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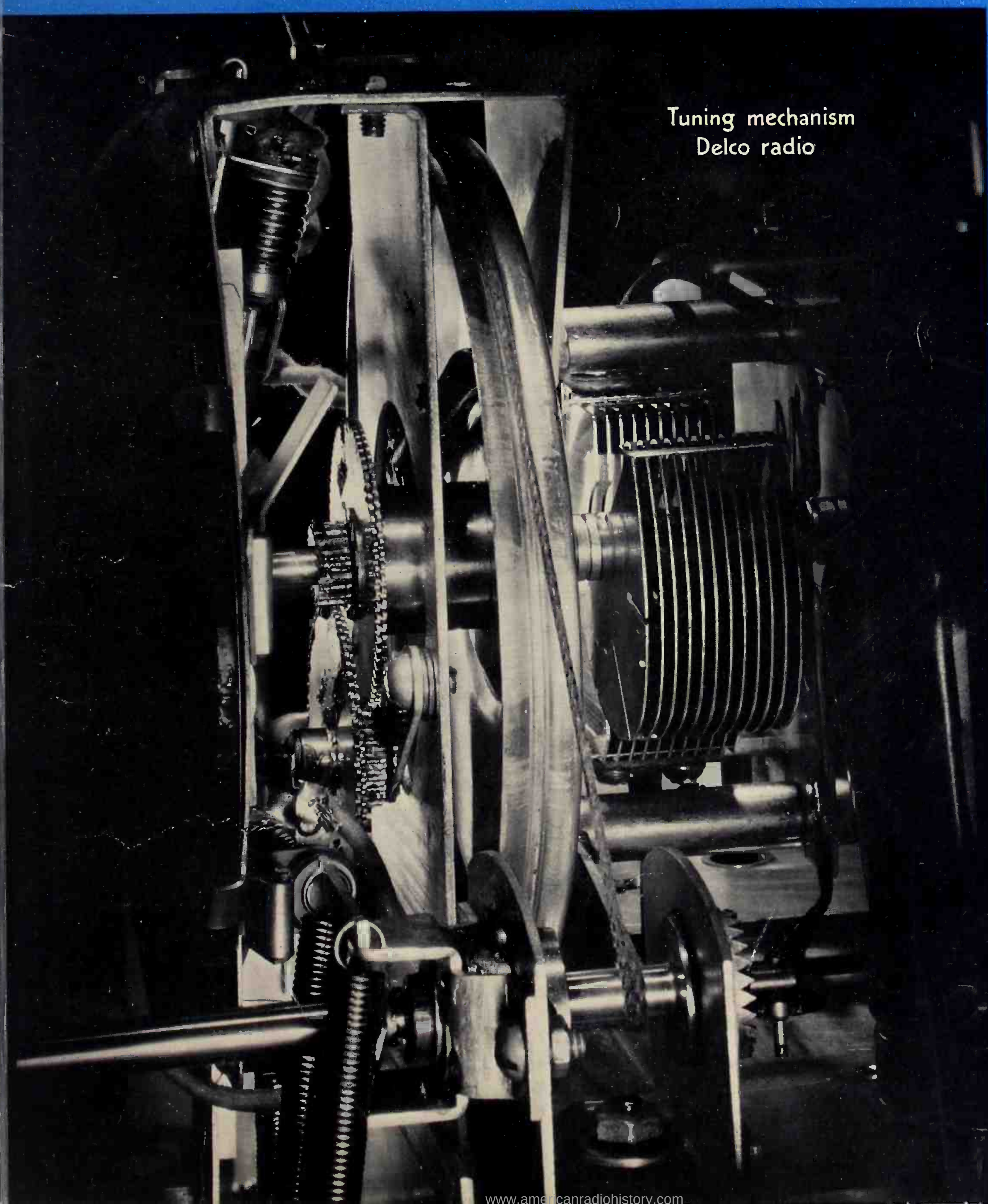
radio, communication, industrial applications of electron tubes . . . engineering and manufacture



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THE MATERIAL OF A THOUSAND USES

ELECTRONICS

radio communication and industrial applications of electron tubes . . . design, engineering, manufacture

HOWARD EHRLICH, Vice-President — KEITH HENNEY, Editor — DONALD G. FINK, Associate Editor — H. W. MATEER, Manager

CONTENTS

October 1935

DEPARTMENTS

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ELECTRONICS

OCTOBER 1935

KEITH HENNEY *Editor*

Crosstalk

▶ NOTES ON THE RADIO SHOW. . . . Prospective buyers at the Grand Central Palace exhibition saw little new. Radio sets still look much alike. But there is much that is new behind the panel. Some that is old is bad, bad as ever. Tuning mechanisms, for example. Knobs still wobble, there is back lash, there is a stickiness to the action of the tuning knob that does not compare, in mechanical design, with the radio engineering in the receiver. Some manufacturers realize that all that is radio is not electrical (see pages 358-360 in this issue for the story of the Centromatic development).

Manufacturers indicate that next year's sets will tune to 70 Mc. This will call for new signal generators. The new tube, 6L7, makes this extension of frequency range possible.

Buyers for the most part could not see, and were not told, of the many advances in technique such as the rapid extension of band-widening systems to the betterment of tone fidelity, of the improvements in a.v.c., bass compensating networks, or the other features discoverable only in a circuit diagram.

▶ RADIO VERSUS MOVIES. . . . Higher fidelity radio receivers will open the eyes, and ears, of the movie-going public to the atrocious tone quality emanating from neighborhood theaters. Overloading due to run-down tubes, poor loud speakers, distortion or elimination of the higher tones, worn out films all contribute to an ear assault that would not be tolerated in the home, or in the theater if the sense of hearing were not dulled by too great stimulation of the sense of sight.

▶ REFERENDUM. . . . The Editors appreciate the many complimentary speeches made about the new *Electronics.* They scan mail carefully for points readers do *not* like. Coated paper, longer articles, better illustrations, better coverage of the vast field of electronics, doubling the number of feature articles, additional editorial pages—all these items cost money and can be justified only if the reader wants them. The paper belongs to the reader, not to the editor.

D. E. Foster says the heavier paper will make his annual bound volumes too heavy; H. Olkin states that the new *Electronics* looks like a "front office" paper, not to be taken into the shop; D. D. Miller wants more radio and less industrial; M. D. Berry wants more industrial and less radio.

But H. W. Dickow feels *Electronics* "should help put the radio engineering industry on a higher plane." George Uzmann—"contains a wealth of technical material, a forerunner of the best in the field," C. B. Scott, Brush Development Company—"this will increase the potency of the advertising material." W. D. Loughlin, Boonton Radio Corporation—compliments *Electronics* on its fine appearance. L. W. Barnett WLW—"specially like the paper . . . a distinguished appearance among all trade journals." G. W. Stone—"particularly pleased with the greater detail given in many of the articles." J. R. Poppele, WOR—"extremely able publication." Arthur H. Lynch—"head and shoulders over every other current radio publication." Austin C. Lescarboura—"first publication which does justice to the growing radio and allied techniques"—and so on.

But let's have the kicks, too.

▶ WHAT! NO ETHER DRIFT? . . . Scientists of the Paris International Time Bureau, according to the Associated Press, have reported that radio signals travel faster in some directions than in others, saying that signals sent from Paris to Saigon, French Indo-China, travel between 280,000 and 285,000 km. per sec., while those traveling from Paris to Buenos Aires make the distance at a rate of 269,000 km. per sec. If this apparent difference of 11,000 to 16,000 km. per sec., between signals traveling eastward and westward, is real, and does arise from differences in the terrain over which the signals travel, it would indicate an ether drift of approximately 7,000 km. per sec., with an absolute motion of radio waves through the ether of approximately 276,000 km. per sec. The ether drift has been persona non grata since Michelson's day. Is it here raising its ugly head again?

▶ PAGE THE RMA. . . . Radio service men are disturbed because the universality of the octal sockets is being violated by manufacturers who insist on punching holes in sockets only where there are tube prongs to stick through them. This forces the radio service man to purchase adapters for his testing equipment at considerable and unpredictable cost. The trend of omitting socket holes does not protect the set user for he can still get tubes into the wrong sockets, and seems to destroy one of the chief advantages of the new style of sockets and bases.

▶ ANTI-NOISE CAMPAIGN DIVIDENDS. . . . Bordens (milk) early falls into line with New York City's campaign on noise. Two thousand horses will prance on rubberized shoes, wagons will have rubber-tired wheels. A decrease of 70 per cent of the existing noise will be effected. Horses will be replaced by others weighing 300 pounds less, each. Wagons will weigh 1,600 instead of 1,900 pounds. Bordens discovers that rubber shoes will last three times as long as iron shoes, weigh about half as much, lighter shoes and wagons will prolong horse life by two or three years, rubber tires will lower wagon floor by 8 inches, facilitating loading and unloading. No small dividends, here.

▶ BUM JOKE. . . . An engineer sent his assistant for a condenser which was to have the highest leakage resistance possible. In time the aspirant for engineers' salaries returned with a condenser whose resistance he stated was "higher than infinity." Questioned on his measurement, he stated, "Well, the needle on the megger went right past the point marked infinity."

raphed for Electronics by Rudy Arnold, Floyd Bennett Airport

FLYING THE WAVE

"Homing" on a broadcast signal wavefront—radio's latest contribution to safe flying

The Aircraft Radio Compass

To the familiar "Follow the Beam" the air pilot has added "Fly the wave," i.e., following a radio direction finder trained on *any* broadcast or beacon signal. Principles, circuits, operating technique, possibilities and limitations, details of commercial instruments

RADIO direction finding by means of loop antennas is one of the oldest and most useful branches of the art, as any shipping master will testify. But the latest development in the loop-finder field, the "homing" type radio compass for use in aircraft, is a far cry from the box-loop to be seen on the wheel-house of every large steamer. The essential principle used in both cases is the same, but the refinements and automatic features necessary in the airplane type make it a very different sort of animal.

In the ship-type direction-finder, the loop is rotated in the field of the incoming signal. When the plane of the loop coincides with the plane of the wavefront, a "null-point" can be distinguished in the headphones connected to the receiver. By rotating the loop, the null-point can be ascertained with an accuracy of one or two degrees in angular direction at distances of 500 miles under favorable conditions. When separate bearings on two shore stations have been taken in this manner, a simple geometrical triangle is thus established from which the absolute location of the ship can be determined.

Attempts to use a similar arrangement on airplanes, however, have met with failure. Noise in the plane makes accurate determination of the null-point by ear extremely difficult; for this reason, and because of the many demands upon the pilot's attention, a *visual* indicator which indicates the bearing directly is essential. In the second place, the extreme speed of the plane makes it necessary to avoid time-consuming triangulation and calculations. The wide mobility of the plane makes it desirable to use the direction-finder on signals from stations widely scattered, rather than on a few specified stations such as can be used in marine practice. The necessity of obtaining directions from signals of various strengths, over distances of a few thousand feet to several hundred miles makes great demands on the sensitivity range of the receiver, and particularly on its a.v.c. action.

These requirements have been the basis of several designs which, while differing slightly in detail, all perform in essentially the same fashion. Most of the requirements, such as good a.v.c., good sensitivity, tuning range, lightness, ruggedness, etc., can be provided by applying known engineering practice. But a visual indicator capable of distinguishing left from right was not so easily forthcoming; in fact a basic invention first described in 1925 by two Germans, Hell and Dieckman, appears to be the *sine quo non* of reliable visual direction-finding. This principle, developed for the U. S. Army by G. G. Kruesi, and commercially by Lear, Wunderlich, Kruesi, Stellwagen, Heller, and others, is not at once obvious, even to engineers familiar with circuit design.

The visual indicator is a meter which moves to the left or right of its center position as the phase relation between the voltage received from a loop antenna leads or lags with respect to the voltage received from a non-directional fixed antenna which is also mounted on the plane. The phase difference between these voltages depends upon the magnitude and direction of the angle between the wave-front and the plane of the loop; and as a result, the visual indicator shows whether the wave is coming from the right or left, and how large the angle is in either direction.

By fixing the loop so that its plane is perpendicular to the fore-and-aft axis of the ship, the ship may

Stream-lined loop on commercial transport plane.

The pilot's position in a TWA Douglas Transport, shown to the right. The compass indicator to which the pilot is pointing is only one of 25 dials and gages he must watch.

be steered directly into the wavefront, simply by keeping the visual indicator on dead center. This is the method of using the device as a "homing" compass. A beacon or broadcast station, whose identity is known and which lies in the direction the pilot desires to follow, is tuned-in on the receiver. Then, on the assumption that the wavefront is exactly perpendicular to the line between the ship and the transmitting antenna of the station, the pilot can fly directly to the station, simply by keeping the visual indicator on center, correcting the course of the ship as the indicator moves to the left or right.

In actual practice, flying the compass is not quite as simple or direct as this, especially at night. The reason is that the wavefront is seldom a true plane, nor is its resultant direction always directly away from the station from which it comes. The most serious cause of wave distortion is the refraction of horizontally polarized components in the Heaviside layer. The variation of this effect changes the apparent resultant direction of the wavefront, periodically, over a period of from a few seconds to several hours. As a result, the needle of the indicator wanders from side to side, as though the direction of the ship were changing. The pilot, unable to distinguish this drift from changes in direction, corrects for them by changing course, and as a result the course is a zigzag (Fig. 1-A).

This "night-error" is much less pronounced during daylight hours, and is very much smaller for a signal from a vertical radiator, since the vertical polarization of such a signal is not refracted to any great extent by the Heaviside layer, and does not affect the apparent direction in any event. Horizontal radiation from improperly balanced transmission lines is often present in the output from a vertical radiator, however, so that all vertical radiator stations are not free from night-error.

Furthermore, reflections from the motor and metal surfaces of the plane introduce an error which must be corrected; otherwise a slight fixed error is present which will cause the pilot to follow a cork-screw course (Fig. 1-B.) Proper installation will usually take care of any such contingency. Variations of the indicator needle due to noise or to modulation of the signal wave must also be avoided; and the calibration of the entire device must be independent of the frequency of the received signal and of the precision with which it is tuned in.

If the design is proper in these respects, if the installation is carefully made, and if flying is directed on vertical radiators of cleared channel stations, a pilot can fly the wave even at night direct to the towers without serious deviation. Even in the presence of a severe side wind, in which the pilot will fly a curved course, shown in Fig. 1-C, the time of flight is approximately the same as that of exact navigation. When flying in cross-wind, however, the pilot usually changes course to correct for the side drift. In this case the pilot gets the true bearing on the station from the compass, sets it on his gyro compass, and follows the gyro. When so flying, the radio compass indicator will show a continuous off-course bearing corresponding to the correction the pilot has made to offset the wind.

An accuracy of 1 or 2 degrees bearing at 300 miles distance probably represents the best conditions. At 100 miles, this accuracy may easily be obtained, and with broadcast stations so widely scattered, in addition to the 71 Department of Commerce Air Beacon stations and 80 marine beacon stations, it is possible to fly across the continent without maps, navigation calculations, or compass, simply by following the waves from station to station.

the voltages received at the terminals of the loop and fixed antennas. The outer circle is the voltage received from the non-directional antenna, and is, of course, of constant magnitude, regardless of the angle θ by which the plane is off course. The two inner circles represent the voltage from the loop antenna whose magnitude changes according to the value of θ as shown. When θ is 90°, the plane of the loop is at right angles to the wavefront and maximum voltage is induced. Furthermore, if θ is 90° to the left, the phase of the induced loop-voltage is exactly reversed (by 180°) from its phase when θ is 90° to the right. That is, the loop voltage for left-hand deviations is opposite to the loop voltage for right hand deviation. In practice the output of the two antennas, loop and non-directional are adjusted so that the maximum loop voltage (θ = 90° left or right) has the same absolute value as the voltage from the fixed antenna, as shown in the diagram.

The solid heart-shaped figure in Fig. 2-B (disregarding the dotted-line figure for the moment) is simply the sum of the two voltage plots in Fig. 2-A, which results when the loop and antenna voltages are combined in the receiver. It will be seen that this resultant voltage has the desired changes in magnitude as θ changes from left to right. However, the voltage is not symmetrical about the on-course axis, and thus a given deviation to the right does not produce the same voltage as the same deviation to the left.

The desired symmetry is obtained by reversing the polarity of the loop periodically. When the loop polarity

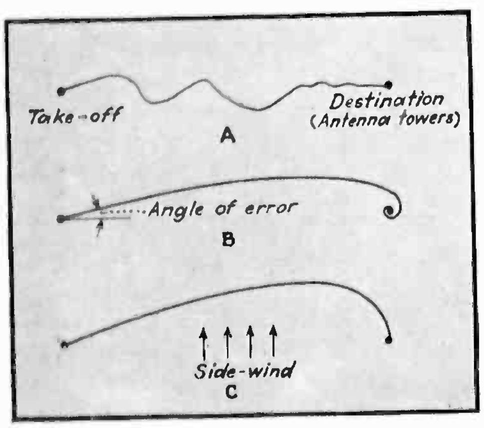
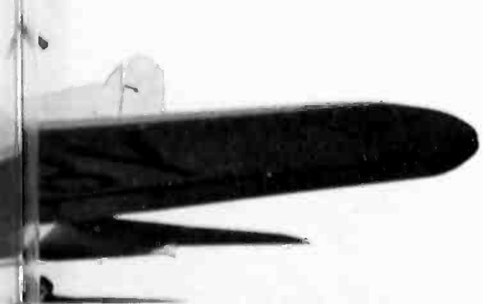


Fig. 1. Courses flown by compass under adverse conditions.



