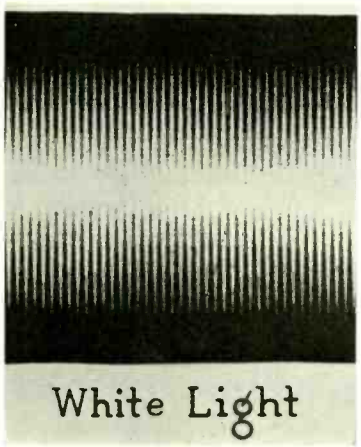
Because of the interest already evidenced in this advance in the design of radio-telephone transmitter equipment a more detailed description will be published at an early date.

ULTRA-VIOLET RECORDING

RECORDING with the new ultra-violet system is a good deal like improving the details of a photograph. In this case the photograph is the picture of the sound track on the film.

In order to get the most faithful recording of speech or music, the picture of its characteristics on the sound track must be as sharp and clear as possible so that every detail, no matter how small, is uniformly impressed on the film. This is especially important in recording the higher-frequency tones, because they are represented on the sound track by finely-spaced peaks and valleys.

The two most important factors that determine the sharpness of the image on the sound track are: (1) the exact focusing of the lenses—and (2) the penetration of the light which is focused on the emulsion of the film negative.



SOUND TRACK OF 9000-CYCLE FREQUENCY TONE.

Ordinary white light is composed of a great many different wavelengths of light; and it is impracticable to focus more than a small number of these wavelengths sharply enough at one time. Thus with white light, many of the wavelengths are somewhat out of focus and blur the edges of the sound image. Then, too, some of this light penetrates too deeply into the emulsion where it is scattered and produces a certain amount of distortion.

What the RCA Photophone engineers have done with the new system has been to interpose an ultra-violet mask in front of the white light — filtering out all the wavelengths but those within a very narrow range. This narrow band of light is in the ultra-violet spectrum and actually invisible to the unaided eye.

The restricted band of light makes possible much sharper focus of the lenses in the optical system. Also, this same narrow band of ultra-violet light makes it possible to control the extent to which it penetrates the emulsion of the negative. The fine peaks and valleys produced by the high-frequency tones are then photographed sharply and clearly and in the exact pattern of the sound. The same method applied to the printing process, after the negative has been made, permits a much wider latitude in making accurate prints for playing in the theatres.

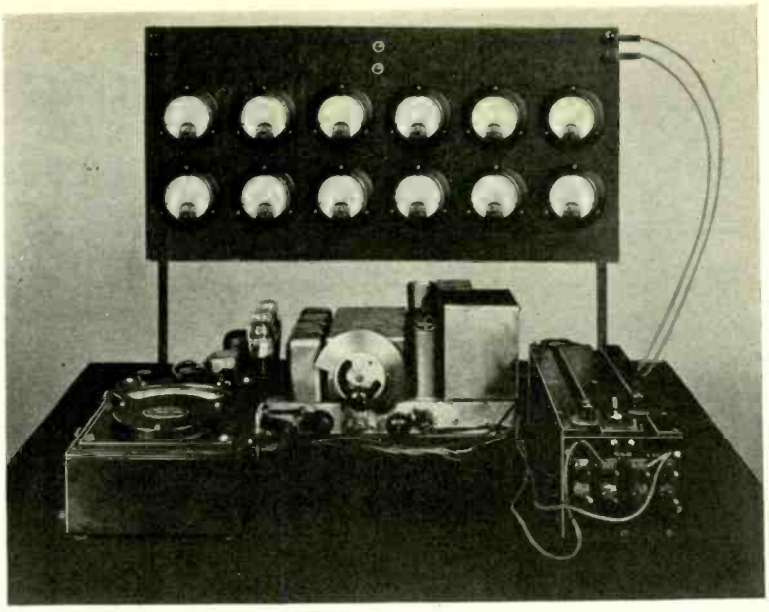
Heretofore, when a high-pitched voice reached the neighborhood of 9000 cycles, the engineers have found it necessary to cut off the top range of frequencies, or depend on extremely critical and laborious printing of the final sound track. The new ultra-violet method gives such a sharp and clear definition of the peaks and valleys of the high-frequency waves on the track that there are now no practicable limitations in recording and reproducing all the frequencies necessary for faithful reproduction from film.

BROADCASTING AT GREAT LAKES EXPOSITION

BROADCASTING PLANS at Great Lakes Exposition, as given by Ralph B. Hum-

phrey, in charge of radio, center about Cleveland's public auditorium which will be converted into "the world's largest broadcasting studio", since 14,000 can be seated in the main hall. Loudspeakers will carry the stage broadcast to the audience within the auditorium which is an integral part of the exposition. The main hall of the building will become "Radioland" from June 27 to October 4, the exposition period, with daily presentations of radio acts from Cleveland's four broadcasting stations.

The Exposition, which starts within two blocks of the heart of the city and extends for about a mile along Cleveland's lake front, was underwritten by a committee of Cleveland business men late in January. More than half of the available exhibition space has already been taken, with plans under way to increase possible floor space.



WOR'S CONTINUOUS LISTENERS.