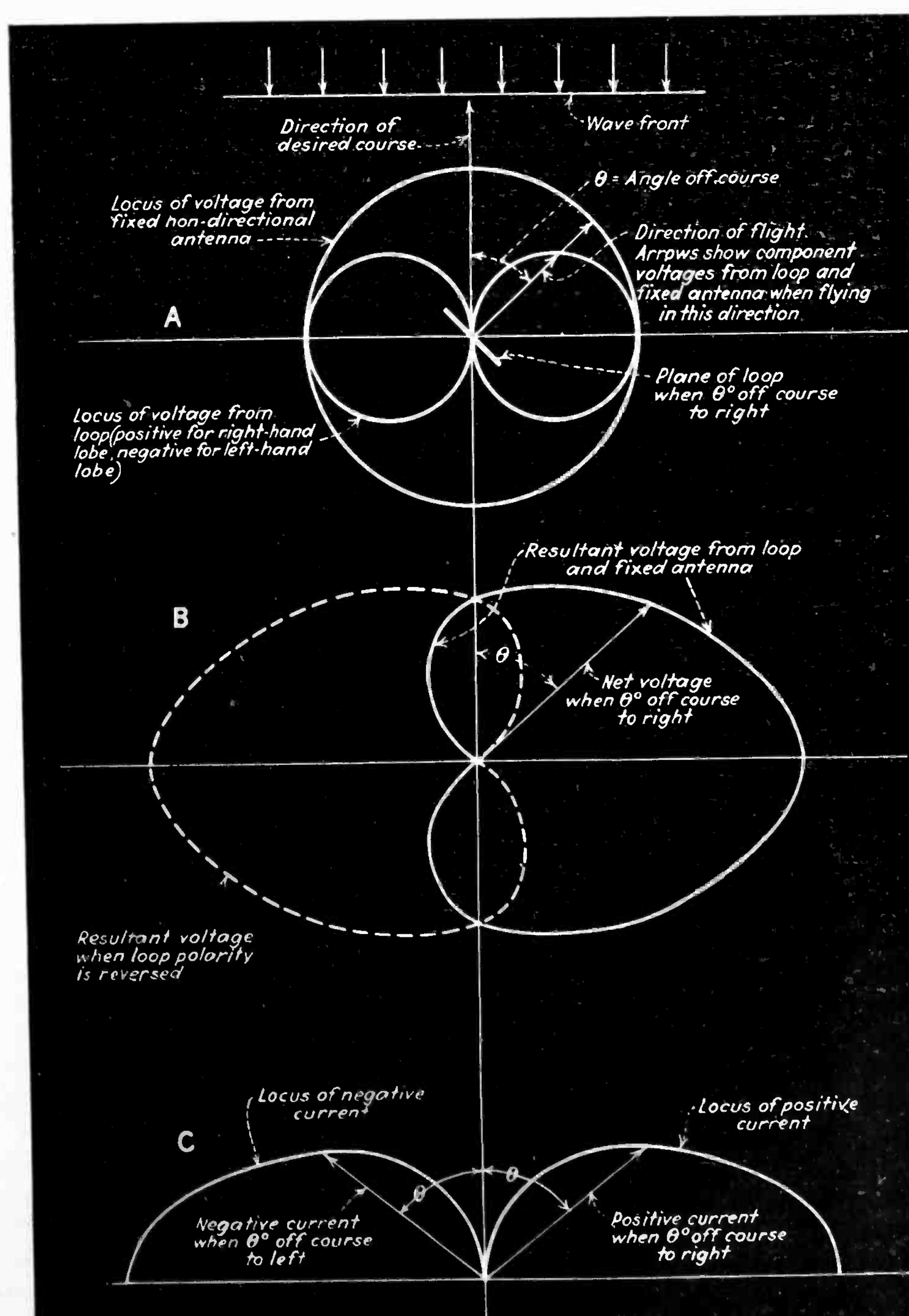


Fig. 2—Right, diagram showing transformation of loop-bearing into a right or left meter indication.

The considerations of the preceding paragraphs may be of only passing interest to the non-flying radio engineer. To him, however, the technical details of the compass are "replete with interest." The diagrams in Fig. 2, show how the bearing of the loop antenna with respect to the wavefront is translated into a meter reading which will show both the magnitude and direction of the bearing. Figure 2-A, represents

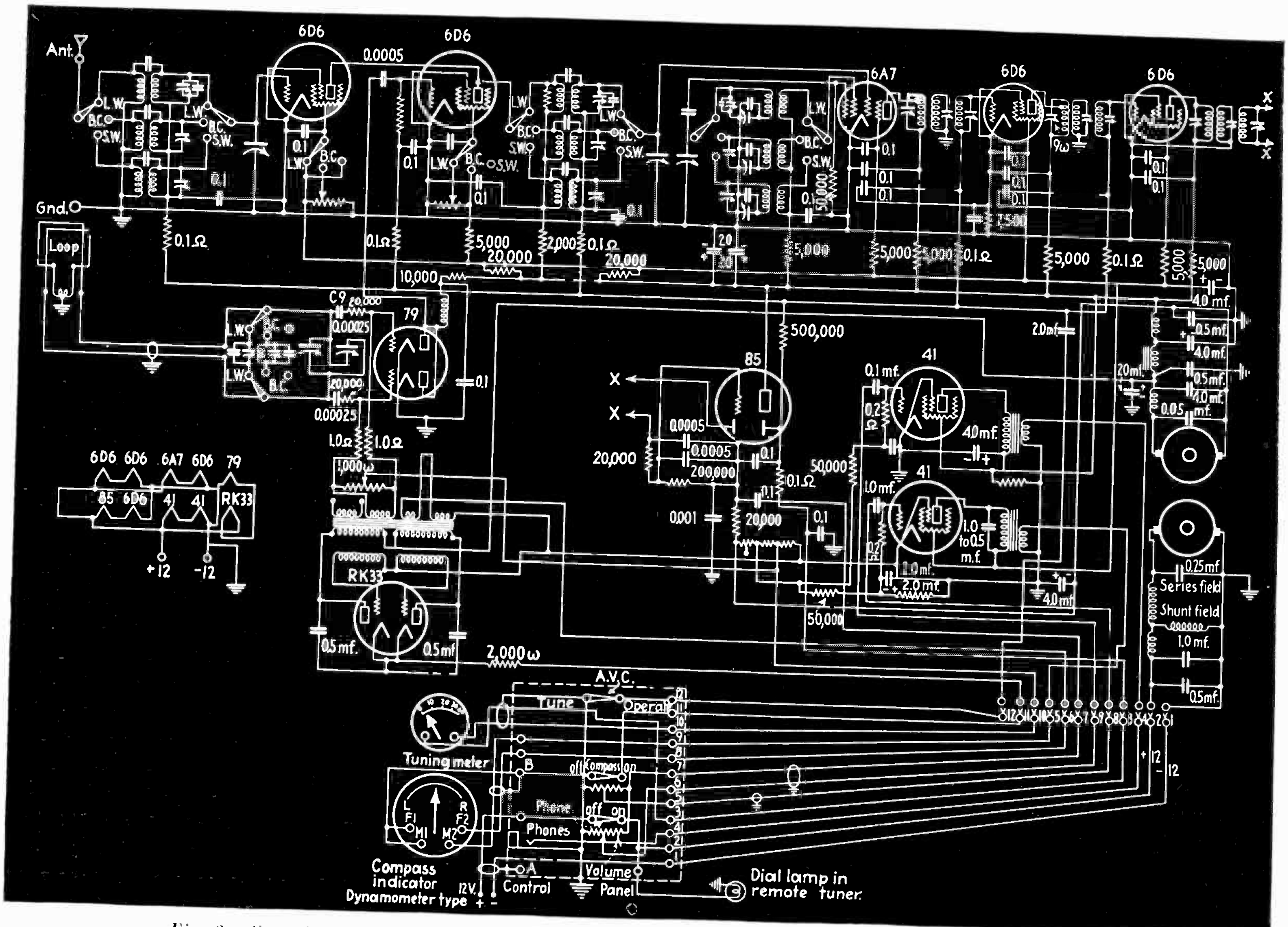


Fig. 3. Complete circuit diagram of the Lear Developments Co. dynamometer type radio compass.

is reversed, the cardioid shifts from right to left into the dotted position shown. This reversal is performed rapidly, by an electronic circuit, at a low audio frequency, so that the two cardioids exist equally and alternately.

The third diagram, Fig. 2-C is the difference between the two cardioids, shown in Fig. 2-B, the difference being taken in the receiver by means of a balanced bridge circuit or by means of a dynamometer indicating instrument. This difference, being taken between alternate voltage values, is in reality an a-c voltage which has a zero d-c component when θ is 0 (on course), a positive d-c component when θ is to the right and a negative component when θ is to the left. This d-c component is applied to a zero-center d-c meter, or if a dynamometer is used, to the armature coil of the meter. Left hand deviations of the ship thus move the pointer to left, right-hand deviations to the right.

Fairchild visual indicator.

Apparatus used in commercial models

At the time of writing, three companies have offered homing-type compasses to the public: in order of appearance, the Lear Development Company, the Fairchild Aerial Camera Corporation, and the Western Electric Company, all of New York. The Electrical Industries Manufacturing Company will offer a compass at the end of October. Although it is understood that several other concerns are preparing similar units, or have already done so, no information on them is available. Considerable development is also in progress in the U. S. Army flying corps, the apparatus being essentially similar to commercially available models.

The Lear compass (See Fig. 3) uses a center-tapped, 20-inch loop mounted in a wooden stream-lined casing (drag of about 5 pounds at 200 mph). The center tap is grounded and the two end-leads are brought from the loop (mounted on the fuselage of the plane) through a twelve-foot shielded low capacity cable to the receiver proper. There, the loop leads connect to the two grids of a balanced modulator tube (a 79). Also superimposed on these grids is an audio frequency (105 cycle) voltage provided from a local oscillator circuit which cuts off each half of the 79 tube alternately, so that with respect to the ground, the loop polarity is reversed (the effective loop being from its grounded center-tap to one end-lead). The reversing voltage from the loop results in the output of the 79; it is then combined in a 6D6 stage with the output of the non-directional antenna, after amplification to make both loop and antenna voltages of the same maximum magnitude. The

[*Continued on page 29*]

R-F Insulator Voltage Limits

Placing radio-frequency insulation on a working basis similar to that for insulators for commercial power frequencies. Test results disclosed indicate a novel departure from conventional voltage rating

INSULATORS have been applied frequently to radio frequency equipment without full knowledge of their ability to withstand the voltages imposed. In consequence, failures have unexpectedly occurred, sometimes with disastrous results. Existing information on the subject is not at all adequate, as it gives 60-cycle puncture voltage only. Voltage tests under actual operating conditions therefore are required to insure proper insulator application.

The fact that an insulator is a dielectric makes it subject to heating at high frequencies because of the inevitable losses in even the best of dielectrics. This heating must be kept within certain limits, or failure of the insulator will follow. Upon this well-known fact was based the following plan for measuring the temperature of the insulator and the r-f voltage to which it was subjected.

The insulators had threaded holes at each end, the lower one for mounting and the upper one for a terminal, as illustrated by Fig. 1. Six insulators of a kind were mounted on an aluminum plate, the upper terminals being connected together electrically so as to put the six insulators in parallel. Voltage at a particular frequency was applied across the insulators. This voltage was measured by the current through a known capacity shunting the insulators.

A thermometer, located on the upper terminal of one insulator in the string, indicated the insulator temperature. Readings of the insulator and ambient temperatures were taken at ten-minute intervals until the temperature rise became constant. The test was then repeated for several different voltages at the same frequency, and similar series of tests were performed at frequencies from 100 to 20,000 kc.

A typical curve of temperature rise versus voltage is shown in Fig. 4. Within the limits of experimental

By REUBEN LEE

Westinghouse Electric and Manufacturing Company

error, the temperautre rise was found to increase as the square of the voltage, up to a certain point *A*. Beyond this point the temperature rise increases to a much greater de-

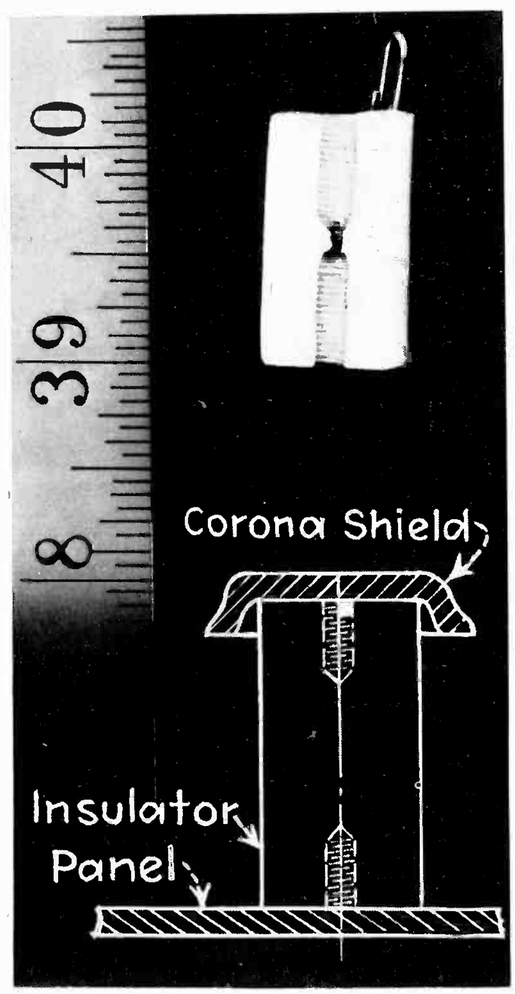


Fig. 1—Below, outline of typical insulator. Above, insulator after breakdown (actual size).

gree. If the voltage is increased somewhat above *A*, failure of the insulator results.

Failure is manifested either by a glow inside the insulator, or by its sudden bursting into pieces. If a glow occurs, it is accompanied by extremely high temperature and loss of insulating properties; that is, the insulator becomes a conductor of relatively low resistance. Examination of an insulator, broken open by hand after this type of failure has occurred, reveals that the insulation in the direct path between terminals has undergone a change of physical state. Sometimes a black pencil-like core runs from one terminal to the other; less frequently the core is like melted glass, nearly transparent. If the failure is explosive, the core may be partly formed, but the localized heating sets up mechanical strains which break the insulator before fusion of the material is completed.

At any point beyond *A*, say point *B*, the temperature rise is caused by two components of heating: W_1 which is ordinary dielectric loss, and W_2 which is the increased heating caused by gradual disintegration of the insulator. If voltage is removed from the insulator before failure occurs, and a voltage below *A* later applied, the insulator is found to act practically the same as it did before it was subjected to high voltage.

There is a similarity between the disintegration just described and the phenomenon of corona in air or oil. The temperature rise of air below the critical disruptive voltage is negligible, but it rises rapidly above this value. If the voltage is further increased, it eventually reaches a point where complete breakdown, or flashover, results. The ionization of the air corresponds to local fusion of the solid material. There is this difference, however, that the air is a good insulator after failure, and can be used again, whereas the fused solid material is forever ruined. But it seems reasonable to think of internal corona or ionization in the insulating material just as there is in air, the high voltage gradient tearing away electrons and liberating ions to form a conducting path in both cases.

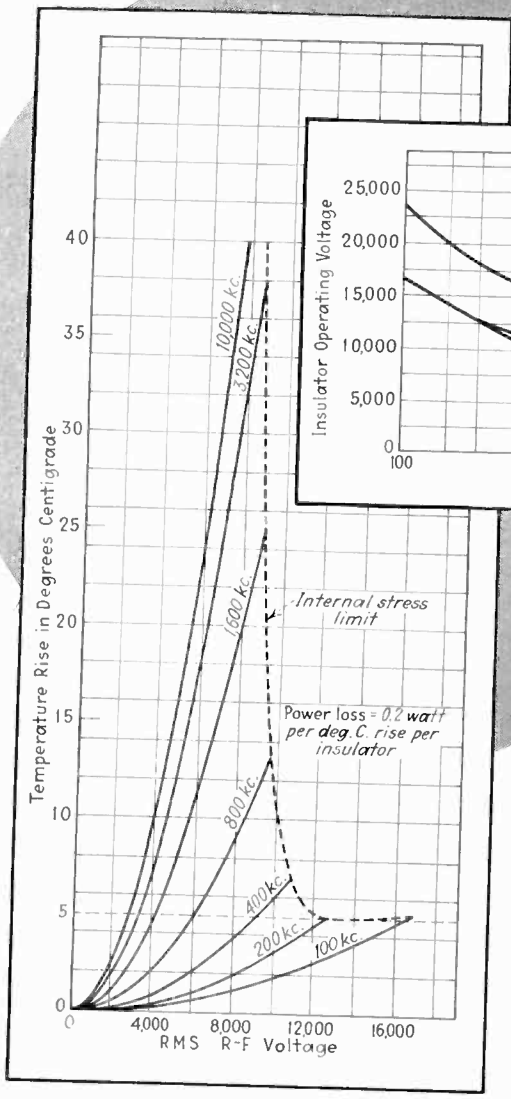


Fig. 2—Insulator voltage—temperature rise curves and limits

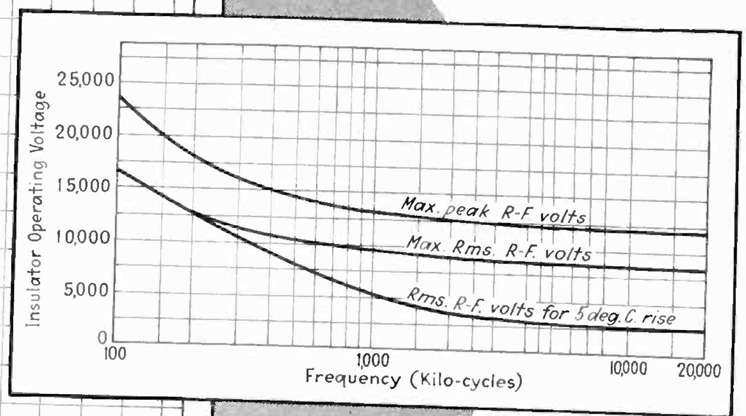


Fig. 3—Operating voltage vs. frequency curves

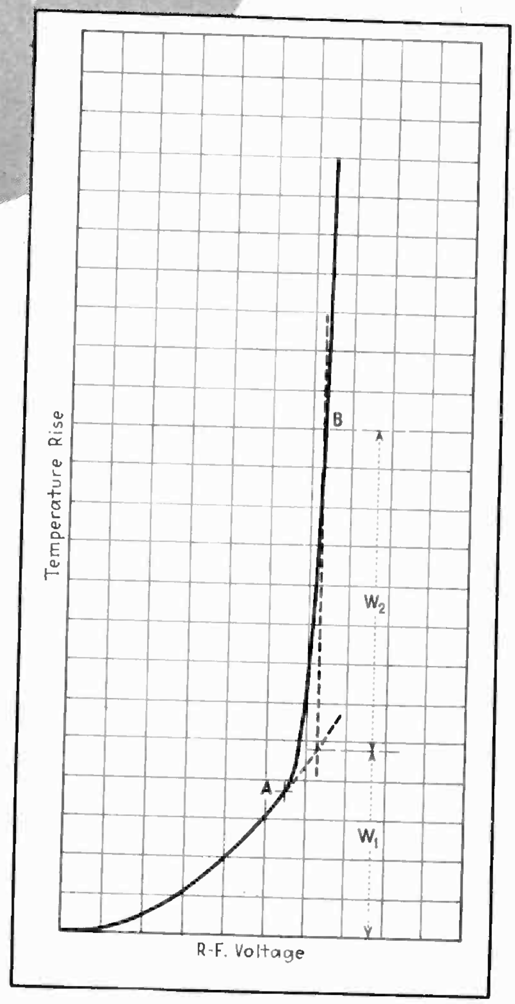


Fig. 4—Typical temperature rise plotted against r-f voltage

An interesting analogy also exists between the behavior of a solid dielectric and that of a material like steel under mechanical stress. The strain is proportional to stress up to the elastic limit, beyond which the steel receives a permanent set. If the stress is increased much further, the material eventually breaks; if the stress is removed before failure occurs, the specimen may later be subjected to lower stress with only slightly different characteristics.