RADIO SERVICE FOR PUERTO RICO FORESTS

SHORT-WAVE RADIO SETS of the Forest Service type will probably be used to link the scattered units of the Puerto Rico National Forests where other methods of communication are impractical or costly because of frequent hurricanes, rains, and the jungle country, according to the Forest Service, U. S. Department of Agriculture.

The Forest Service's radio system now includes about 1200 stations on the National Forests of continental United States and Alaska. A. Gael Simson, technical expert in charge of radio for the Forest Service, says, "the use of radio in the Caribbean National Forest in Puerto Rico is feasible, and from the point of view of emergency communication, it is necessary. Frequent hurricanes and heavy rainfall increase the need for reliable communication in the protection of the forests. Radio is much more practical on the island than the costlier land-line telephone service which is subject to wet rainy season and hurricane damage."

TELEPHONES FOR TRANSPORT PLANES

TELEPHONES will make their debut aboard air transport planes for the first time when American Airlines, Inc., introduces its new fleet of Douglas Super sleeper planes within the next few weeks, according to Clayton C. Shangraw, Superintendent of Communications for the company.

Shangraw explained, however, that the telephones would not be immediately available to passengers but would be installed primarily for the use of flying personnel in communicating with dispatch offices while on the ground.

At the present time, he pointed out, pilots often receive last minute instructions from their dispatchers by radio, after they have boarded the plane and are ready to leave the loading station. This means unnecessary use of the radio and a drain on the power system of the plane. Through installation of telephones, use of the radio will be reserved for flight.

A special socket on the lower exterior of the pilot's compartment will enable ground crews to plug in the telephone connection as soon as the plane takes its place at the loading platform, and to disconnect it immediately before take-off. In the air, communication will be by two-way radio as at present.

Radio equipment for these 20 new planes, the largest land planes ever built for domestic operation, will be of the most modern design and embody many important improvements over previous equipment. Provision also is made for the installation of radio-direction finders and instrument-radio landing equipment, anticipating the time when such practice becomes practical in every-day airline operation.

CONTINUOUS LISTENERS

A GROUP of radio "listeners" that have not missed a note or syllable broadcast by WOR in the past eight months are still on the job in the laboratory of the Weston Electrical Instrument Corporation. And they will continue to follow every feature, every day until they have completed a year's continuous listening.

The "listeners" consist of six decibel meters of a new type which follow each rise and fall of signal volume at high speed. They will operate continuously for twelve months as part of a study of the advantages of this "high-speed" type of decibel meter in checking broadcast-signal characteristics.

Operated by a fixed-frequency radio receiver that was turned on last June and has been in continuous operation ever since, the meters spring into action with WOR's first morning signal. As political speakers grow emphatic, the pointers oscillate violently at a speed which the eye can scarcely follow; with more rhythmic musical strains, they drift lazily across the scale with the regularity of a metronome. The gunshot of a radio drama sends the pointers from zero to the end of the scale in less than a 0.15 of a second, accurately indicating the peak of audio-signal intensity.

As the meters operate night and day, without supervision a greater part of the time, changes in signal-level volume often take place which subject the pointers to severe battering against the scale stops. In spite of this severe service, more rigorous than a lifetime of ordinary instrument use, the six "listeners" are still providing the information sought in perfect unanimity.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

CHICAGO

CONGRATULATIONS are due George I. Martin, Chairman, and B. R. Donges, Secretary, of the Chicago Chapter of the Veteran Wireless Operators Association, for their outstanding work in establishing a "going" organization in the Chicago area.

Among the members signed up within the past few weeks by the Chicago officers are numbered the following: Edward W. Zacharias, who began his professional operating career in 1922; Frank L. Velten, operator aboard the S S *Cherokee* back in 1915 and more recently has radio-operated aboard vessels plying the Great Lakes; Walter Kenworth, who was employed by the Marconi Wireless Company at San Francisco and then with the Telefunken Company of New York during the period 1912-1915; Ernest J. Necker, a member of the United States Army Signal Corps in 1922 and subsequently with the transoceanic stations of RCA, now with the Mackay Company in Chicago; then, too, they located Dwight M. Williams, who acted in the capacity of Temporary Secretary of the Chicago group for the 1935 Dinner-Cruise in the "Windy" city—glad to hear from you again DWM; J. H. Dodman, who operated aboard ship for several years back in the early 1920's and subsequently entered the broadcast field with WAAM in Newark in 1925—now with Mackay Radio in Chicago; Allan C. Forbes, radio operator aboard the S S *China* and *Manchuria* back in 1913 and continued aboard various ships until 1917; H. D. Hayes, who did all of his professional operating out of San Francisco with the United Wireless Telegraph Company, including among his assignments periods aboard both the *Harvard* and *Yale* during the period 1910-1912; Theodore Cohen, with the United States Army Signal Corps in 1919 and later in Civil Service assignments, now with the Mackay Company; Edwin A. Beane, another real Veteran, who numbers among his billets vessels controlled by the Massie Wireless Telegraph Company, National Electric Signalling Company then with the Marconi Wireless Telegraph Company beginning in April 1912 and terminating his service in April 1917; L. A. Delson, who applies for Associate Membership—his operating assignments include various vessels plying the Great Lakes with an initial assignment aboard the Str. *Marquette* in July 1931; Carleton D. Morris, who had a very active and varied career in professional operating between 1917-1929 with the Marconi, U. S. S. R., RCA, Tropical Radio, Independent Wireless, Inter-City Radio, Wyandotte Transportation, and Michigan Wireless Companies; George J. Maki, in the Signal Corps of the United States Army in 1925 and now with RCA Communications in Chicago; Harold E. Fulton, on coast-wise ships in 1917, then transoceanic for RCA and at present with RCA Communications in the capacity of City Office Manager in the Chicago area; Dormand S. Hill, who was in the Signal Corps during the World War; Raymond D. Hutchens another member of the RCAC staff in the midwest metropolis.