As mentioned previously, the increase in voltage above the limit *A* in Fig. 4 necessary to cause failure is relatively small. The amount of increase necessary varies considerably with individual insulators. Thus it often happened that another insulator in the string failed, while the insulator on which the thermometer was placed indicated only a slight rise in temperature beyond point *A*. In all cases the failure occurred after point *A* was reached, however. This point may therefore be taken as an upper operating limit of voltage. The work that has been done at 60 cycles on solid insulations confirms this idea in that stresses above the elastic limit eventually cause failure.

For each insulator, then, a series or family of curves was plotted from the data, a curve for each frequency as typified in Fig. 2. Internal overstress starts at a temperature which increases, but at a voltage which decreases, with increased frequency. A dotted line marked "internal stress limit" is drawn through all such points, and indicates the voltage limit at different frequencies.

Inasmuch as no failures in the 132 insulators tested occurred below point *A*, this limit was taken as absolute, no safety-factor being necessary.

The temperature rise corresponding to the voltage limit increases as the frequency increases. This is in accordance with low frequency experience, for at 60 cycles an insulator may puncture without appreciable temperature rise, failure being caused by cumulative cracking.

The watts recorded in Fig. 2 were found by noting the difference in watts input when the insulators were added to the test amplifier load circuit, due allowance being made for amplifier efficiency. This was checked by the published values for power-factor.

In most cases the "internal stress limit" occurs at lower temperatures with lower frequency. In some cases as in Fig. 2 this continues down to a certain point, beyond which the temperature *increases* with lower frequency. This occurs usually at 100 or 200 kc where the voltage limit is high and the temperature low. It is attributable to corona in the neighboring air, which while not enough to be audible or visible, is yet enough to cause a slight temperature rise.

A set of curves such as Fig. 2 furnish complete operating data for the insulator. If it is operated above the "internal stress limit," deterioration and eventual failure may follow. Below this limit, the insulator will operate safely for an indefinite period of time, regardless of the temperature. Operating the insulator at any temperature requires power, however, and it is necessary in applying the insulator to determine whether the power is available to operate the insulator up to the internal stress limit or not. If not, the power available becomes the limiting factor.

For example, suppose only 1 watt per insulator is permissible from the standpoint of power. This limits the temperature rise at which the insulator of Fig. 2 may be used to 5°C. The difference in operating voltage is most marked at the higher frequencies, and is better illustrated if the voltage is replotted against frequency as in Fig. 3. Here the curve "max. rms. r-f. volts" corresponds to the internal stress limit and is prac-

[*Continued on page 42*]

Filtering for Double Radiation

KRNT and KSO use same antenna for simultaneous broadcasting of different programs, a feat made possible by the careful filtering described here

By VICTOR ANDREW
Doolittle and Falknor, Inc., Chicago

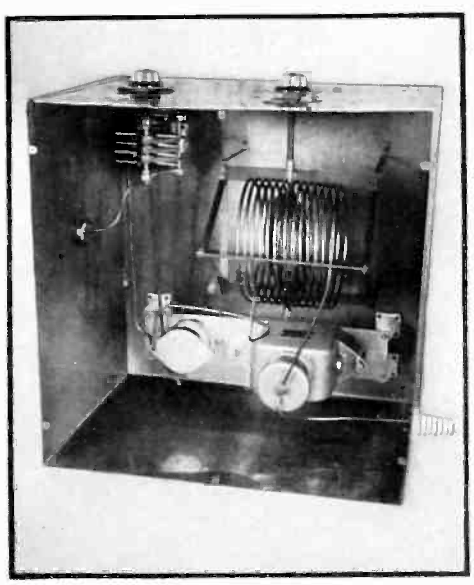
RADIATION of two different broadcast programs on different frequencies from the same antenna has been used in regular operation for some time in New England. The second installation of its kind has recently been made in Des Moines, Iowa, where stations KRNT and KSO were recently moved. A vertical radiator is used for both transmitters, which operate simultaneously on frequencies differing by only 8 per cent (1320 and 1430 kc.). In order to secure maximum efficiency of radiation without "backing up" of the energy of one transmitter into the other, quite elaborate filtering and tuning circuits are required.

The complete circuit at the antenna end of the transmission lines is shown in the diagram. Separate concentric lines are used for the two transmitters. Since the antenna is greater than a half wave length for either frequency, inductive loading is used in unit V to resonate it approximately midway between the two frequencies. Tracing back from the antenna, the circuit then divides to go to the two transmitters. In unit II, C_1 and L_2 are series resonant to 1,320 kc., and are therefore equivalent to a short circuit. L_3 resonates the antenna to 1,320 kc. The pi network L_4, C_3, and C_4 matches the impedance of the transmission line to the antenna resistance at 1,320 kc. The reactances of the three elements in the network are equal, and each equal to the square root of the product of the line impedance and the antenna resistance.

The 1,320 kc. signal is prevented from backing into the 1,430 kc. transmitter by the circuit L_5, L_6, and C_5, which is parallel resonant to 1,320 kc., and therefore equal to an open circuit at this point. The pi network in unit III is designed to further attenuate 1,320 kc.

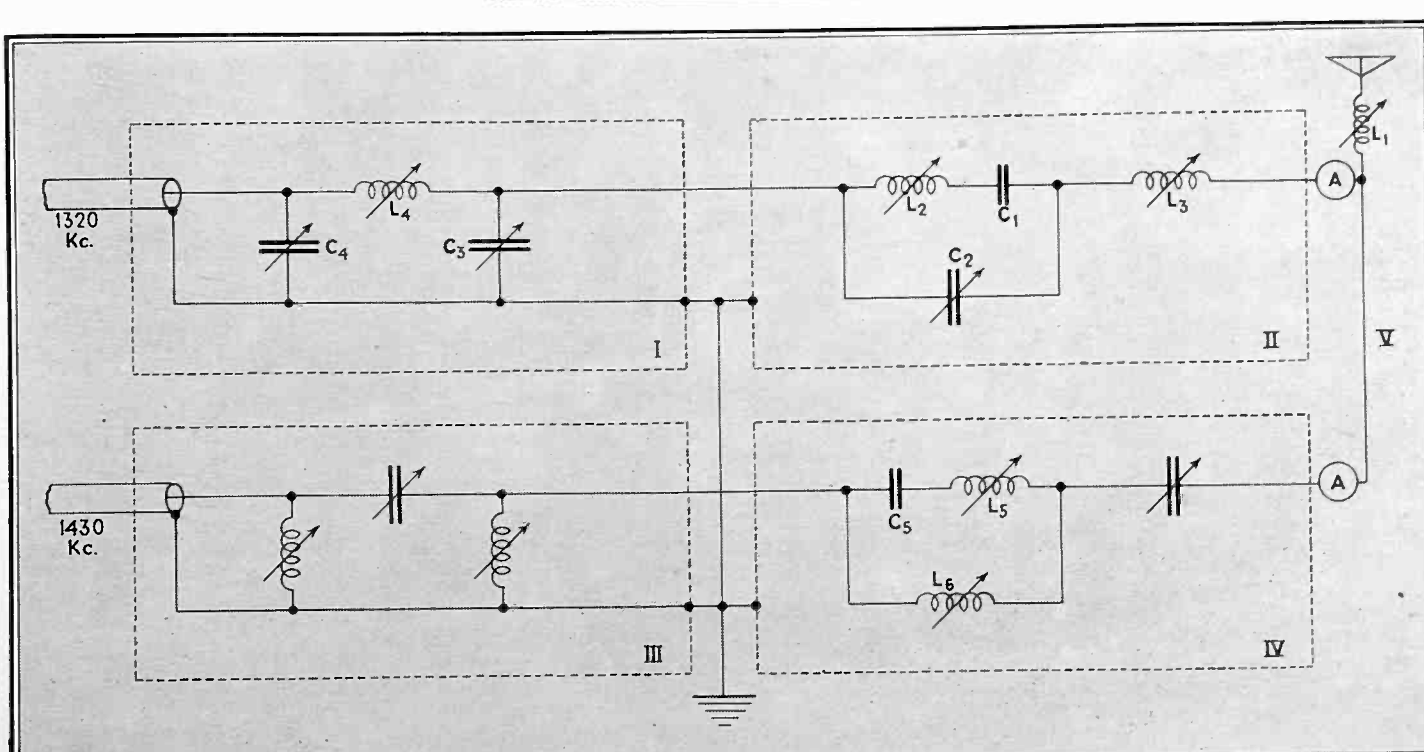
The 1,430 kc. signal passes through to same filtering, matching, and tuning equipment, except that the positions of inductances and capacities are all reversed. Since the frequencies are so close together and units II and III must function as series resonant to one frequency and parallel resonant to the other frequency, these circuits were built with great care to have the lowest possible resistance.

Units I, II, III, and IV are housed in four separate copper shields.

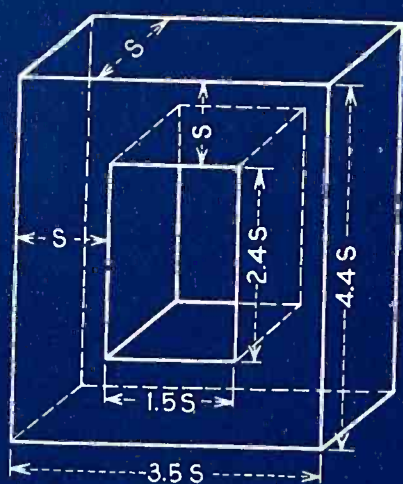


Left, one of the filter units in its shield

Filter circuit used by KRNT—KSO



Charts for Transformer Design

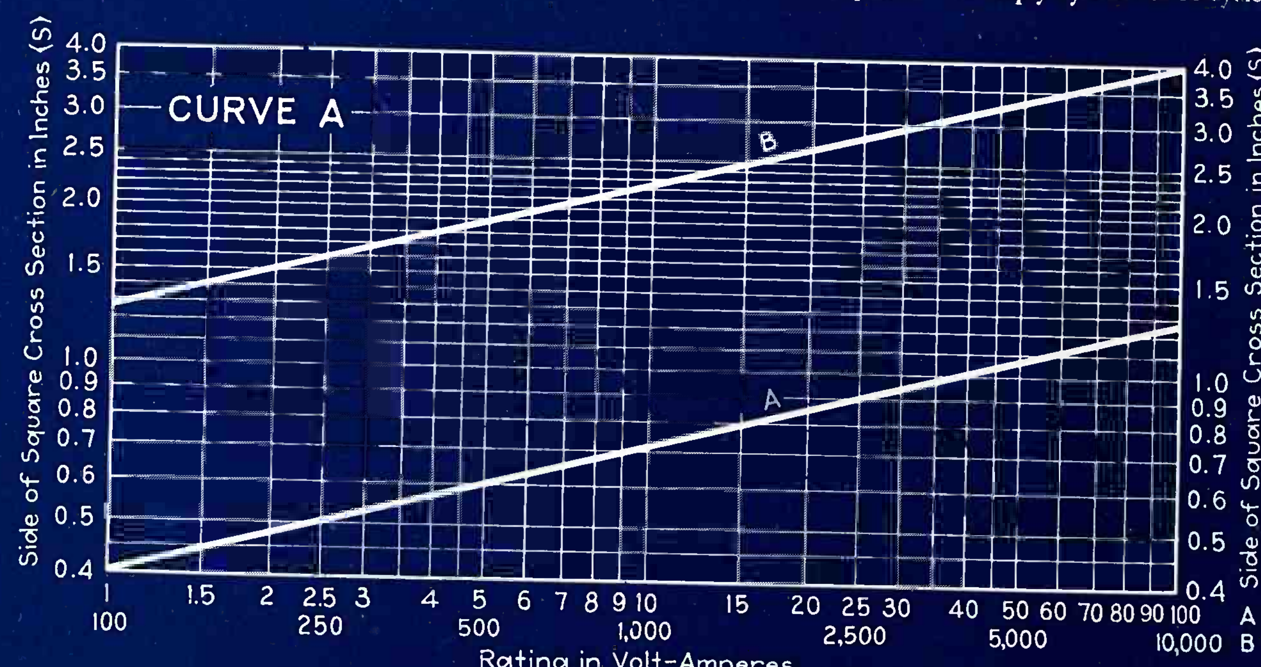


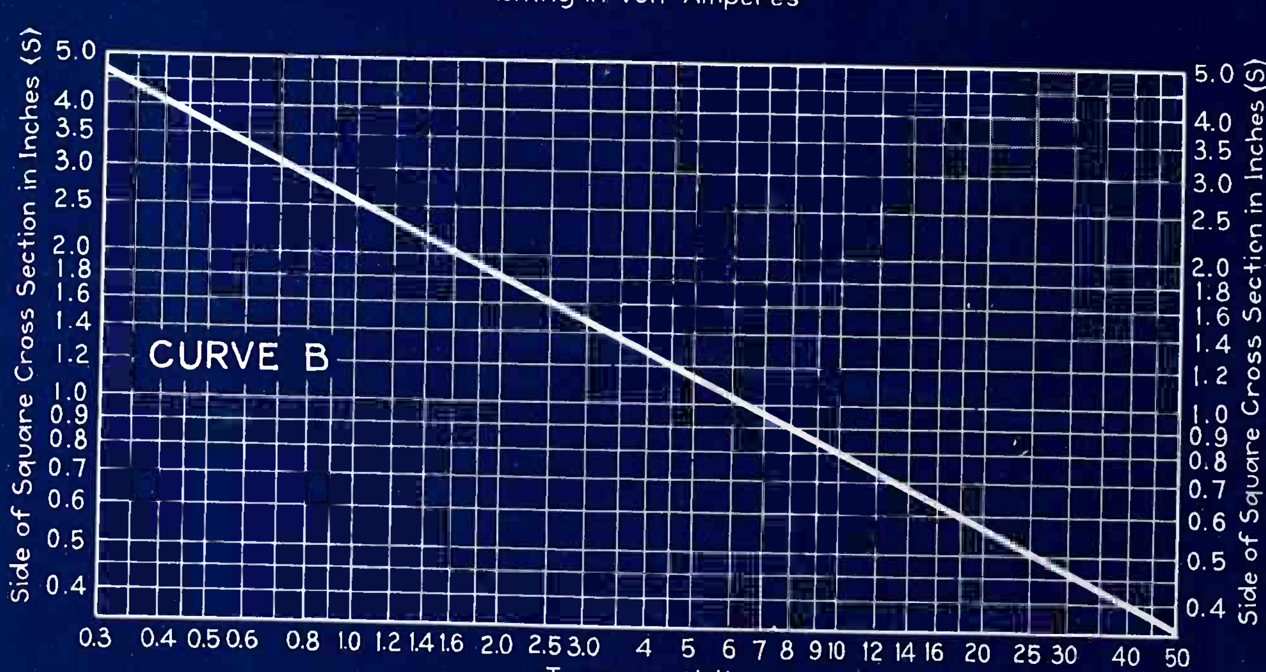
Core Dimensions

THE charts on this and the following page are reprinted from "Information for the Amateur Designer of Transformers for 25- to 60-Cycle Circuits," Circular of the National Bureau of Standards, No. C408, to which the reader is referred for detailed information. Copies may be obtained from The Superintendent of Documents, Washington, D. C., for five cents each.

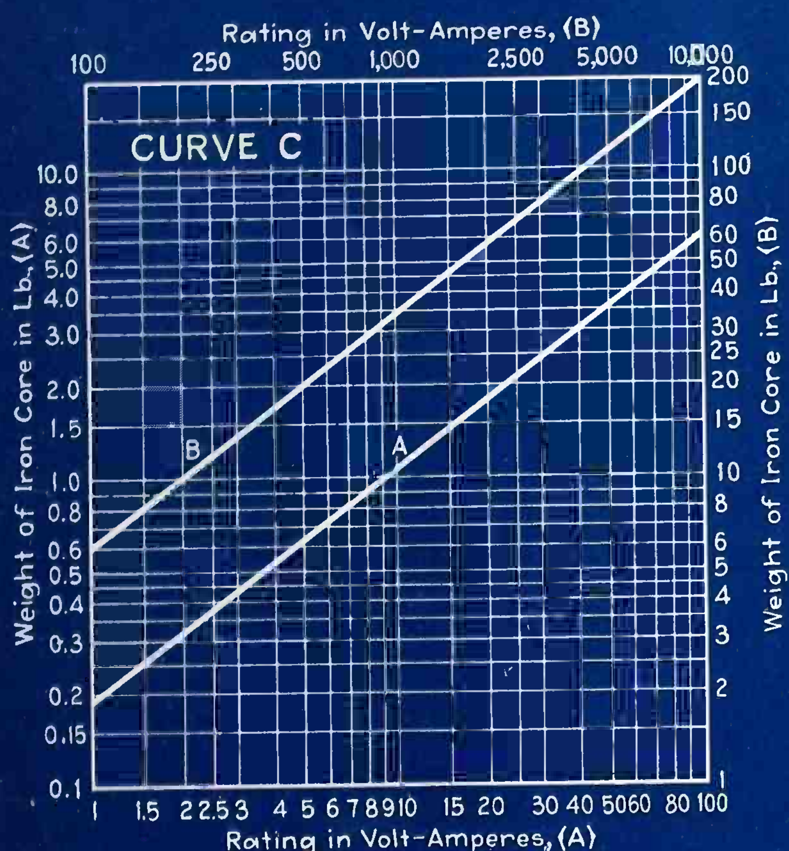
Directions for Use: Multiply the desired output volts by the desired output amperes to obtain the output volt-amperes. Refer to Curve A, find corresponding value of dimension S, which gives core dimensions, as shown to left (29-gage transformer sheets). Refer to Curve B find number of turns per volt corresponding to the value of S already determined. Multiply this figure by secondary voltage to find number of secondary turns; multiply by primary voltage to find primary turns. Refer to Curve C to find weight of iron core. Refer to Curve D to find wire size required for rated secondary current. Refer to Curve E to find efficiency. Divide rated output volt-amperes by efficiency to find input volt-amperes (unity power factor). Divide input v-a. by input volts to find input current. Find primary wire size by referring to Curve D.

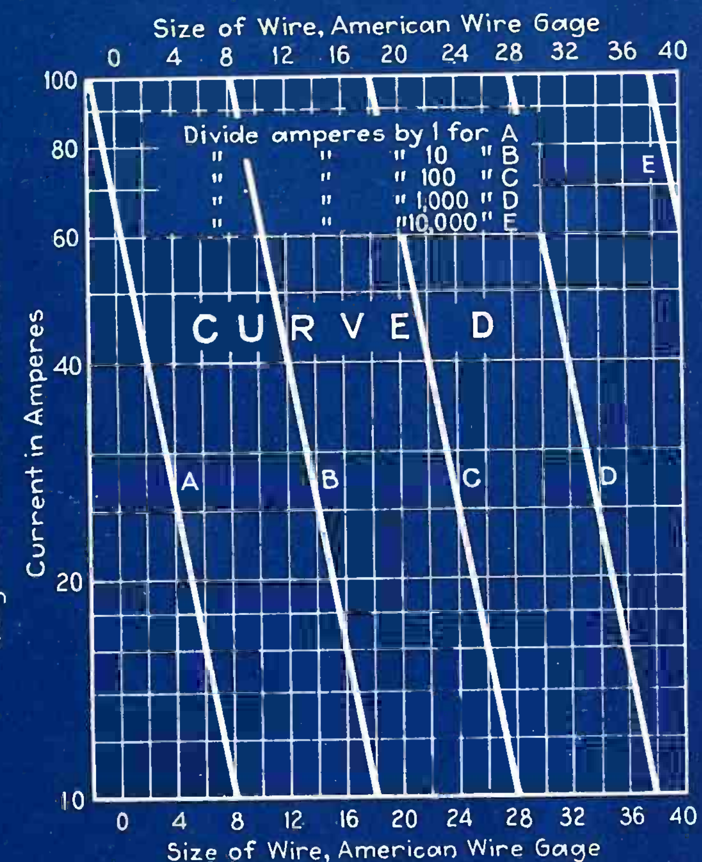
The resulting design is conservative; overloads of from 50 to 80 per cent may be carried indefinitely. Above procedure refers to 60-cycle transformers. Multiply S and turns-per-volt (obtained by above procedure) by 1.3 to get the required values for 25-cycle operation. Multiply by 1.06 for 50-cycle operation.

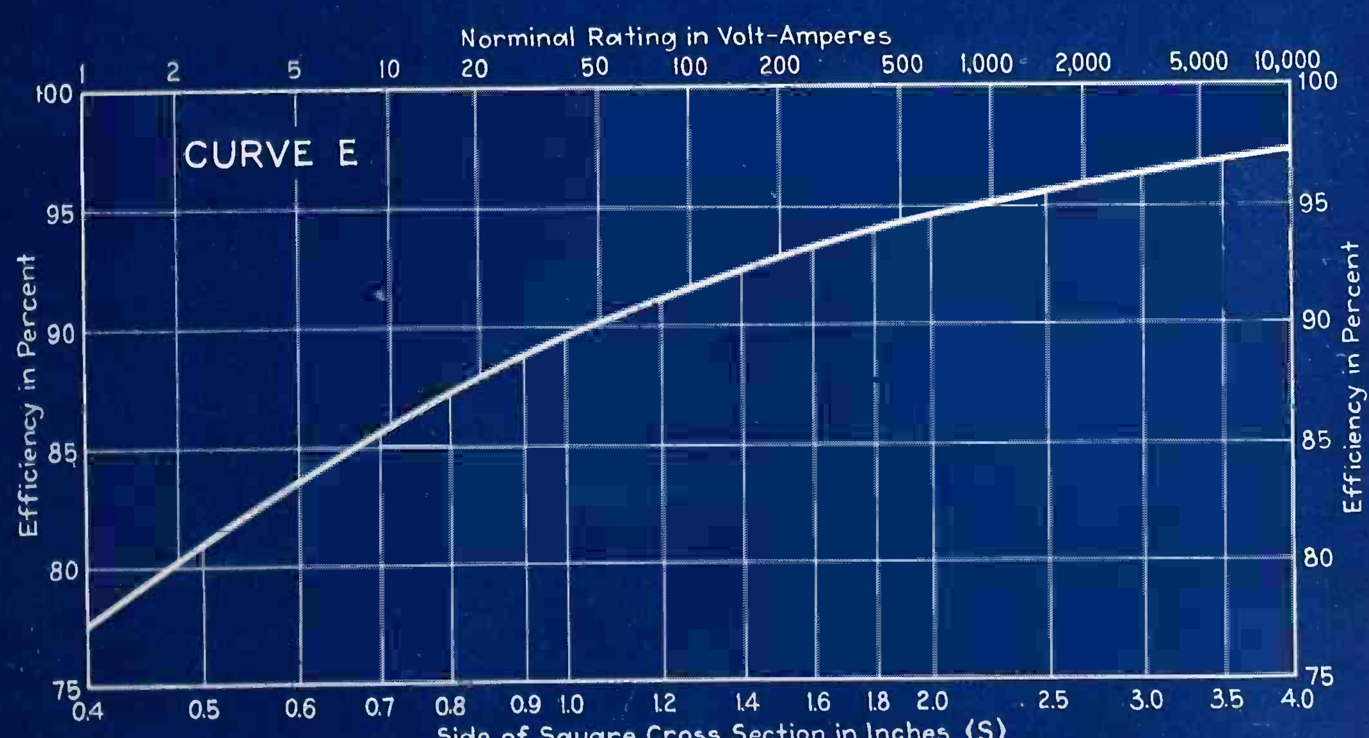




Charts for Transformer Design







The Centromatic Unit

A new Bosch radio in which coordination of the electrical and mechanical design is carried out to the advantage of manufacture, performance, sales and service

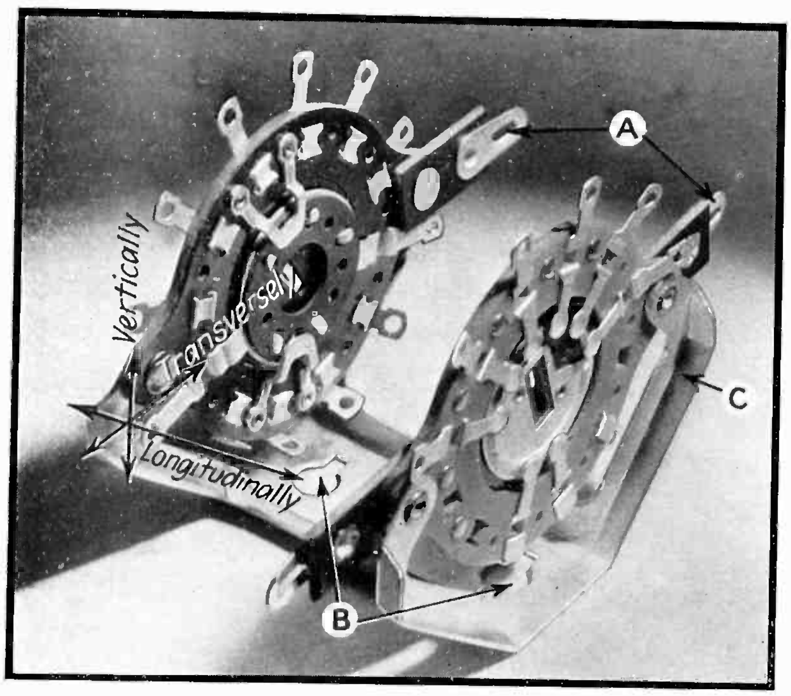
THE bane of the radio set manufacturer's existence, since the advent of multi-wave receivers, has been the problem of fabricating such receivers with some degree of uniformity—at a price. Partial production control has been established only by virtue of uneconomic measures in some cases tolerated and in others entirely neglected by the set manufacturer. This was due to the seemingly unending complexities of uncorrelated mechanical and electrical structures. A casual inspection of the bottom of a modern chassis will substantiate these observations. As a consequence, the service man has been unjustly condemned by the designing engineer. The American Bosch Centr-O-Matic Unit described here is the result of attempts to get around these troubles.

The unit consists of all the components comprising the radio section of a complete chassis from antenna to plate circuit of first detector; properly coordinated from the standpoint of optimum electrical performance and economical mechanical design. The inherent advantages of this structure are manifold and are detailed below.

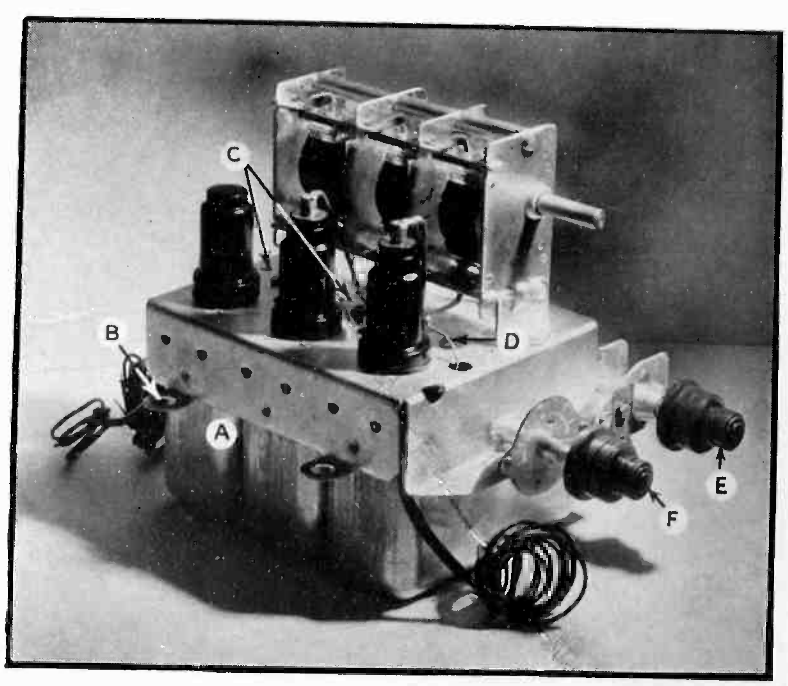
The fundamental disadvantages of past radio designs in multi-wave receivers have been non-uniformity of performance, lack of serviceability, uneconomical production control as well as uneconomical fabrication. The major portion of these troubles is due to the apparently essential tuned-circuit leads connecting the various components. Over these leads no great degree of control has been maintained as to length and position, among them introducing instability, non-uniformity as to calibration and performance, and multiplying the inevitable production troubles. Serviceability should be as important to the radio designer as antenna step-up and has been recognized only in a tolerant manner. Circuit components known to be critical as to proximity of physical interrelation were positioned at some remote point necessitating long interconnecting leads. This phase of the radio art has obviously stagnated and is the result of little or no coordination between the electrical and mechanical designers.

Preliminary requirements

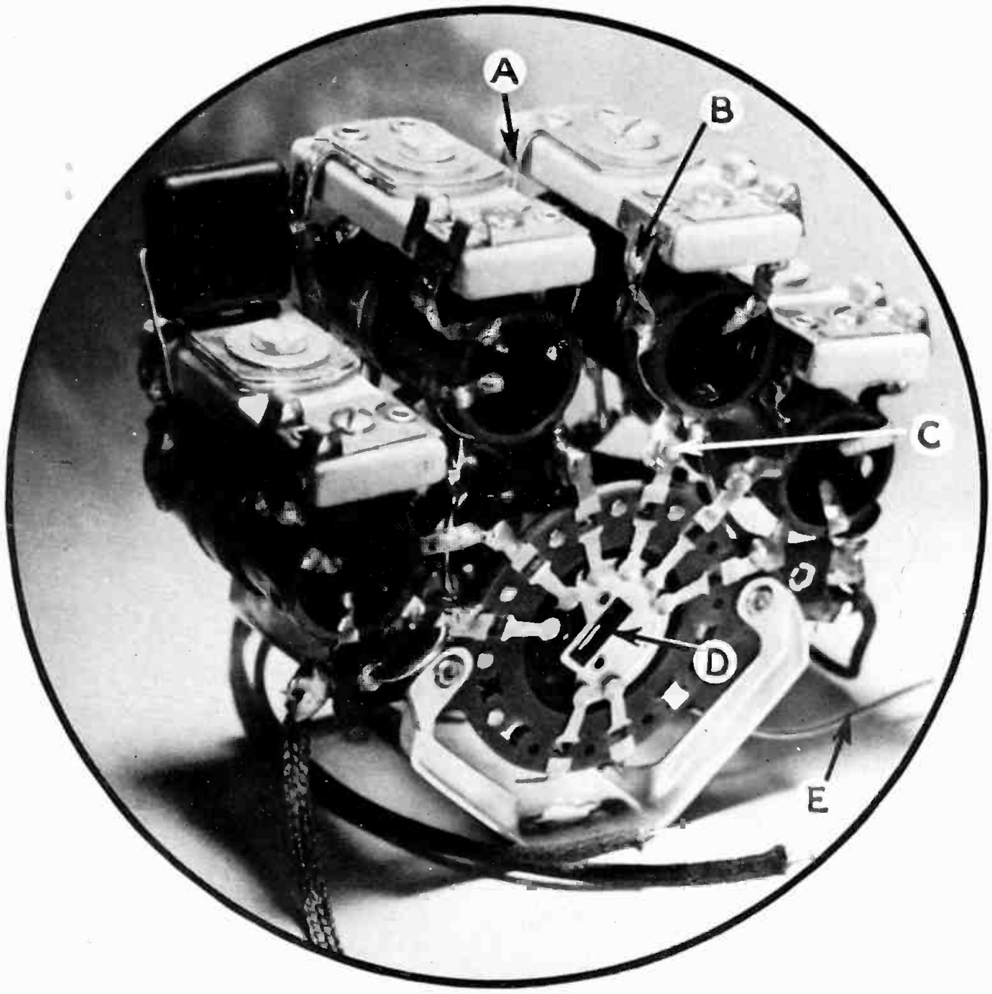
In the early stages of development that ultimately grew into the Centr-O-Matic Unit, certain fundamental requirements were set up as part of a program progressing over several radio seasons. These requirements consisted of first, a practical coil and switch assembly which could be manufactured as a sub-assembly in such a form that it could easily be tested and finally assembled to the chassis as a whole near its associated tubes and other components; second,



Bracket and switch assembly. Rigidity in three dimensions as indicated. A. Lugs for supporting resistors and bypass condensers. B. Dowel hole with key slot for locking assembly and for alignment. C. Bracket of pressed steel



Unit without dial. A. Interstage shields. B. Lugs with soft rubber shock-proof bushings. C. Extruded dowels for alignment. D. Bus connection from coil and switch. E. Tuning knob. F. Wavelength change switch



Oscillator section. A. Isolantite base. B. Condenser supported on coil by solder lugs. C. Coils supported by solder lugs. D. Rectangular opening for actuating shaft. E. Bus to stator, braid to rotor of gang condenser; insulated wire to sockets and power supply

that it be an advancement in the art from the standpoint of serviceability; third, that it afford a greater element of production control; fourth, that it be a more economical structure; and fifth, that no special tools need be designed for its fabrication. All the requirements stated were fulfilled. Yet the unit was not entirely satisfactory. Refinements dictated by experience in production and changes in coil design formulated the next advancement. After another season of constant contact with the design it was found that a reconstruction of premises must be made.

The fundamentals were:

a. The elimination of "hot" tuned circuit connecting leads wherever possible. This was dictated by the impossibility of maintaining in production a satisfactory degree of uniformity in the length and position of such leads. The use of bus-bar interconnecting leads was a step in the right direction, but did not approach the precision of a unit employing practically no leads.

b. Unit assembly of switch sections and coils to a greater degree than hitherto attained.

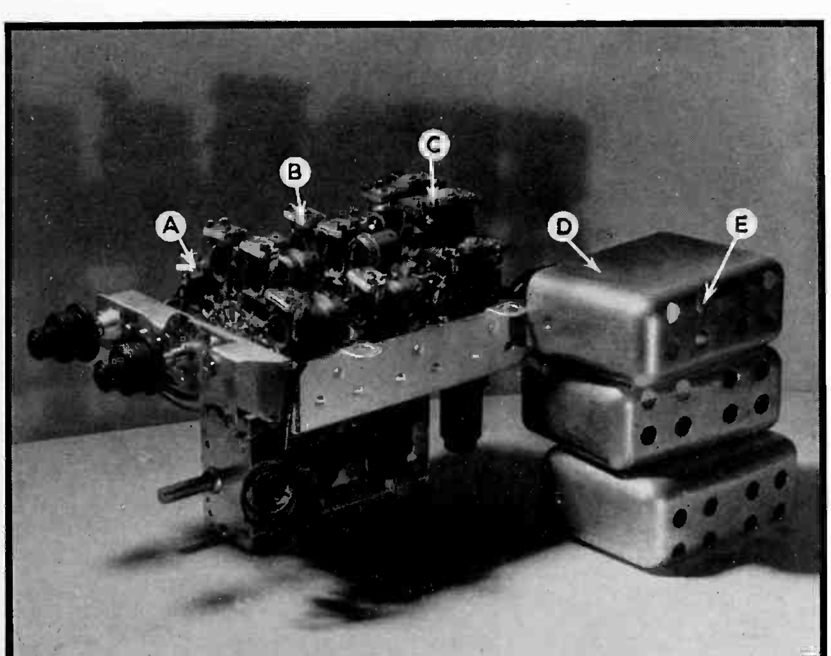
c. Complete serviceability of coil and switch assembly.

d. Integral assembly of coils, switches, tuning condenser, tube, sockets, tuning mechanism and band indicator.

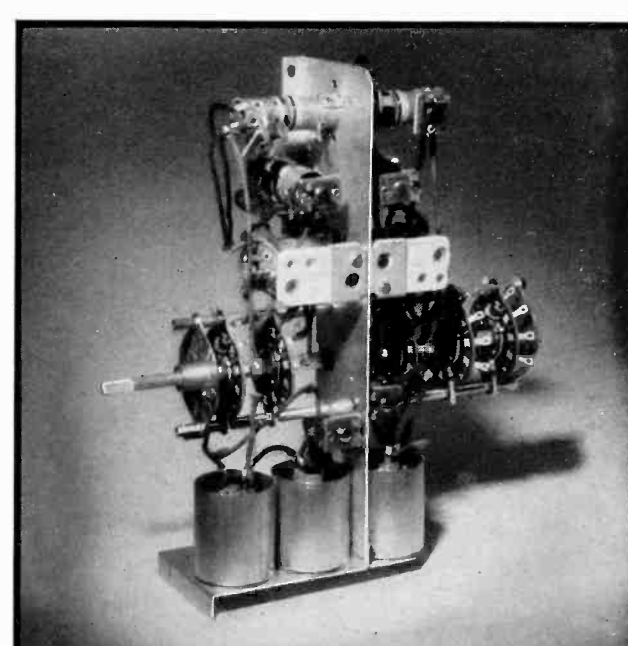
e. Standardization of coil forms and coil shields.

f. Standardization of mechanical structure to permit its use in a variety of receivers.