V. A. Kamin, formerly in charge of the radio division of Sears Roebuck in Chicago is now President of the Corona Radio and Television Corporation at 420 North Sacramento Blvd., Chicago. . . . Charles E. Drew formerly a resident of New York City is now a resident of the midwest seaport. . . . J. McWilliams Stone is out in that general neighborhood, too, residing in Geneva, Ill. . . . We haven't heard of Robert A. Dalton's whereabouts in Chicago lately he was one of our first members in that part of the country and very active several years ago. . . . Just received return mail from Jack Kurilla—last address WCFL, Navy Pier, Chicago. . . . Sidney Winsberg is Treasurer of the Chicago Chapter.

George Martin tells us that they managed to round up a convivial group for appropriate festivities on the 11th of February and that they plan to have an even larger "get-together" some time this month.

All interested in associating themselves with the Veteran Wireless Operators Association, residents of the Chicago area, are requested to contact either George Martin, Superintendent, RCA Institutes, 1154 Merchandise Mart, or B. R. Donges, Maintenance Supervisor, NBC, Merchandise Mart, both, of course, in Chicago.

HONOLULU

THERE IS no let-up in the activity of George Street, Chairman of the Surf-Board Chapter, in signing up new members. Every letter he sends contains at least one application for membership. Among his most recent are Lt. Col. Leland H. Stanford, U. S. Army Signal Corps at Fort Shafter, Oahu, T. H.; and not satisfied to sign up members for his own group GS sends in the application of Roy C. Campbell and suggests we include him in the San Francisco group. George states that RCC began his operating career aboard Columbus's Yacht in 1492 and since has sailed on every ship still afloat in the Pacific.

We quote the Honolulu Advertiser of February 12th: "Members of the Veteran Wireless Operators Association who attended the festivities last night at the Oahu Country Club are associated with all of the communications companies located in Honolulu, among them RCAC, Mackay Radio, Globe Wireless, Mutual Telephone, and the federal district communications department as well as the United States Army Signal Corps and the U. S. Navy communications department."

George Street tells us:—"The Army Signal Corps did very nicely and showed up with three Officers and three enlisted men to man the portable field set which was operated successfully between the Dining Room and the Schofield Barracks station which carried various and sundry traffic to the mainland chapters. We exchanged messages with New York, Boston, Omaha and Miami.

"Mr. J. A. Balch, President of the Mutual Telephone Company gave a very interesting talk about his company which incidentally is one of the few pioneer wireless telegraph and telephone companies still in business.

"Sergeant Maddaloni, who was in charge of the Army portable set told us he went to the Marconi Wireless School in Italy in 1912.

"A quartet of sailors from the German Cruiser *Emden* attended and delighted those present with several numbers in German.

"The German boys and the American-Italian Sergeant plus a part-Hawaiian and one Chinese lent the color of international goodwill in which communications plays an ever increasingly important part."

MIAMI

ACTIVITY in the Miami area under the leadership of V. H. C. Eberlin, Chairman, and C. J. Corrigan, Secretary, did not cease with their initial Dinner-Cruise at the Royal Palm Club, which incidentally was an outstanding success and, taken as a criterion, great things are expected of the "Winter-Wonderland" Chapter.

"Professional radio operators attended the first meeting of the Miami Chapter of the Veteran Wireless Operators Association last night on the third floor of the post office building."—Miami Daily News of January 23rd.

C. W. McKee has returned to the fold through the efforts of the Miami officers; John A. Laurent, who started his professional operating in the U. S. Navy and then with RCA out of Gulf ports, sends in his application; Fred Dawson, radio operator on various vessels between 1913 and 1916 then at coast stations and at present engaged in airways point-to-point communications, also signs up. Good work VHC and CJC. Keep it up.

BOSTON

UNFORTUNATELY a comprehensive report written by Harry Chetham, Boston Secretary, went astray and we are unable to include as much material as we should like concerning the highlights of the Second Annual Dinner-Cruise of the Boston Chapter.

HC continues, however, to sign up additional members and we will include mention of them and notes on the banquet in the next issue.

"I can remember being present at the Telephone Labs., in New York on the first trans-continental telephone test in 1916 with a fellow by the name of Hamilton. We were at Tufts College together, too, and I should like to locate him." HC doesn't recall Mr. Hamilton's first name. If any of our readers know Mr. Hamilton's whereabouts they should communicate with Harry Chetham at 98 School Street, Somerville, Mass.