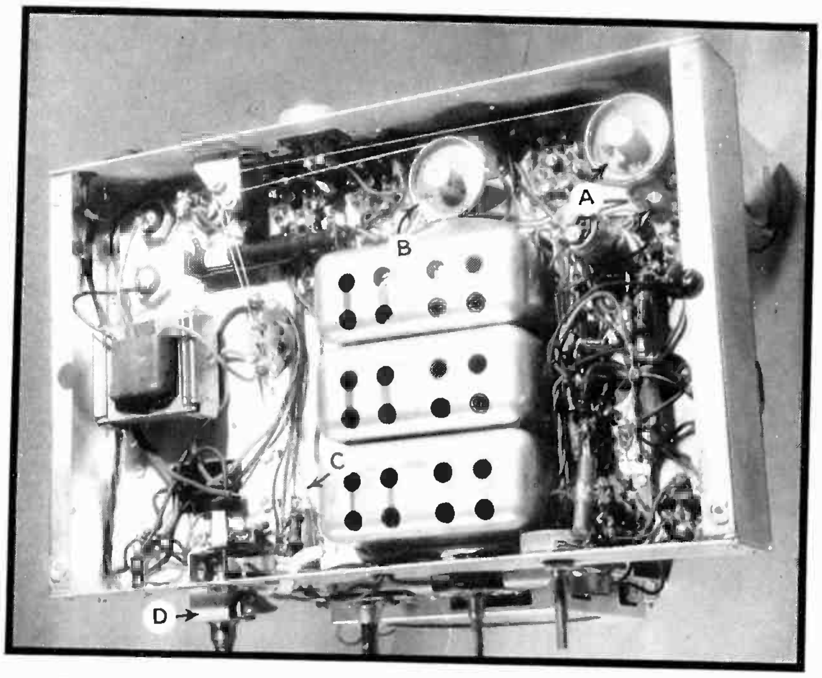
g. Development not to be handicapped by a lack of adequate tools or fixtures for fabrication or assembly. This was due to the possible distribution of the cost of such tools over a number of receivers; however, in adopting such a policy it was realized



Bottom view with interstage shields removed. A. Antenna section. B. R-F section. C. Oscillator section. D. Shields. E. Holes through which alignment is effected when shields are in place



Predecessor of the Centromatic unit. A complete coil and switch assembly as used in the Bosch radio receivers, model 480. This was followed by the unit described here



Bottom view, Bosch Model 595. A. Spiral spring coupled between pulleys and frame of transformers exerts a force in a direction to wind up the cords. B. Pulleys are on the shaft of the rotating coils of the variable selectivity i-f transformers. C. Cords. D. Cam and lever mechanism for changing bandwidth

that the costs of these items would have to be reasonable and justified.

h. All circuit alignment condensers to be in parallel planes, if not in an identical plane. This was thought to be a highly important and desirable feature from the standpoint of production adjustment.

After due consideration of these fundamentals, it was recognized that entirely new and revolutionary designs would have to be formulated. The starting point was the coil and switch unit, and over a period of months many designs were conceived.

Some of the salient features of the new design follow: the bracket supporting the switch sections was doweled so as to afford perfect alignment of a multiplicity of coil and switch units when used in tandem, any one unit being easily removable from the complete assembly, and secured to this assembly by only one drive screw. Soldering lugs were so disposed on coil forms as to allow their being soldered directly to corresponding lugs on the switch sections, automatically arranging the coils symmetrically about the switch section, excluding the usual interconnecting wires and forming a rigid medium of support for the coils at four points.

A single type of bracket and switch assembly accommodates all the individual functions of radio frequency, first detector or oscillator unit. All trim and combination trim and lag condensers were positioned in parallel planes and soldered directly to coil terminals, obviating the use of conventional supporting mediums. Coil forms were standardized; a common form being used for all of the r-f coils. This was a big factor in a reduction of costs as compared with conventional designs. The disadvantages of composite coils, such as relatively high shrinkage in manufacture, confusion of terminals, short leakage paths, and efficiency compromises, are well known.

The next step in the design of the unit was to correlate the coil and switch assemblies to their associated circuit components as an inherent part of a complete sub-assembly. This completed unit incorporated all the parts performing the r-f functions of a superheterodyne and was properly sound-shocked from the chassis main. The flexible mounting supports were widely separated to avoid the usual chassis-cabinet alignment problems and insure the absence of acoustic feed-back.

One of the features is a consolidation of frequency-indicating and drive mechanisms with gang condenser shaft. This relieves the design of manufacturing and service difficulties associated with devices having the condenser shaft at a remote point relative to the frequency indicating mechanism and utilizing so-called "monkey motions" for the mechanical link between the two. Much of the manufacturer's calibration troubles, due to lost motion and accumulative mechanical error, can be laid at the door of these monkey motions. Additional features were incorporated to ease the service man's job such as universal snap-on shields provided with sizable alignment holes and plainly marked in color to indicate the frequency band under observation (these colors corresponding to the colors used on the dial scale); a readily detachable switch-actuating member to facilitate in the removal of the individual switch and coil assemblies without disturbing these units; the elimination of at least 40 per cent of the wires usually found in the radio section of conventional chassis; compactness with complete serviceability, and simplification of adjustment.

The standardization of the Centr-O-Matic Unit was brought to such a degree as to allow its application in a wide variety of radio chassis. Only minor revisions were necessitated in accommodating the varying circuit requirements found in a line of radio receivers.

The electrical advantages of the design are unique. With the exclusion of the tuned circuit wires came a high degree of uniformity as to calibration and performance. The element of control is therefore increased, if one considers that the precision of the device rests only with the precision of its components and is no longer influenced by the presence of the uncontrollable interconnecting wires. These wires must be considered a vital part of the tuned circuit L particularly at the higher order of radio frequencies.

Owing to the nature of the interstage shields, an appreciable increase in coil Q was effected with its attendant increase in selectivity and gain. These shields were also responsible for additional stability because of the large area of contact utilized between shield and base. The utilization of shorting switch sections in shorting all coils, except the ones in use, deleted any probability of sensitivity "holes" through absorption.

Stray r-f currents were minimized by a careful control of circuit grounds, thereby increasing the inherent circuit stability and decreasing the usual number of decouplers and by-pass condensers used.

(EDITOR'S NOTE. *This material was prepared in conference between the editors and Bosch engineers.*

"Zero Level"

A conversation piece anent the ins and outs of broadcast control room problems, in which is questioned the present methods of "riding gain," indicating volume level; suggesting compressors and expandors, new "VI's," wider volume range

By W. N. WEEDEN

SCENE — Master Control Room of Broadcast Station WOOF
TIME—Late Summer PM.
CAST—Day Supervisor—Joe Smith—at Master Control Board, and Jim Brown — Control Engineer with enthusiasm, but not much experience.

ALL quiet in the Master Control Room for the first time in weeks, thinks Joe Smith. The station log is up to date, program sheet corrected, four telephones answered simultaneously, tests conducted with the man at remote from which next broadcast will originate, and program, which will run for half hour (if all goes well) has been switched. Fills and lights pipe, and settles himself more comfortably to contemplate the joys of a trip to the beach on his next day off—if the weather is good; or perhaps to wonder whether he will be able to make the 6:07 from Grand Central Station or whether the Chief will stop him on the way out.

At this point, the serenity is marred by the entrance of our second character, Jim Brown, fresh from a three hour rehearsal of a symphonic program. Having a few minutes on his hands before his next show, and sensing that this would be a good opportunity to approach his boss with a problem that has been on his mind for some time, he opens up.

The commercial wants it loud—so does the announcer

"Say, Joe, that Beethoven symphony the orchestra's going to play tonight sounded swell—too bad that the public won't hear it the way it sounded in the control room during rehearsal with no 'gain riding.' When it goes on the air tonight with the soft passages brought up 10 db, and the peaks cut down 10 db, I'll feel like a butcher. If the conductor only knew that half of the dynamic range he worked so hard at would be whittled away by the fader, do you suppose that he would insist on the boys paying so much attention to their pianissimos and fortissimos? Hang it all, Joe, why can't we put it on the air as is? I don't believe any harm would be done—it sure sounded swell on the monitor speaker."

"Yes, Jim, I agree with you about putting out most classical music as is. Of course, if we had to handle Oshkosh Symphony Orchestra with 110 men, we would have to ride again on it, because its dynamic range is probably 60-70 db, whereas the finest station today can't handle a range of more than 55 db. With a hand picked telephone line from studio to transmitter, if you're feeding a network, the best you can do is 40 db, but there are enough old lines in use to limit to 30 db. Therefore, we have to bring up the lows, and cut the crescendos. However, with programs like the symphony tonight from our own studio, with the 30 piece house orchestra, I don't believe that the volume range would exceed 40 db, so you shouldn't have to touch the mixer."

"That's swell—I didn't expect you to agree with me. If you had only heard the climax to the last move-

In rehearsal the soprano holds herself down—but on the air she hits plus 4

ment—why it just held you spellbound. When you think of the music lovers who listen to these programs, it seems a pity to cut the dynamic range to the point where all of the emotional stimulation you'd get out of actually listening to the orchestra just isn't there, any more than it would be if you took any number of high school orchestras, or fair conductors who are without the genius to call forth the wide variety of emotion expressed by the composer. In other words, of course, the notes might all be played correctly, but the music would leave you cold just the same."

"Sure," interrupted Joe, "I've been through the mill too, and the most impressive demonstration I ever attended brought out the importance of music's dynamic range in a way that I'll never forget. That was the Bell Labs' binaural system that was as nearly perfect as possible with their knowledge and facilities. That was a comparison that few of us had experienced previously. Don't get the idea, though, because I agree with you about the value of the dynamic range of a good orchestra, that putting it on the air is simple. For one thing, the sales and commercial departments like to see the best coverage of the service area, which means that with carrier power fixed, the higher the average modulation, the better the signal. Also, don't forget that 99.44 per cent of the listening public are using inadequate receiving equipment—much of it ranging from sets 5 years old to the modern cigar-box or ultra midget receiver from which little can be expected in the way of faithful reproduction.

What Do the Listeners Want?

"Then, how many listeners have available 15 watts of undistorted power?" Joe continues. "Wait—don't interrupt me—you were going to say, 'Who wants 15 watts in an average living room?' Well, to handle a volume range of 25 db, which is about what we put out at present, the receiver, with a fairly efficient dynamic speaker, is required to supply from 25 milliwatts to about 18 watts on peaks. This amount of power is necessary to give a pleasing average level in a room 15 feet square. Now, granted that you have a fair number of listeners equipped with receivers of this type, you can see that if the range is to be further increased to 40 db, which we should be capable of transmitting, several factors will have to be taken care of at the receiver. Noise of all sorts will have to be greatly reduced—including set and room noise, so that signals of much lower value than the previously mentioned 25 milliwatts can be heard. Also, it will be necessary to train the neighbors so that they don't holler too loudly at the 18 watt peaks, particularly during the summer—when we have our windows all open. What's more, most people only want background music, something loud enough so they can't quite hear their wives read them the evening paper, or to make unnecessary any intelligent conversation. And what's more—"

"Wait a minute, Joe—You're running out of wind. I had no idea what I was letting myself in for when I started this argument. Ten minutes ago, you mentioned high average modulation in connection with coverage. When I first came into the station, I watched several of the fellows handling orchestral programs, and with the orchestra only coasting along, the VI would be kicking—2's" (Editor's note—*"VI," studio jargon for volume indicator. At the moment there seems to be no uniformity as regards VI practice. There are vacuum tube voltmeter devices with a linear scale reading from 0 to 50 with 30 corresponding to the "zero" referred to here. There are other rectifier type instruments reading 0 at some point, apparently corresponding to the maximum permissible modulation but with readings to +4 and down to about-8. The level is maintained so that voice peaks reach-2 and music peaks reach +2.*) "Then as the orchestra took a crescendo, the engineer would have to crank down the gain as fast as the orchestra power increased. This flattening of the peaks to a point where there are no appreciable increases in volume disgusted me, so that when I worked on a similar program, I would start off with the fader several steps lower, so that there was plenty of room for the orchestra to build up, without having to decrease the gain. In fact, I've worked on the principle that if the fader is set so that the orchestra peaks come up to zero, or plus 1, then it could be left pretty much alone on orchestras having no more than 30 men, but there were plenty of times when the Master (Master Control Operator—*Ed.*) would call me on the phone and tell me that the VI hadn't hit zero for several minutes, and what was the matter with me, and wouldn't it be a good idea to bring it up a few db? Well, just about then the orchestra, which had usually been pretty low for several minutes would suddenly bring up their level with a bang—and I'd be holding the bag, unless I was able to whip the fader down fast enough to prevent the VI from going up to plus 10, and you know how that sounds."

Control Men Should Know Their Music

"Of course, Jim, we've all been through that. The trouble with some of these supervisors, and men at the transmitter, is that most of them got into the business in the early days when a 500 watt transmitter was something to write home about. To ride over normal noise levels, such transmitters had to be operated as near 100% modulation as possible. But I'm not the boss, so I guess we'll have to struggle along."

"Yes, Joe, it looks as though we would have to make the best of it. There's another thing I just thought of. Very few of the control men seem to get any kick out of classical music, and in fact some of them act as though they were suffering when working on such a show—or at least bored to death."

"That's an angle I hadn't thought of, Jim. It probably explains why they ride gain the way they do. If you don't appreciate what the orchestra is trying to do—it probably seems OK to chop the peaks, and pull up the lows, although you may be neutralizing all of the work of the orchestra leader. It looks as though you should use men who know and care for fine music on that type of program if you want to get the most out of it. Perhaps the stations in the future will conduct classes in musical appreciation for their engineers and production men, Joe. What do you think of that idea?"

Hail to the production men

"That's fine, except that you wouldn't include the production men, because they already know everything. That's one of the things about this business that gripes me the worst. You take a production man with no training, background or what-have-you, and make him responsible for mike placing—when he doesn't know half as much about acoustics as the engineer. Of course, I'm not saying that a lot of the engineers know as much as they should—but I'd bet on them every time. Then they (production men) sit beside you when you're running a show and tell you 'bring up the climax'—'bring it up,' when it is probably kicking plus one or two right then. If you point that out, he'll say—'Oh, that's OK, that won't wreck the transmitter, I want that climax brought up nice and full.' What's 10 db to him?

"And there's another thing too, Jim. Even if everybody in the station agreed to transmit a 40 db range, how are you going to be sure what is —30, —40 or —50 db with our meters? With half to two thirds of the scale giving a range of 4 to 10 db, you're lucky if you can estimate —20, let alone the values mentioned above."

"That's right, Joe. I hadn't thought of that. Well, I have seen VT voltmeters described which would be ideal for the job. Ballantine and others have developed meters which cover a range of 30 to 50 db with nice open scales—each 10 db occupying the same amount of space on the scale. They were designed for recording acoustic measurements, loud speaker curves, and percentage modulation, and they should make swell VI's although I don't know anything about their dynamic characteristics.

"I agree with you on that, Jim. Until recently, I took it for granted that the VI gave a true picture of the power produced by different sounds, but I have been reading lately some papers from the Bell Labs, showing that on speech certain sounds may be at least 3 db higher than the VI indicates. It looks to me as though the only answer would be a cathode ray tube with calibrated screen. That would give a true picture of all sounds up near 100 per cent modulation, but we would have to depend on your logarithmic VT voltmeter to show whether a weak sound was within the 40 db limit, or whether it should be pulled up a few db to be safely above the

[*Continued on page 60*]

The control operator has too many bosses: the production man who runs the show, the man from the advertising agency who wants the announcements loud, and so on

Industrial High Frequency Power

The design of a 20 kw. master-oscillator controlled-tube converter for providing industrial power at 7 to 10 kilocycles, with a brief review of its many uses. Comparison of the MOPA with alternators, spark-gap converters and self-excited oscillators

By H. V. NOBLE
Gulf Research and Development Corporation, Pittsburgh

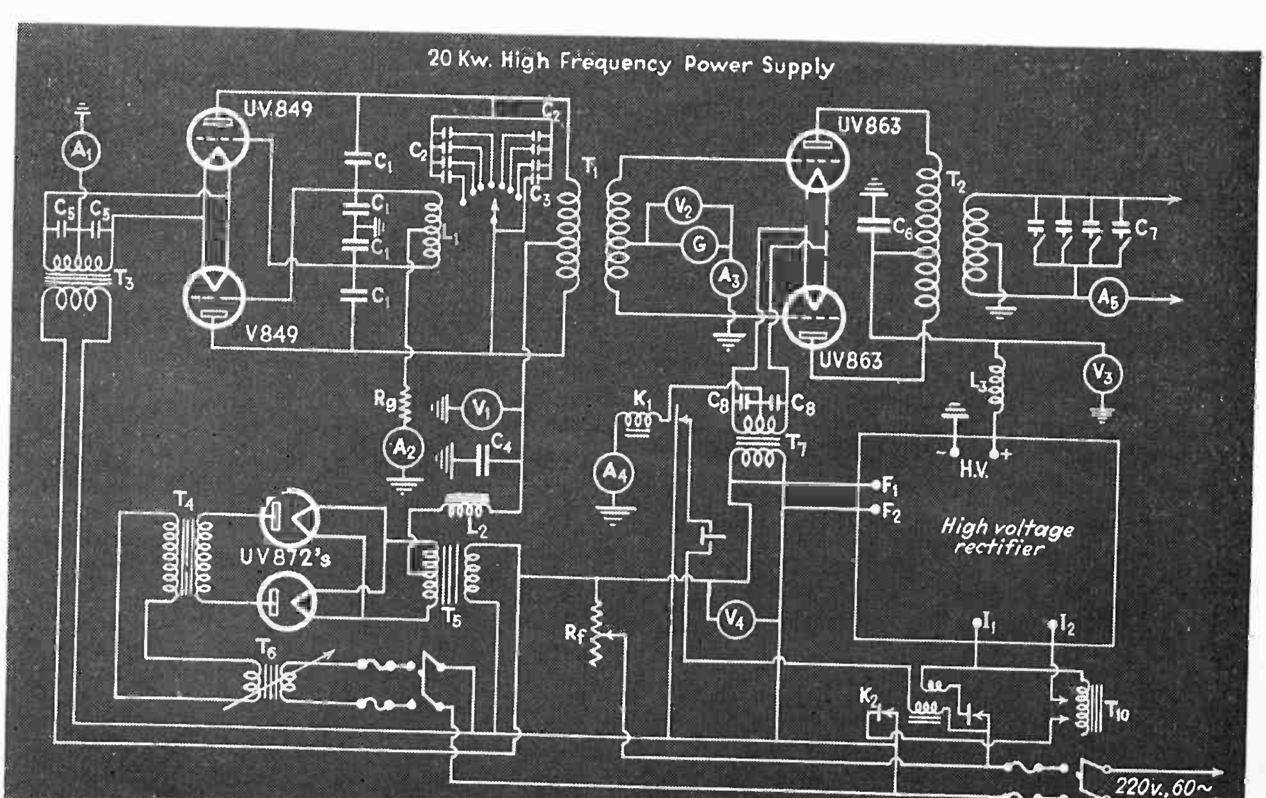
OF THE several different types of converters now available for the production of industrial power at high frequencies, the master-oscillator power-amplifier type of tube converter seems to have the highest ratio of advantages to disadvantages. The high-frequency alternator, while producing an output of high effective value, is bulky, requires a source of high-speed driving power, and is limited to frequencies of 10,000 cycles or under. The spark-gap converter is small, operates at high frequencies, and is comparatively inexpensive, but its power output is limited because units cannot be in parallel, and because the effective value of the highly damped oscillations is small.

The self-excited oscillator, more flexible than the alternator or the spark-gap type, is comparatively inefficient and suffers from loss of output at heavy loads, due to spurious parasitic oscillations. Power factor correction in this type of oscillator, while essential, is expensive because of the high voltages encountered. In addition the self-excited oscillator changes frequency with variations in the effective load, such as occur when the charge of an induction furnace heats up. In addition, there is a practical and economic limit to the lowest frequency for which a self-excited oscillator can be built.

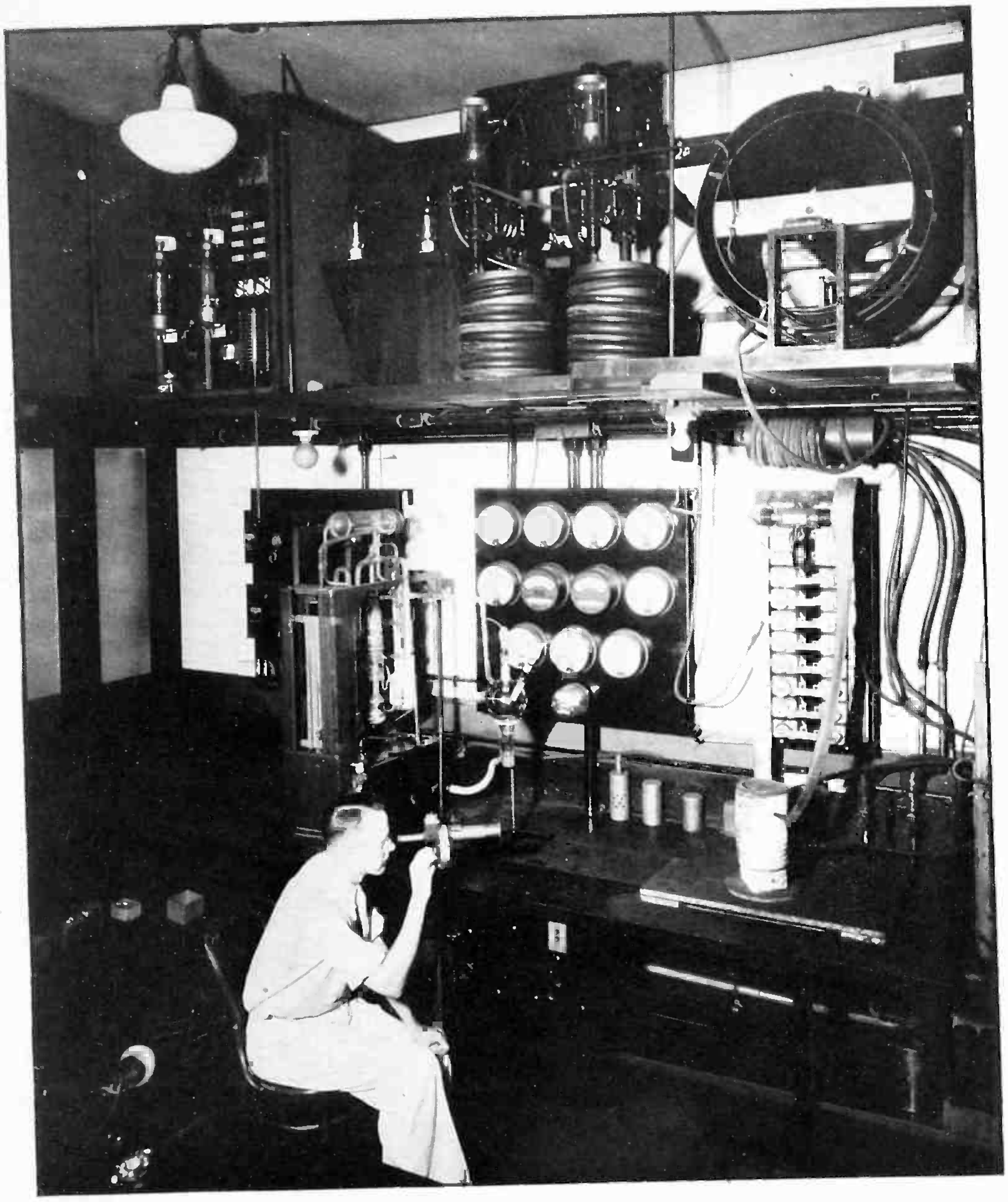
The separately-excited tube converter (MOPA), however, will continue to supply a high effective power at the same frequency regardless of the load, and is therefore similar to the rotating machine. The tube converters are capable of supplying power economically from a frequency of 5,000 to 10,000,000 cycles or higher at efficiencies of 70 to 80 per cent, up to 1,000 kw.

Sometime ago it became necessary to supplement a 20-kw. 10,000-cycle alternator with additional high frequency power. The cost of another rotating machine was prohibitive at the time so a vacuum tube type converter was considered to see if it would be practical and economical.

In this design it was sought to keep as many of the advantages as well as to eliminate most of the disadvantages of the previously mentioned high frequency power sources. In the first place, the design was to be so standardized that it might be used for any frequency with any amount of power at high efficiencies with a minimum of changes in circuit and apparatus. In the second place, the power supply was to be such that the rated output could be put into the load although the load power factor might be as low as 10 per cent. Thirdly, variation of load during operation should not affect either the frequency or power output. Lastly, the efficiency was to be relatively high.



Circuit diagram of the 20 kw. master-oscillator power-amplifier



The high frequency generator used to heat a charge in a crucible, in the Westinghouse Laboratories. The output transformer is shown at the upper right, with the amplifier tubes to the left

The best solution of the problem seemed to be a vacuum tube master-oscillator power-amplifier arrangement receiving power from 220- or 440-volt, single phase, 60 cycle line and delivering high frequency power at a variable voltage (600 volts maximum in this design). In such a design the excitation frequency and excitation power to the amplifier is supplied by the master oscillator which was practically isolated from the load and is, therefore, not affected by changes in the load. The power amplifier supplied power by means of an untuned transformer to power-factor correction condensers which were connected across the transmission line delivering power to the load. Since the output transformer was untuned the amplifier was operated as a push-pull or full wave "Class B" amplifier.

Since two tubes were required for the push-pull power amplifier, and the output was to be 20 kw., the amplifier tubes used were of the water-cooled 20-kw. type. Of these, the UV-863, because of the low bias required, was the best adapted economically for this particular service. The maximum plate dissipation rating for the UV-863 was 10 kw. Thus, with 50 per cent efficiency, the maximum output possible was 20 kw. for two tubes. It was designed, however, to maintain the efficiency above 60 per cent at all times which meant a maximum output of at least 30 kw.

The average excitation power necessary for the above tubes at maximum output was estimated to be about 500 watts or less. This power could be supplied best by a push-pull master oscillator using two UV-849 tubes which have an output rating of 350 watts each.

Since the power output of a "Class B" amplifier is proportional to the square of the grid excitation voltage, the output power could be controlled excellently by regulating the supply voltage to the master oscillator by means of a small hand-controlled voltage regulator.

Master-Oscillator Design

Power Rating: 500 watts
Frequency Range: 7,000 to 10,000 cycles
Tank Capacity—(C_1; C_2; C_3). (See diagram for symbols.)

Since UV-849 tubes would be used in a push-pull oscillator with a plate supply voltage of about 2,200 volts maximum, the maximum r-m-s voltage E across T_1 would be about 2,500 volts.

If the output power P is 500 watts, the equivalent resistance, R, on the input side of T_1 is:

$$R = \frac{E^2}{P} = \frac{(2,500)^2}{500} = 12,500 \text{ ohms}$$

For good design and stability, the circulating (reactive) power in the tank circuit (in volt-amperes) should be not less than 20 times the output power in watts, i.e.;

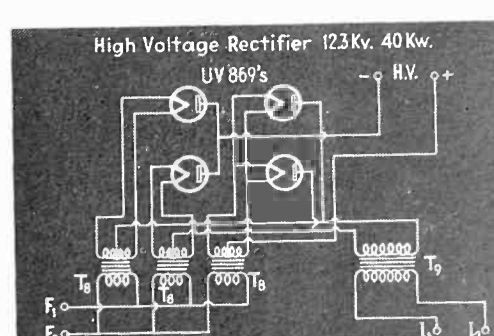
volt-amperes = 20 × watts.

$$\therefore 2\pi f\, CE^2 = 20\, \frac{E^2}{R}$$

$$\therefore 20 = 2\pi fCR$$

where f is the frequency and C is the tank capacity.

For the upper limit, $f = 10,000$; $20 = 2\pi \cdot 10,000 \cdot C \cdot 12,500$ or $C = 0.0265\ \mu fd.$, for the high frequency-limit.



High voltage power supply for h-f generator

The capacitive reactance $x_c = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 10,000 \times 0.0265}$

or $x_c = 602$ ohms

at resonance $x_c = x_L$

∴ the tank inductance $L = \frac{602}{2\pi f}$

$L = 0.0096$ henry.

For the lower limit $f = 7{,}000$; $x_L = 2\pi\ 7{,}000 \times 0.0096 = 422$ ohms $= x_c$ at 7,000 cycles

∴ $C = 0.0538\ \mu fd$; for the low frequency-limit

This capacity at this frequency would give a circulating power to

output power ratio of $\frac{12{,}500}{422} = 29.6$

which is a satisfactory value.

The capacity change from 7,000 to 10,000 cycles was from 0.0538 to 0.0265 μfd. i.e. 0.0273 μfd. This change could be made in 9 steps of 0.003 μfd. each.

Thus C_2 = nine 0.003 μfd. condensers.

C_1 consisted of four 0.03 μfd. condensers in series for grid excitation. This made an effective tank capacity

of $\frac{0.03}{4} = 0.0075\ \mu fd.$

$C_3 = 0.0265 - .0075 = 0.019\ \mu fd.$

Actually $C_3 = 0.02\ \mu fd.$

Tank Inductance — T_1

From a Bureau of Standards formula.

$L = \frac{0.0395\ a^2\ n^2\ k}{b}$ = inductance in microhenries.

where a = radius of coil in cm.,
b = length of coil in cm.,
n = number of turns in the coil

and k = a function of $\frac{2a}{b}$; in this case = 0.82

choose a = 15 cm. = 6 in.,
b = 60 cm. = 24 in.

L must equal 9,600 microhenries

∴ 9,600 =

$$\frac{0.0395 \times 225 \times 0.82\ n^2}{60} = 0.114\ n^2$$

∴ $n = 294$ *turns*

A peak swing of 2,400 volts was necessary for exciting two UV-863's i.e., an r-m-s voltage of 1,700 volts across the secondary of T_1. Assuming a coupling factor of 0.8, the number of secondary turns =

$$\frac{1{,}700 \times 294}{2{,}500 \times 0.8} = 250 \text{ turns}$$

Tubes—Two UV-849 tubes rated at 350 watts each supplied sufficient power.

Power Supply—The plate power supply was obtained from a full wave rectifier capable of supplying 2,200 volts at 0.5 amp.

Filament Supply — The filament power was supplied by suitable transformers from the a-c power lines.

Output; 20 kw. at 600 volts across the load, 7 to 10 kc.

Tubes—Two UV-863 tubes operating as a Class B push-pull amplifier with a plate voltage of 12 kv. will deliver sufficient power.

Output Transformer — Assuming an input a-c voltage of 15 kv. and an exciting current of 0.25 amp., then the inductive reactance is:

$x_L = 15{,}000/0.25 = 60{,}000$ ohms.
$L = 1.365$ henries

A four layer coil of 400 turns each with a diameter of 24 inches and a length of 30 inches wound with No. 18 dcc wire was of the proper value.

The 600-volt output coil was wound with ¼-inch copper tubing for water cooling and consisted of two 40-turn coils.

Power Factor Correction Capacity — C_7. Assuming the minimum power factor of the load = 10%.

$$\text{k.v.a.} = \frac{\text{kw.}}{0.10} = \frac{20}{0.10} = 200 \text{ k.v.a.}$$

$$\therefore x_c = \frac{(600)^2}{200{,}000} = 1.8 \text{ ohms}$$

$$\therefore C_7 = \frac{1}{2\pi f x_c} = \frac{1}{2\pi \times 7{,}000 \times 1.8} =$$

$$12.6\ \mu fd.$$

This was made of thirteen 1-μfd. condensers.

Power Supply—A full wave rectifier capable of supplying a voltage of 6 to 12 kv. at 3 amperes was used.

The apparatus is silent in operation and small enough to be placed on a shelf about 3 feet wide and 15 feet long near the ceiling in a room where the power is used.

ED. NOTE: *Original ms. prepared at Westinghouse Electric and Manufacturing Company Laboratories, Pittsburgh.*

USES FOR HIGH-FREQUENCY POWER

► ONE OF THE most important uses of high frequency energy is the melting or heating of metal or ore charges in induction furnaces where the charge is put in a crucible or suitable container inside a coil carrying alternating current. Eddy currents set up in the charge heat it by I^2r loss. If the charge is magnetic, hysteresis losses aid in raising the temperature.

Induction furnaces are of two types: the crucible is non-conducting electrically (the heat comes from the charge itself) or, the crucible is conducting, as graphite (the heat comes from the I^2r loss in the crucible.) The latter type is essential for such charges as pure copper where the heat developed by the low-resistance charge is small.

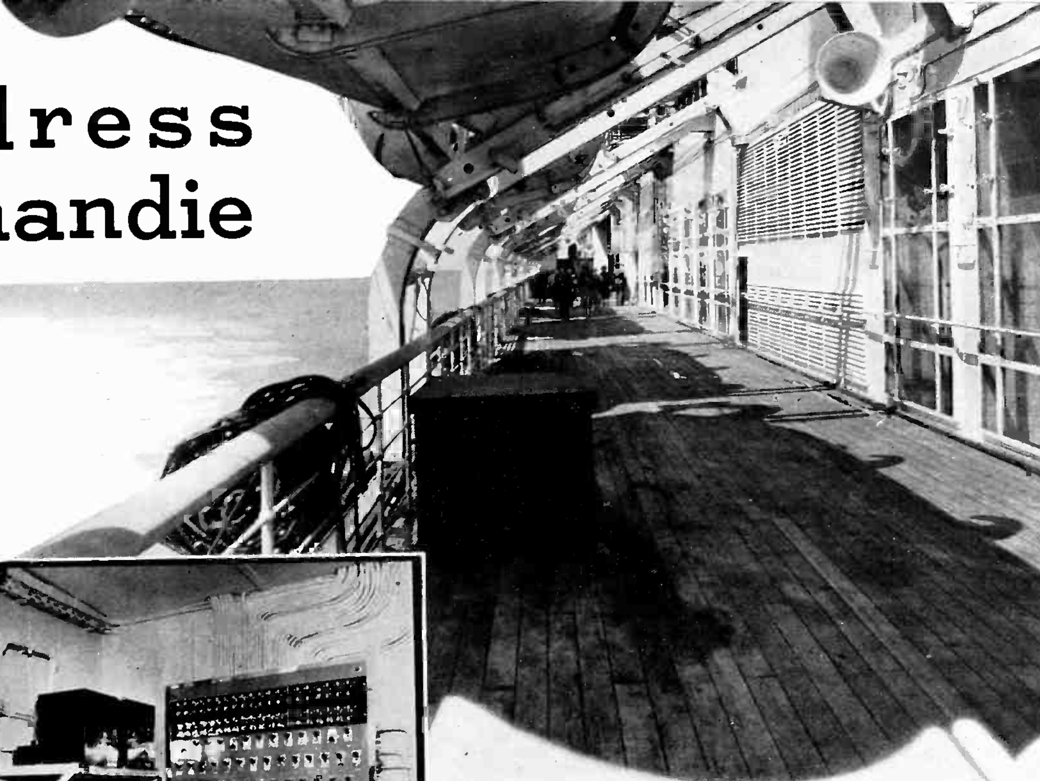
High frequency furnaces offer many advantages, namely: freedom from contamination of the melt, high temperatures obtainable, circulation of the molten charge by the electromagnetic forces within it, the possibility of use in a vacuum or controlled atmosphere, and ease of repetition in the duplication of alloys and refining of metals. Such furnaces have been used considerably in the laboratory on the small scale, but it is only recently that large capacity furnaces have been used in production work, the main delaying force being the high cost of the high frequency power supply.

► A rather unusual use of induction heating is the drying of paints and enamels on metal surfaces. The metal, covered with fresh paint or enamel, is placed in a high frequency field and the heat generated in the metal dries the coating from the inside to the outside thus permitting gases and vapors formed during drying to escape through the outer surface while it is still soft, thus avoiding tiny pits. Enameled metal treated in such a manner has a much higher gloss and harder surface than when the enamel dries in the usual way, from the outside to the inside.