NEW ORLEANS

THE NEW ORDEANS CHAPTER, J. A. Pohl, Temporary Chairman, and E. L. Commagere, Temporary Secretary, were unable to muster a gathering of "Oldtimers" on February 11th, 1936, but they did send a message of greeting to all other chapters of the V. W. O. A. New Orleans appears to be an ideal spot for a Gulf Chapter and we are certain that under the able leadership of the above mentioned officers that applications will commence coming soon.

OVER THE TAPE...

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

HIRAM PERCY MAXIM

On February 21, amateur radio stations observed a nation-wide silent period as a mark of respect for their late beloved leader, Hiram Percy Maxim.

As the famous scientist and inventor was being interred at Hagerstown, Md., thousands of radio amateurs throughout the country silenced their transmitters in tribute.

POLICE-RADIO OPERATORS' MANUAL

A 64-page booklet, written primarily to assist policemen who desire to become radio operators but of interest to all intending to become operators of broadcast stations, has been published by the General Electric Company. Entitled "Police-Radio Operators' Manual" and designated as Publication GEB-100, it has been made available by the company's Radio Department at Schenectady, N. Y., and is priced at $1.00.

The majority of the material in the booklet is included in a section devoted to questions and answers under subheads entitled "Radiotelephone Transmitters," "Receivers," "General Principles of Electricity," "Operation and Care of Storage Batteries," "Power-Supply Apparatus," and "Radio-Communication Laws and Regulations." The questions are typical of the ones asked in examinations for first-class radiotelephone operators' licenses. Additional material is included in two other sections of the booklet—one devoted to general information on police-radio systems, and the other to supplementary information on licenses and examinations.

DENCOSE OPENS NEW QUARTERS

Dencose Incorporated, manufacturers and distributors of the Vibro-Master line of sound equipment have consolidated their executive offices and assembly plant at 1650 Broadway, New York City, where they operate their recording studios.

The executives of Dencose are Thomas A. Cook, Charles E. Sedweek and Enford A. Dennis, the latter, well-known in the sound-engineering field, being the Chief Engineer. This company controls the Wadsworth-Emerson patents for recording on aluminum and other resistant materials.

The company is initiating a national expansion program calling for the installation of completely-equipped Vibro-Master studios and service units in key cities throughout the United States and in several foreign countries.

TRANSFORMER BULLETIN

Bulletin 1002 on "Transformers for Audio Amplification and Transmission" has just been issued by The American Transformer Company, 178 Emmet Street, Newark, New Jersey. This 32-page booklet contains a great deal of technical information.

ANTI-SIDETONE CIRCUITS

The Strowger Technical Journal, for December, 1935, contains an interesting article entitled "Anti-Sidetone Circuits—Their Forms and Development." This article, which was written by Dr. Arthur Bessey Smith, presents a review of the basic developments in anti-sidetone telephone circuits, with notes on the adaptation of their modern forms to the practical conditions of present-day use.

The Strowger Technical Journal is issued by the Associated Electric Laboratories, Inc., 1033 West Van Buren Street, Chicago, Illinois.

"TREATISE ON ELECTROLYTIC CONDENSERS"

A very interesting and valuable 58-page "Treatise on Electrolytic Condensers" has just been made available. This treatise, which was written by Paul MacKnight Deeley, Chief Engineer, Electrolytic Division, Cornell-Dubilier Corporation of New York City, should be of interest to engineers in general and to those who use electrolytic capacitors.

NEW RADIO-EQUIPPED PLANES FOR CHICAGO AND SOUTHERN AIR LINES

The purchase of a fleet of new Lockheed Electras by Chicago and Southern Air Lines was announced recently by Carleton Putnam, President of the company.

The new airliners will cut three hours from present schedules between Chicago and New Orleans, with correspondingly faster service between intermediate points, and will set a new standard of luxury for air travel to these cities.

Costing $50,000 each, the ships accommodate ten passengers, pilot and co-pilot. They are of all-metal construction and contain two-way radiotelephone, scientific sound-proofing and are powered with 450-horsepower Wright Whirlwind motors. Top speed for the Electras is over 200 miles per hour and normal cruising speed is 180 miles per hour, or three miles per minute.

Chicago and Southern has recently installed completely-equipped radio ground stations at all principal points along its route. Stations are powered with 400-watt new-type Western Electric ten-frequency transmitters.

ENGINEERING BULLETIN

The Engineering Department of The Ken-Rad Corporation, Inc., Owensboro, Kentucky, has recently compiled a 14-page bulletin on "The Relation of Modulation Products with Multi-Tone Signal to Harmonic Distortion with Mono-Tone Signal in Audio-Amplifier Analysis." This interesting article may be secured by writing to the above organization for Bulletin CEB 36-5.

TIME

When WOR signs off at 1:30 a.m., the exact time and date are announced. This enables distant listeners to identify station, which operates on EST—one hour earlier than Central time, two hours earlier than Mountain time, three hours earlier than Pacific time. Quantities of mail from foreign listeners and fans in America's remote parts prompted this innovation.