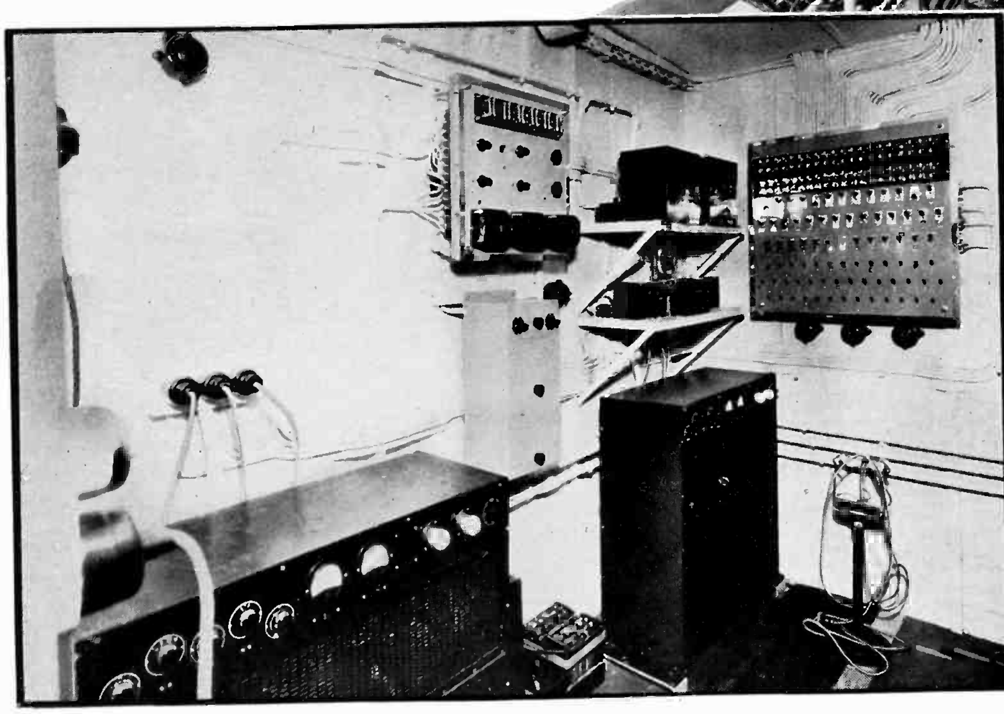
► Another use of high frequency is in arc welding. Sixty cycle power is unsatisfactory because the arc dies out when the current goes through zero. With high frequency, the arc does not have time to deionize through the zero part of the current cycle and is thus established continuously as in the case where direct current is used. Sixty cycle and high frequency may be blended for arc welding so that the arc is maintained by the H.F. during the zero part of the sixty cycle current and the major portion of the welding power is supplied by the low frequency during the active portion of the cycle. Choke coils and condensers are necessary to separate the power supplies.

Public Address on S.S. Normandie

World's greatest ship is fully equipped with loud speakers and microphones



Installation on the boat deck (Pont des embarcations).



Views of the control room from which records are played. Power equipment, turn tables, amplifiers, loud speakers were supplied by Philips.

Loud speakers in wall of the winter garden.

In the tourists salon there are loud speakers, too. On board the Normandie there are 74 loud speaker outlets with the possibility of picking up the output from any one of 7 microphones distributed about the great ship.

The "Petoscope"

A new principle in photocell application which, more nearly approximating the popular "electric eye," will detect moving objects in full daylight. Aircraft in flight, speeding automobiles, pedestrians violating "keep off the grass" signs come under its control

By

ALAN S. FITZGERALD

READERS of ELECTRONICS are by now well acquainted with the multitude of uses to which light-sensitive devices have been applied in recent years. In a large proportion of the systems and devices in which photo cells are employed, instrumentalities of various kinds are actuated by the interception of a beam of light by a person, vehicle or other object. The opening of doors, control of traffic, and the counting of factory products on a belt conveyor are typical applications in this category.

The general public and the lay press are accustomed to describe any contrivance which makes use of photoelectric principles as an "electric eye." This designation, though it may be appropriate in some cases, is less apt in the case of systems of the light-beam interception type. In this type of application, unless the object moves precisely in a known path and appears at an exact position, the "electric eye" doesn't see it.

The human eye, on the contrary, is conscious of objects lying anywhere within an extended field of view. We are aware of things and events even if we are not, at the moment, looking directly at them. The photo cell in these applications has no wider range of vision than an immovable eye looking through a fixed piece of pipe. But the living eye is capable of perceiving a visible effect representing a small part of the field of view and having an indeterminate position in it.

The "Petoscope" represents a radically new and different method of applying the photo cell. It is an attempt to use light-sensitive apparatus in such a way that its action is much more nearly comparable to an organic or biological eye, so that photo-electric apparatus may be employed for purposes which require responsiveness of this type. This opens up a new field for photo-electric applications.

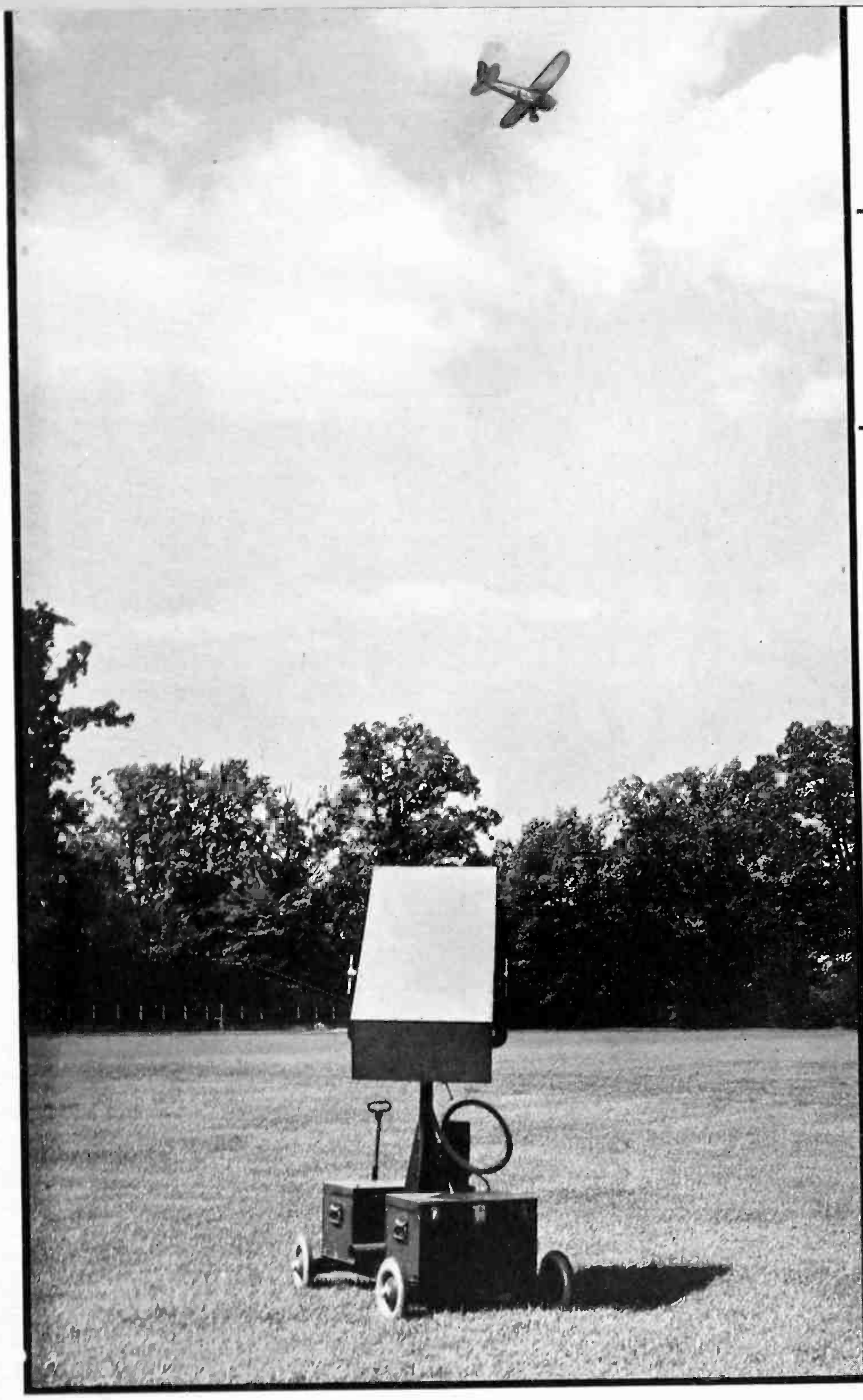
Featuring the ability of the device to perceive objects moving in a random direction anywhere in a field of view as compared with lightbeam interception arrangements embracing only definitely located movement, the name "Petoscope," connoting the ability to see flying objects, has been adopted.

Principle of Operation

The apparatus is entirely self-contained, requiring no light source or other external appurtenances. It may be directed upon or toward any desired scene with the facility with which one may use a photographic camera. This feature of the Petoscope is of great importance for applications of a temporary or peripatetic type, where the setting up and alignment of light-beam projector and photo-cell housings would be impracticable.

It is a feature of a very large majority of photo-electric applica-

Mr. Lewis Bremer and the author with the device and Mr. Bremer's ship



Exposure made when a bell rung by the Petoscope indicated it had picked up the aircraft

tions that the object to which they are to be responsive is, incidentally, a moving one. It is a matter of common experience that the living eye perceives objects in motion much more readily than it notices stationary things. Analogous to these characteristics of biological vision and reflex action, the Petoscope achieves a degree of responsive sensitivity far surpassing photo-electric apparatus of the light-beam type, because the system is arranged to respond specifically to motion.

The essential principles on which the Petoscope is based are as follows: A pair of objective lenses, L_1L_2, embrace a field of view which includes a movable object such as, for example, a person, an automobile, or an airplane. The objective lenses throw duplicate images of the field of view onto two screens, S_1S_2, divided into a number of small portions alternately transparent and opaque. On page 28 the screens are shown divided regularly according to a checkerboard pattern. The rectangular divisions are identical in shape and dimensions. But it will be seen that the screens have opposite characteristics. Each square which is transparent in S_1 is opaque in S_2. Likewise, each square which is opaque in one is clear in the other.

Light which penetrates the transparent parts of the screens is concentrated by two condensing lenses C_1C_2, onto two photo-cells P_1P_2. It follows, therefore, that a ray of light emanating from any given point in the field will be transmitted in duplicate as far as the screens. If the light from this point falls upon a transparent portion of S_1 and is transmitted to P_1, it is bound to fall upon an opaque portion of S_2 and cannot reach P_2. Thus, light from any point in the field of view may reach one or other of the photocells; but not both of them at the same time, under any circumstances.

Suppose now that the point from which the ray of light is derived is a part of some moving object. As the object moves, the duplicate images will correspondingly travel across the screens. When the image of the object appears on a transparent portion of S_1 it will affect P_1 but will be on an opaque portion of S_2 and will be cut off from P_2. A moment later it will come on to an opaque area on S_1 and on to a transparent portion of S_2 when it will activate the photocell P_2 but not P_1. Thus, movement of the object will alternately influence the two photocells. The frequency of these alternations will depend upon the speed of movement, the distance of the object from the lenses, and upon the size and number of the divisions on the screens.

If, on the other hand, there is no movement of any kind occurring in the field of view, no matter what degree of differing color or shade may be distributed, according to any kind of pattern, in the background, or other objects comprising the field, the light reaching the photocells will be of steady value, and, assuming the screens are reasonably finely divided, the amount of light impinging upon the photocells will be the same. Variation in the intensity of the general illumination will cause like variations in the photo-electric currents generated in both P_1 and P_2.

The photocells, therefore, are connected in a bridge circuit arrangement and are coupled to the amplifier through a condenser. Thus, only a difference between the quantity of light received by the two photocells will unbalance the bridge. And, because of the condenser, only a fluctuating out-of-balance voltage will affect the amplifier.

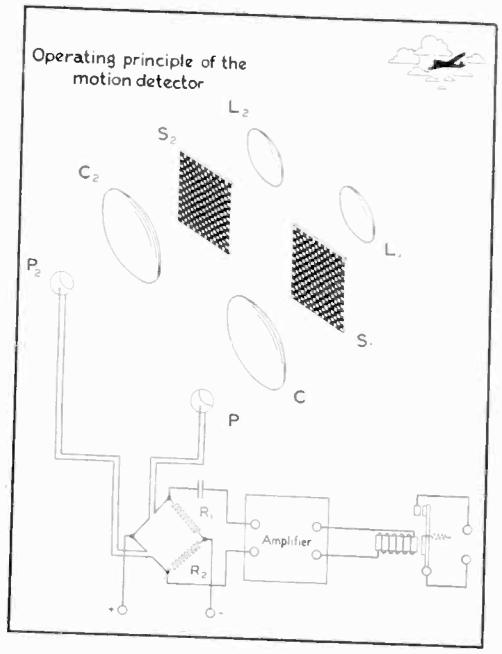
The amplifier, therefore, will not respond to changes in the intensity of daylight because this tends to affect both the photocells simultaneously. Likewise, in applications involving artificial light, the 120 cycle flicker, present in all normal light sources, tends to balance out in the duplicate optical system and bridge circuit. Lengthening shadows on a landscape, varying with the clock, cause such slow rates of change, that with a coupling condenser suitable for transmitting to the amplifier photo-electric currents of frequencies such as are occasioned by objects moving at commonly encountered speeds, the amplifier is inappreciably affected.

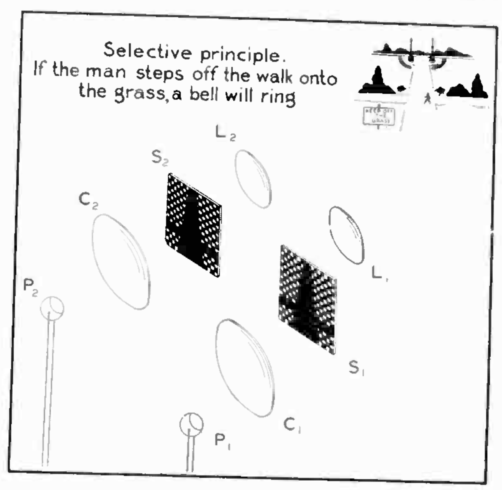
Due to these features an exceptionally high degree of sensitivity can be achieved because the maximum gain, for which it is possible to design amplifying equipment, can, in many instances, be utilized.

The connections of the amplifier are of the conventional resistance-capacity type. Four stages of amplification are used together with a fifth stage comprising a power tube, in the anode circuit of which is a sensitive relay. The sensitive relay controls a power relay for operating a bell, electric horn, and other similar devices.

The Apparatus

A general idea of the main constructional features of the apparatus may be seen in the figures. These illustrate a piece of apparatus that has been built in the author's laboratory for the purpose of studying, under field conditions, the possibilities of this system of applying photocells. In building this equipment, it was aimed to construct something which would be sufficiently practical, rugged, and reliable for carrying out extensive outdoor test work without unreasonable inconvenience. On the other hand, no great effort was made to build a highly efficient optical system. All of the lenses used are of an inexpensive type intended for use as stereopticon condensers. The cost of procuring corrected lenses of large aperture was not considered justifiable for preliminary exploration of the possibilities of this device.





How the Petoscope works

The apparatus comprises an optical head which is mounted on a central column supported by a movable chassis. The optical head can be raised upon the central column and can be tilted to any desired angle by means of gearing operated by hand wheels. It may also be rotated about the axis of the column.

The optical head comprises a duplicate refracting system together with two photocells, an electron-tube amplifier and a sensitive relay. The optical head also includes batteries for the photocells and for the first stage of amplification only. Additional batteries for the remaining stages of amplification are carried in the battery boxes mounted at the rear and the front of the chassis.

A control box mounted at the base of the central column, comprises cathode heating and anode battery switches together with further switches which control the power relay, the bell, the horn, and several outlets provided in the control box into which additional devices may be plugged when required. The power relay is mounted in a weather-proof box below the switch and outlet boxes.

In the internal view of the optical head the five tube amplifier and relay at the rear can be seen.

The two objective lenses are mounted immovably in the front wall of the optical head. Each photocell, condenser and screen is, however, mounted upon an individual frame. Each of these frames is attached to the base of the optical head and provision is made for sliding each frame backward and forward for focussing, and for aligning the two optical axes, according to the distance of the object.

Applications

In operation the Petoscope will detect an automobile approximately one hundred yards away. It will respond to a person walking at a distance of fifty yards from the apparatus. It has an angle of vision of about twenty-five degrees. Anybody moving or walking in the area embraced by this solid angle up to the effective range of the apparatus causes a bell to ring or a horn to sound.

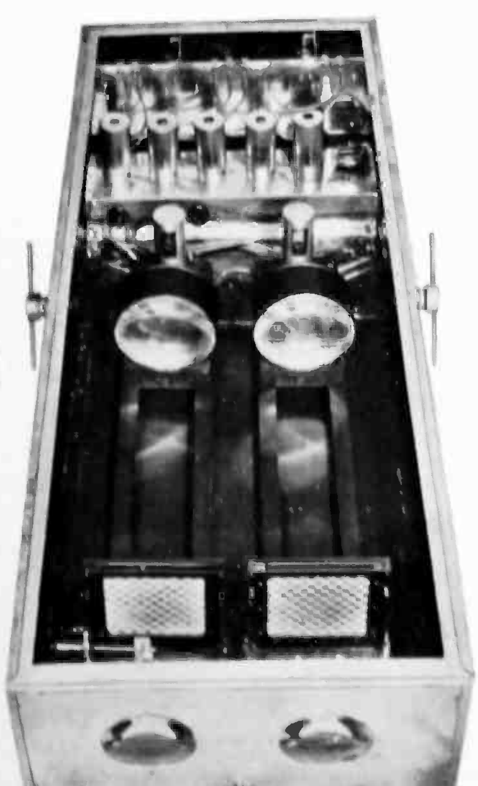
The Petoscope can be made to act in a selective manner by blacking out desired portions of the screens. It will then be blind to any movement taking place in portions of the field of view corresponding to the blacked out part of the screens. Immediately the object moves outside of the blind area the Petoscope will give an audible signal.

A field of application which emphasizes the unique action of the Petoscope is its use in connection with the flight of aircraft, which, as compared with pedestrians and automobiles are not very readily susceptible to detection by the interception of a definite beam of light; first, because of the difficulty of providing a light source and a photocell on opposite sides of an airplane, and second because aircraft do not follow predetermined paths such as highways.

Through the courtesy of Messrs. H. A. Little and Lewis Bremer, 3rd, well known Philadelphia flyers, the responsiveness of the Petoscope to the flight of airplanes has been studied at Patco Field, Pennsylvania. A number of instantaneous photographs of ships at various altitudes were made as the Petoscope was actuated by the passage of the airplane over the apparatus. Consistent operation was obtained with a two-passenger ship at heights up to 2,000 feet with weather conditions of good visibility but cloudy.

It would appear that apparatus substantially similar to that illustrated should be of value for timing aircraft in speed tests.

Taking into consideration the very primitive optical arrangements, referred to above, which this particular model of the Petoscope comprises, these results indicate that a unit equipped with larger and accurately corrected lenses, more along the lines of astronomical instruments, would greatly surpass the present performance and that the construction of equipment capable of detecting aircraft at any visible distance is not beyond present technical achievement. Moreover, the principle utilized is not limited to visible light effects but may be equally applied in connection with infra-red and any other non-visible wave lengths. These potentialities have evident military significance.