ASSOCIATED CINEMA PURCHASES FREEMAN LANG

Freeman Lang's sound studios in Hollywood were sold late in February to the newly-formed Associated Cinema Studios headed by Mark L. Gerstle, San Francisco department store executive.

Frank Purkett, Vice-President of the former firm, remains as Vice-President and General Manager and will personally supervise production.

The organization will operate a film service and sound trucks for independent producers. It will also operate transcription laboratories for radio production. The Lang firm had been a pioneer radio recording firm in the west.

J. B. Westmoreland, Chief Engineer of the former firm, will remain in similar capacity with the Associated Studios. New technical equipment will be installed and it will include test equipment and a research department.

VACUUM TUBES AND TELEPHONE CONVERSATIONS

When President Walter S. Gifford of the American Telephone and Telegraph Company and T. G. Miller, Head of that company's Long Lines Department, made history a few months ago by talking around the world to each other by telephone, the vacuum tube played an important part in the conversation. How important, a few figures will make clear.

The two men were in adjoining offices, scarcely 50 feet apart, as Mr. Gifford's voice traveled west and reached Mr. Miller's ear from the east, while the latter's words journeyed in the opposite direction and arrived from the west. In each round-the-world circuit, 490 vacuum tubes were employed, a total of 980 for the two-way conversation.

Many of the vacuum tubes were in telephone repeaters along the wire lines stretching between New York and San Francisco. Still others were in radiotelephone transmitters and receivers which sent the electric waves across vast distances of ocean and received the enfeebled radiations after their long voyages. About 85 percent of the distance around the world was covered by the radiotelephone links, the remaining 15 percent being in telephone wires.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

RCA TYPE 41-B PRE-AMPLIFIER

The Type 41-B pre-amplifier is a two-stage fixed-gain amplifier. Coupling between stages is resistance-capacitance, while transformers provide for input and output coupling. The amplifier has been designed to work from a 250-ohm microphone circuit and into a 250-ohm or 500-ohm line.

An RCA-1603 Radiotron is used in each of the two stages of this amplifier. Use of these new 6-element tubes as triodes make possible a relatively high mu with a fairly low plate impedance. The arrangement used provides an overall gain of 40 db without the necessity of using high plate voltages.

Filter circuits are provided in each stage to prevent cross-talk and howling when the amplifier is used from a common plate-supply source. Jacks in the cathode circuits provide for checking plate currents of each tube.

The filaments of the RCA-1603 Radiotrons employed require 0.6 ampere from a 6.3-volt source. The filament supply may be either a-c or d-c.

Complete information on the Type 41-B amplifier may be obtained from the Transmitter Section of the RCA Manufacturing Co., Inc., Camden, N. J.

NEW TUNING INDICATOR

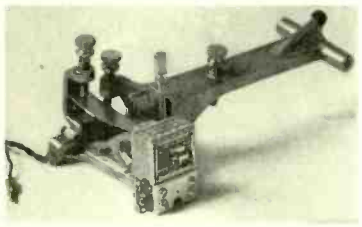
National Union Radio Corporation announced recently that their laboratories have completed developments on a new cathode-ray tuning-indicator tube. The tube which is now in production bears the type number 6G5. An outstanding feature of the tube is the fact that the triode portion has a variable-mu characteristic, which permits the application of avc voltage, it is stated. This means that appreciable movement of the tuning-ray shadow is produced on weak signals and yet overload on strong signals is prevented.

NEW FLOATING RECORDING HEAD

Universal Microphone Co., Inglewood, Calif., in February started to manufacture and distribute a new floating head for its professional recording machine which makes it possible to record on coated discs regardless of irregularities or rough surfaces on the records, it is stated.

The new Universal full-floating recording head has adjustments for changing both the vertical and the lateral angularity, and permits an exceptionally fine adjustment of pressure on the stylus with the regulation depth of the cut.

There is also a micrometer adjustment to be used in changing the angularity of the actual cutting point of the stylus, which eliminates groove noise such as whistles, hiss and other objectionable noise.



SPHERICAL MICROPHONE

The new spherical microphone, recently introduced by The Brush Development Company, Cleveland, Ohio, is said to meet the demand for an all-around, low-priced, general-purpose microphone for station announcement, p-a, police, commercial interstation and amateur transmission work. The microphone case resembles those used on the company's expensive laboratory microphones. These are of wire mesh construction—finished attractively in dull chromium.

The microphone is non-directional. Sound waves emanating from any direction can pass through the mesh to the internal members without interference. There is no distortion from close speaking, it is stated.

Brush spherical, or BR2S, microphone requires no input transformer nor elaborate stand mounting. It operates directly into the grid of the first amplifier tube. The microphone is assembled integrally with a Brush three-prong locking-type plug—and is furnished with sockets for either suspension or stand mounting. Size, 2⅛ inches in diameter; output level, minus 66 db.

Full details will be found in Brush Data Sheet No. 13. Copies may be secured from The Brush Development Company, Cleveland, Ohio, on request.

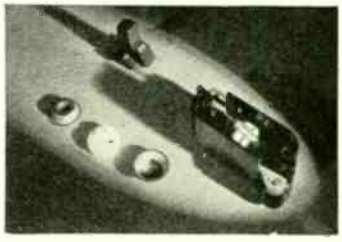
NEW SILENT SWITCH

A small, compact electric switch, which is completely silent in operation and which has no moving parts to wear out, was announced as a new development of the General Electric Company's research laboratory on the occasion of the recent opening in Rockefeller Center of the New York Museum of Science and Industry. About the size of a marble, the "works" of the new switch utilizes the mercury-break principle to function without a suggestion of a click. In the laboratory at Schenectady, one of the mercury switches has turned a 200-watt incandescent lamp on and off some 65 million times in the last two years without failing or wearing out.

The switch consists of two shallow chrome-steel cups about three-quarters of an inch in diameter, sealed together with a strip of lead glass to form a hollow compartment. Separating the cups is a disk of ceramic material in which there is a small hole located near the edge. The compartment is evacuated after fabrication and in it about four grams of mercury are inserted. The mercury fills roughly one quarter of the space. After insertion of the mercury, the compartment is filled with hydrogen at about atmospheric pressure and sealed off by welding.

In the "off" position, the hole in the ceramic insulating disk is above the line of the enclosed mercury. However, when rotated twenty degrees the switch assumes a position where the mercury can flow through the hole, thus establishing a contact between the two chrome-steel cups and closing the circuit.

Hydrogen is used in the switch because of its properties as a cooling agent and because in it an arc can be better quenched.



AMERICAN TYPE AG CRYSTAL MIKE

The American Microphone Co., of Los Angeles, announces the introduction of an improved diaphragm-type crystal microphone. The features of this unit are unusually high output level, wide-angle pick up and rugged construction, it is stated.

This microphone is said to meet the demand for present-day requirements of a self-energizing microphone requiring no polarizing voltage. The unit is enclosed in a chromium-plated housing and is well protected against moisture and temperature changes.

The type AG Crystal Microphone is equipped with a 5/8-inch 27 female thread which enables mounting on a microphone stand. A desk-stand fitting is also available for this unit. In addition, the unit is available in the Model AH type which is a hand microphone equipped with a switch and filter to absorb surge of make and break contacting.

NEW PRECISION CONDENSER

Worm-drive air condensers have for many years been widely used as continuously-adjustable standards of capacitance. It has long been recognized that these condensers are subject to small variations from their desired characteristics caused by such factors as temperature, aging, worm, eccentricity, backlash, and various strains. In the General Radio Type 222 Precision Condenser these variations were known and allowance could be made for them when necessary.

The availability of new materials and methods of construction, however, made it possible to replace this condenser with one of completely new design, the Type 722, shown in the accompanying illustration, in which these factors are markedly reduced.

In designing the new condenser, the chief requirement was stability of capacitance. The whole condenser assembly is mounted in a cast frame. This frame, the stator rods and spacers, and the roter shaft are made of an alloy of copper and aluminum. Since the condenser plates are of aluminum, all parts have the same temperature coefficient of linear expansion, resulting in a low temperature coefficient of capacitance.

Connection to the rotor is made by means of a phosphor bronze brush running on a brass drum.

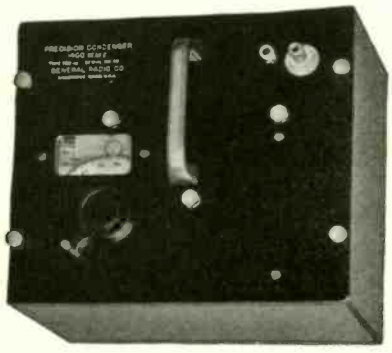
Since it is difficult to mount a worm gear on a shaft without some slight eccentricity, the worm in the Type 722 is cut directly on the shaft. The dial end of the worm shaft runs in ball bearings; the other end is supported by an adjustable spring mounting.

This arrangement of bearings and drive mechanism results in a backlash of less than ½ worm division and a low worm correction.

The worm drives a 50-tooth gear, so that 25 revolutions of the worm rotate the main shaft through 180 degrees. One-half revolution (100 divisions) of the worm advances the main scale one division. Since the main scale carries 50 divisions, the 180-degree rotation is divided into 5000 worm divisions, each half of the worm dial being engraved 0 to 100.

The capacitance per worm division on the 1400-mmfd model is approximately 0.28 mmfd and on the 500-mmfd model is 0.11 mmfd. Since the scale can be set to about 1/5 of a worm division, the precision of setting for these two models is 0.06 mmfd and 0.02 mmfd respectively.

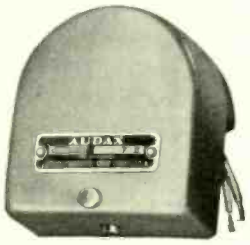
Complete information may be obtained from the General Radio Company, 30 State St., Cambridge, Mass.



AUDAX CUTTING HEAD

The Audax Model 7B cutting head for instantaneous recording, although only recently introduced, is already in use in many of the leading recording studios.

The 7B cutter is the latest addition to various other models made by the Audak Company, 500 Fifth Avenue, New York



City. Complete information will be mailed upon request to the manufacturer.

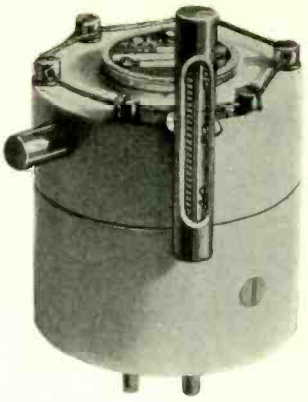
MOVING-COIL MICROPHONES

The Radio Receptor Co., Inc., 106 Seventh Ave., New York City, manufacturers of moving-coil dynamic microphones, have just announced reduction of prices on all units. Increased production and modernized manufacturing facilities have made these reductions possible, it is stated. Complete descriptive literature and prices will be forwarded upon request to the above address.

QUARTZ CRYSTAL MOUNTING

The type BC46 quartz crystal mounting, recently announced by the Bliley Electric Company, combines in one compact unit, a crystal mounting and a constant-temperature oven which will maintain its operating temperature to within 1 degree Centigrade over an ambient temperature range of 10 to 40 degrees Centigrade.

The mounting, in brief, consists of a thermal block, a bimetallic thermostat and a heating element, all enclosed in an Isolantite shell. The thermal block serves as one crystal electrode which allows an efficient transfer of heat to the crystal. The position of the thermostat and heater has



been determined to give maximum temperature stability from the standpoint of thermostat operation and freedom from serious changes in temperature as a result of heat cycles, it is stated. The thermostat, itself, has generously proportioned contacts to minimize arcing and to prevent sticking.

Of interest to broadcast-station engineers is the variable air-gap feature of the crystal mounting, the optional inclusion of a thermometer for recording the oven temperature, and the Federal Communications Commission's approval of the unit for use in broadcast stations when used in conjunction with low-temperature coefficient crystals. The variable air-gap feature is valuable in that changes in circuit constants, tubes, etc., which may cause the crystal frequency to be somewhat different than the original calibrated frequency, may be compensated by a readjustment of the air-gap.

For applications where the crystal frequency may be too high to permit the use of an air-gap, the mounting is available with variable electrode pressure. This type is designated as the BC47 oven mounting.

These temperature controlled units are fully described in the 1936 Bliley catalogue, copies of which are available upon request.

NEW CARBON MICROPHONES

A new series of inexpensive two-button carbon microphones with improved constructional features is announced by Shure Brothers, 215 W. Huron Street, Chicago. The new models are mechanically rugged and are very attractive in design, it is stated.

Model 3B is designed for spring suspension in standard carbon microphone rings. The unit has a rigid cast frame, 3 inches in diameter with a protective grill in front through which sound is admitted to the diaphragm. The finish is bright nickel-plate overall. Net weight, ½ lb.

Model 10B is a convertible hand microphone which is readily adapted for stand mounting with spring suspension by removing the head and inserting four "Quickway Hooks." The microphone is finished in bright nickel-plate with black enameled handle and measures 8⅞ inches in length overall. Furnished complete with 6 feet of 3-conductor cordage and 4 "Quickway Hooks" for stand mounting. Net weight, ¾ lb.

Model 10BS is similar to Model 10B, but includes a built-in, concealed switch which automatically cuts out the microphone when the unit is placed in a horizontal position.

THE Group Subscription Plan for COMMUNICATION AND BROADCAST ENGINEERING enables a group of engineers or department heads to subscribe at two-thirds the usual yearly rate.

The regular individual rate is $3.00 a year. In groups of 4 or more, the subscription rate is $2.00 a year. (In foreign countries, $3.00.) Each subscriber should print his name and address clearly and state his occupation—whether an executive, engineer, department head, plant superintendent, or foreman, etc.

Possibly your associates would be interested in this group plan

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INDEX OF ADVERTISERS

A NEW GENERAL RADIO WAVEMETER

IN many laboratory, operating and production problems where moderately accurate measurements are adequate, there always will be need for a wide-range, sensitive frequency meter of the condenser-coil type.

For many years the General Radio Type 224 Wavemeter has been the standard instrument for measurements of this type.

General Radio now announces an improved wavemeter, the Type 724-A, which replaces the Type 224 with these important improvements:

Frequency Range: Covers the entire present day useful spectrum of 16 kc to 50 mc (18,750 m to 6 m).

Accuracy: 1% from 16 kc to 50 kc; 0.25% from 50 kc to 50 mc.

Coil System: Seven low-resistance plug-in coils; Isolantite coil forms and improved design affording much better stability; coupling variable by rotating coil in plug rather than by shifting wavemeter.

Condenser: Modification of the new Type 722; improved mechanical construction with greater electrical stability; condenser plates straight-frequency-line shape; 7,500 divisions for 270 degree rotation of main dial; condenser may be set to 1 part in 25,000.

Resonance Indicator: Vacuum-tube voltmeter rectifier; improved sensitivity; galvanometer cannot be damaged through coupling too closely.

Calibration: Tabular form; calibration at 13 or 16 points supplied for each coil with interpolation in kc per division and divisions per kc between each set of points.

Price: Type 724-A Wavemeter, complete with carrying case, tube, coils and calibration $190.00

WRITE FOR BULLETIN 3603-K FOR COMPLETE DETAILS

Orders and inquiries should be addressed to General Radio Company, 30 State Street, Cambridge, Massachusetts.

GENERAL RADIO COMPANY

NEW TUBES DESIGNED FOR ULTRA HIGH FREQUENCY OPERATION

ADVANCED IN DESIGN
AMAZING IN PERFORMANCE

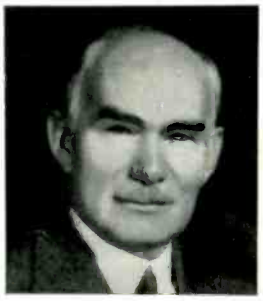
The tube with the highest ratio of Transconductance to Interelectrode Capacitance

A design characteristic which is mainly responsible for the extraordinary performance of these tubes at ultra high frequencies. Plate power outputs as high as 400 watts have been obtained from a single tube at five meters. If you have been attempting to operate your 204A at high frequencies . . . substitute the Amperex HF 300. Increase in power output will astound you.

There are many other brilliant engineering refinements and radical design developments incorporated in the structure of these tubes as well as the entire line of Amperex Carbon Anode Tubes.

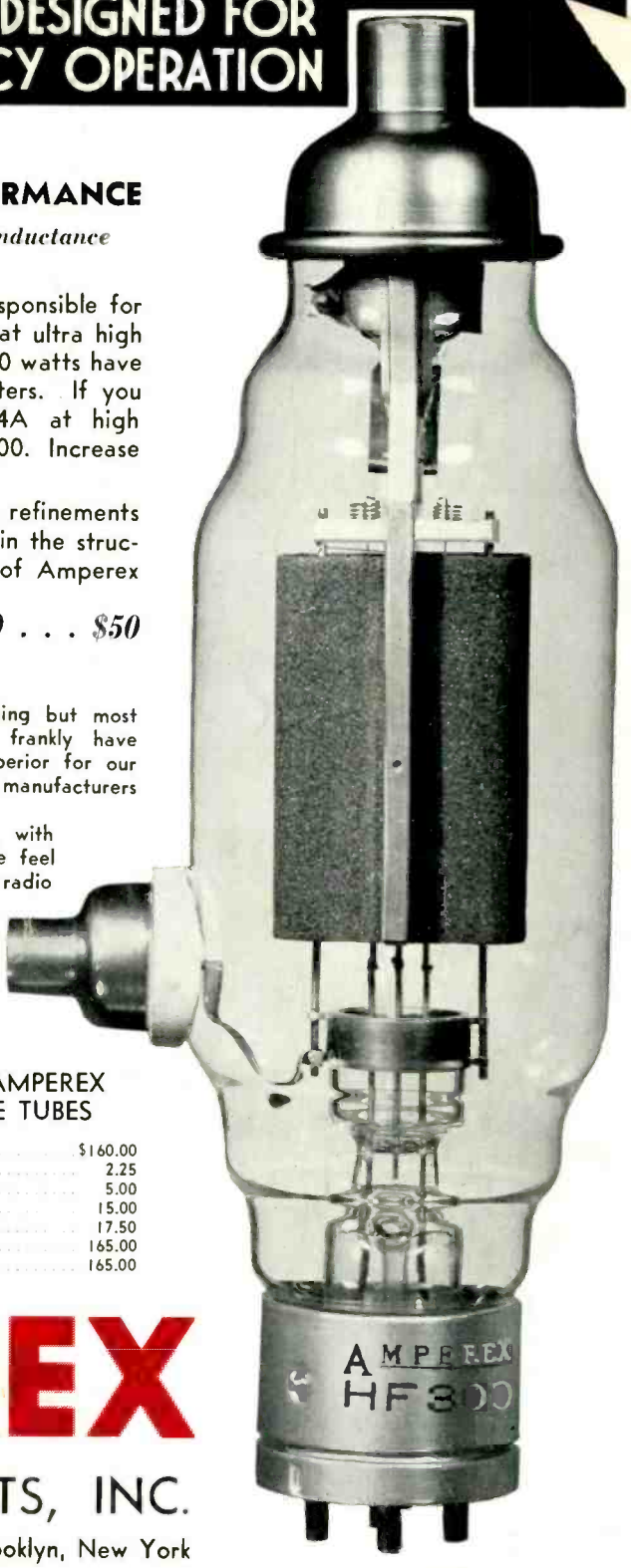
HF 300 . . . $50

LEE DE FOREST SAYS:



". . . we have had nothing but most satisfactory—results, and frankly have found Amperex tubes superior for our work to those of other manufacturers which we have tried.

"We are highly pleased with the results obtained. We feel that manufacturers of radio transmitters are fortunate to have available oscillator tubes possessing this degree of reliability."



PARTIAL LIST OF AMPEREX BROADCAST TYPE TUBES

203A	$15.00	849	$160.00
204A	95.00	866	2.25
205D	5.00	866A	5.00
211	15.00	872	15.00
212E	75.00	872A	17.50
264B	1.75	869	165.00
801	3.25	869A	165.00

WRITE FOR DATA

on our complete line of tubes for broadcast purposes. . . .

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ELECTRONIC PRODUCTS, INC.

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