Interior showing lenses, screens and photocells

Aircraft Radio Compass

[*Continued from page 10*]

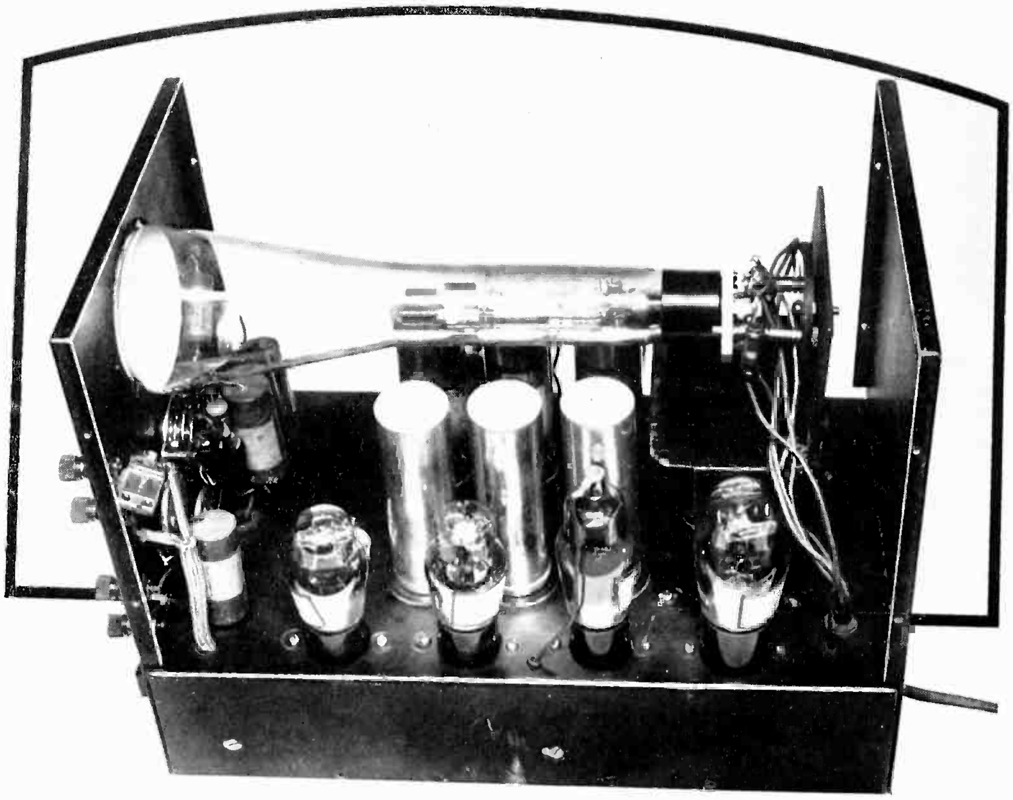
double cardioid voltages shown in Fig. 2-B are thus produced in the output of the 6D6 stage; they are fed to a high-gain superheterodyne circuit having wide a.v.c. action (flat from 10 to at least 1,000,000 microvolts within 2 db., down 10 db. at 1 microvolt, measured at 300 kc.). After amplification and detection the cardioid voltage is impressed through a 105-cycle tuned transformer on a dynamometer type indicator (shown in Fig. 3) which produces the result shown in Fig. 2-C. A separate audio channel having wide frequency range takes the audio output from the super and feeds it to a pair of phones, for aural monitoring. When on course, the modulation of the station appears in the headphones, so that station identification, weather reports, news, and entertainment may be received while the compass is being used. When off-course, the voice modulation is slightly broken into by the 105-cycle voltage which then appears to actuate the meter. The device can thus be used for flying the wave aurally, except that the 105-cycle tone gives no idea of the direction (left or right) off-course.

The frequency ranges covered are 195-415 kc. and 550-1500, compass and voice, with an extra band of 2800 to 7700 kc. for voice only (airways communication bands). The standard installation has a fixed loop with the loop-plane perpendicular to the fore-and-aft axis. A rotatable loop can be supplied.

In the Fairchild-Kruesi compass the loop is sectionalized to permit close tuning, and is switched by relays at the base of the loop mounting. The loop is normally mounted so that it can be rotated, to take bearings on stations not in the direct course. The leads of the loop are brought to the receiver through 6-ft. low-capacity cable. The balanced modulator consists of a pair of 37's, the audio commutating voltage is 165 cycles, and is fed into the cathode return of each 37 tube. Dynamometer type instruments are used for indication exclusively. The receiver is a superheterodyne with two audio channels, one tuned for the low-frequency indication voltage, the other wide enough for listening to voice and music. The a-v-c level is flat within 3 db from 50 to at least 500,000 microvolts. 8 six-volt tubes are used. The frequency range is from 150 to 410 kc. and 550 to 1500 kc. The needle indication is not affected by voice modulation up to 100 per cent, nor by noise at a signal-to-noise ratio as low as 1 to 1. The sensitivity is six milliwatts output for a 2 microvolt signal 30 per cent. modulated (20 microhenery, 100 $\mu\mu$fd antenna). With a 5 microvolt signal, 15 degree deviation off-course sends the visual indicating instrument off scale; a 2 degree deviation moves the pointer ⅛ inch.

One of the most recently announced forms of the compass is that manufactured by the Western Electric Company, New York. The compass, while similar in many respects to the Lear and the Kruesi, is intended for use with a receiver (type 17-A) sold separately, and now installed in many planes. The compass unit and loop are provided as separate units. One of the features of the installation is a switch which cuts off the voltage from the fixed antenna. This permits reception from the loop alone which considerably reduces the static pick-up especially during rain storms. When so used, of course, the loop does not give the sense of the bearing. A rotatable loop is the standard installation, the beacon and broadcast bands, which are covered by the 17-A receiver, are available for compass use. The commutation frequency appears in the phones, but not when directly on course, at which bearing the modulation of the station may be heard without interference.

The compass manufactured by the Electrical Industries Manufacturing Company is unique in that any length of cable up to 100 feet may be connected between the loop and the receiver, since the loop is not center-tapped or grounded, and since a carefully balanced transmission line is used between loop and receiver. The local modulation (1,000 cycles) is not heard when on-course. The entire unit, which is intended for marine as well as airplane use, is self-contained, except for remote tuning control. The tuning range covers the broadcast and beacon bands (200 to 400 kc., and 550 to 1500 kc.).—D.G.F.



Cathode-ray resonance curve indicator using capacity control tube as part of sweep circuit

Tube Capacity Put to Work

An annoyance becomes a useful agent when amplifier tube input capacity is utilized as an automatic frequency or tone control, as a sweep circuit component for visual inspection, in frequency modulation, *et cetera*

By JOHN M. HOLLYWOOD and MARSHALL P. WILDER

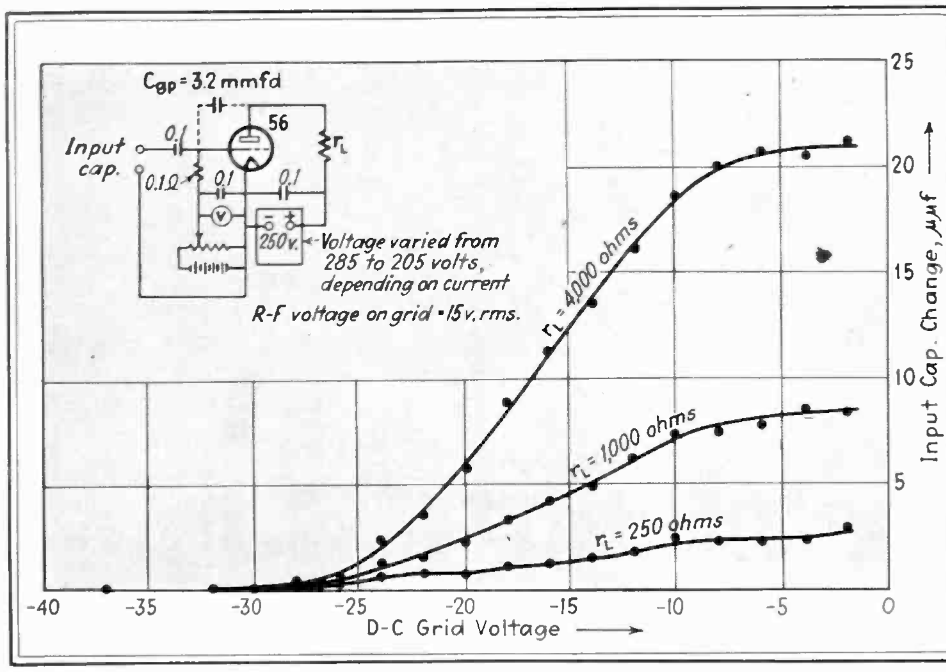
IT IS well known that the input capacitance of a vacuum tube depends upon the amplification of the tube and the nature of its plate load impedance. The effect has been calculated by H. W. Nichols and J. M. Miller, and described[1] by H. J. Van der Bijl and L. J. Peters and others. However, it has been regarded chiefly as a cause of annoying complications in circuit performance, and its useful applications are quite recent. Several uses are described here, such as frequency modulated oscillators, frequency modulated transmitters, visual radio and audio selectivity or spectrum analyzers, remote control of tuned circuits, automatic noise suppressor circuits, automatically tuned receivers, and others.

The effect may be seen from the vector diagram and circuit. The vector diagram shows that the voltage E_{pg} across the grid to plate capacitance C_{gp} varies with the output voltage E_{cp}, which in turn depends upon the internal resistance r_p and the nature of the load Z_L. An increase in the voltage across C_{gp} increases its reactive current and makes it appear to the input voltage source like a correspondingly increased input capacitance C_i. Variations in input capacitance may therefore be obtained by manual or electrical control of the load impedance or by electrical control of the internal resistance of the triode, or of its mutual conductance, to say the same thing in a different way. The latter is of particular interest; it opens up many possibilities with regard to methods of frequency modulation or tuning by electrical means. It is not necessary to use a triode; a multi-electrode tube can be used if an additional capacity is connected between grid and plate when the normal capacity is too small. In applying this effect, it must be remembered that the input resistance as well as capacitance is affected, and usually is the limiting factor in the amount of capacitance variation obtainable. The normal grid to plate capacitance is roughly multiplied by the gain of the circuit, so that multiplications of several hundred to one are possible using multi-electrode tubes. Unfortunately, the ratio of input resistance to reactance is usually excessive unless only small capacitance variations are employed.

Use As Tone Control

A commercial application of this effect was as an automatic noise suppressor circuit.[2] The input capacitance of a vacuum tube was used as a tone control. The grid bias for this tube was connected with automatic volume control voltage so that when no signal was being received and the noise level was correspondingly high, the input capacitance of this tube was increased and its tone control action cut down the strength of the higher audio frequencies, reducing the noise.

One useful application is as a simple means of frequency modulation



Extent of capacity change secured from use of a standard triode as control tube

for an oscillator. The input capacitance of a tube is used to tune an oscillator, the frequency of which can then be varied by electrical means. Varying grid bias on the tube is an effective way of varying its mutual conductance and so changing its input capacitance.

Such a frequency modulated oscillator is used in a device for aligning the tuned circuits of radio broadcast receivers visually with a cathode ray tube to show the selectivity curve.[3] This device is built into a general purpose oscilloscope, the combination being a self-contained unit.[4]

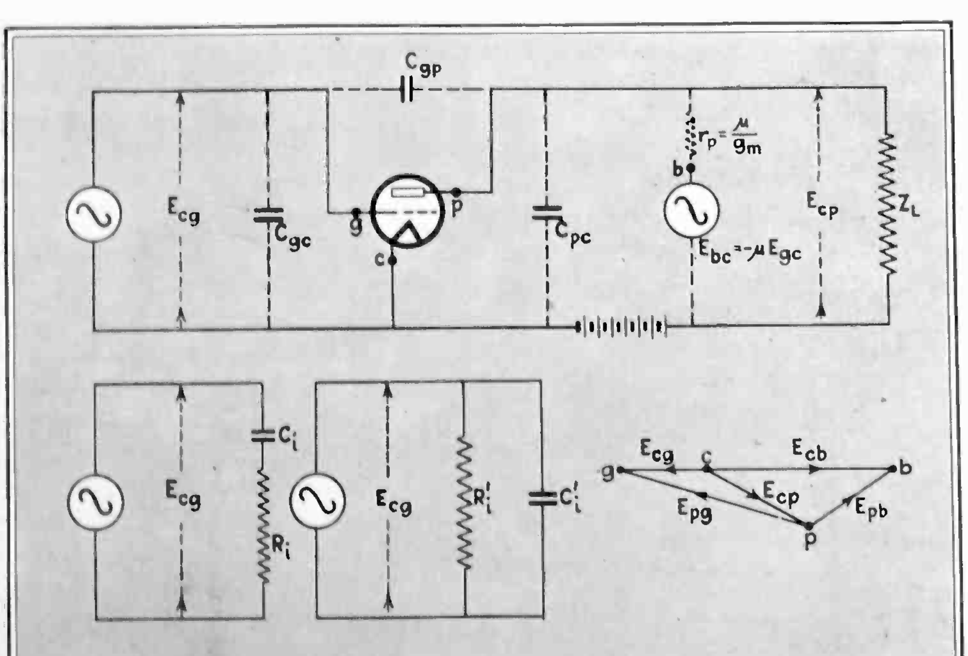
Visual selectivity analyzers are not new. They have been described by Marx and Banneitz[5] and by O. H. Schuck.[6] However, it is only recently that developments in high vacuum cathode ray tubes and in electronic devices for replacing motor driven variable condensers have greatly simplified such instruments.

Selectivity Analyzer

In this device, the grid bias of the "capacity control tube" (as we shall term tubes used for obtaining variations in input capacitance by electrical means) is varied in proportion to the horizontal deflection of the cathode ray beam, while the vertical deflection is proportional to the output of the receiver or network whose frequency response is to be determined. This automatically gives a picture on the screen of the selectivity curve of the network. To make the frequency scale linear, the grid bias of the capacity control tube must be varied only over the linear range of the curve of mutual conductance versus grid voltage, that is, not too near zero grid bias or plate current cut off. Also, the oscillator voltage applied to the grid circuit of this tube must not overload the grid.

Automatic Tuning

Another use for a frequency modulated oscillator is as the oscillator in an automatically tuned broadcast receiver. S. Y. White[7] has described such a receiver. It employs manual tuning to select roughly the frequency desired. If there is a carrier wave on that channel, an automatic tuning device tunes the oscillator so that the frequency difference between it and the signal is precisely the intermediate frequency of the receiver. Thus, when a signal is tuned-in approximately by hand, the automatic tuning device completes the tuning operation very precisely, eliminating the poor audio frequency response and other ills that result from careless manual tuning.



Circuit for making use of controlled input capacity

An oscillator, frequency-modulated by a "capacity control tube" can be used in a "sound prism" somewhat like that described by O. H. Schuck in a paper given before the Institute of Radio Engineers in May, 1934. Here the frequency spectrum of speech or music is obtained repeatedly at fractional second intervals, and shown on an oscillograph. This is done by passing the beat frequency between the frequency modulated oscillator and the sound source through a fairly selective filter, rectifying it, and applying the resulting voltage to the vertical deflection axis of the oscillograph. The horizontal deflection of the oscillograph is proportional to time, and a known function of the grid bias of the capacity control tube which controls the oscillator frequency. The result is a picture of the frequency spectrum of the sound.[8]

In both the sound prism and in visual selectivity curve devices, such as the device described for aligning broadcast receivers, the problem arises as to whether, when a voltage of periodically varying frequency is applied to a selective circuit, the response of that circuit at any instant is the same as that obtained if the frequency applied at that instant were to be applied in the steady state case. In this regard, a paper by W. L. Barrow[9] is of interest. He shows that application of a sinusoidally varying capacitance to an oscillator results in production not of a continuous frequency spectrum, but several discrete frequencies centered on the normal oscillator frequency and spaced from it at frequency intervals equal to the frequency at which the capacity is varied.

If such a frequency spectrum is impressed on a highly selective circuit, a paradoxical situation arises. The circuit will deliver zero output unless tuned to one of the discrete frequencies, and will then deliver steady sinusoidal output. Examination of its output at different times or the corresponding points on the cycle of capacity variation of the oscillator is supposed to show the selectivity curve of the circuit; but here one would gain the impression that this highly selective circuit has perfectly flat response!

This situation illustrates an important point; that the fidelity of reproduction of a selectivity curve of a network obtained with a frequency modulated oscillator is proportional roughly to the number of harmonics of the frequency of curve tracing that can be enclosed in the frequency band passed by the network under examination; so that large errors will be introduced if a highly selective network is examined, also that rounding of sharp corners and other errors due to this difficulty will be made small if the frequency of modulation is made sufficiently small. In broadcast receiver visual aligners, the band passed is roughly 10,000 cycles, so that 100 discrete frequencies might be admitted if the frequency of curve tracing is 100 cycles; a curve tracing frequency of 100 times a second or less would therefore be admissible with corresponding loss of details smaller in size than a hundredth of the length of the curve. In sound prisms, it follows that sharpest frequency spectra will not be obtained with a highly selective filter; very roughly, the optimum selectivity of the filter would be the geometric mean between the frequency of tracing of the curve and the frequency range of the spectrum to be analyzed; if tracing frequency is ten cycles and spectrum range 10,000 cycles, the filter should pass a band width of roughly 300 cycles for sharpest response.

Quantitative Data

To return more closely to the subject of this article, some calculations on the behavior of input capacitance of a triode might be of interest. This has been treated at length in the references cited, but the approximations given here are perhaps more convenient.

Referring to the figure, if frequency is low, and if C_{gc} and C_{pc} are neglected, the former because it may be considered part of the capacitance of the circuit to which the "capacity control tube" might be attached, the latter because it has little effect at low frequency; and if the load impedance Z_L is a pure resistance, then

$$R_i = \left(\frac{rR}{r + R + g_m rR}\right) = \frac{\left(\frac{rR}{r+R}\right)}{(G+1)}$$

$$C_i = C_{gp}\left(\frac{r + R + g_m rR}{r + R}\right) = C_{gp}(G+1)$$

$$\text{where} \begin{cases} G = \text{gain} = \left(\frac{g_m rR}{r+R}\right) \\ r = r_p \\ R = Z_L \text{ for this case} \end{cases}$$

$$\text{If gain is large, i.e. } \left(\frac{g_m rR}{r+R}\right) >> 1,$$

$$R_i \cong \frac{1}{g_m}.$$

These equations show that under the conditions stated, R_i is equal to the internal and external plate resistances in parallel divided by the gain plus one, and for large values of gain approximately independent of everything but mutual conductance. A tube with high mutual conductance is best for lowest input resistance. C_i is equal to the normal grid to plate capacitance multiplied by the gain plus one.

Phase of Plate Load

The equations given do not show the effect of increasing frequency, or effect of plate load other than a pure resistance. The phase angle of the plate load has much effect on the input resistance; it may be made negative with an inductive plate load.

The equivalent parallel input resistance R'_i and capacitance C'_i are often more useful than the series values given above. They are, under the same conditions as before,

$$C'_i \cong C_i \cong C_{gp}\ (G+1)$$

$$R'_i \cong \frac{1}{\omega^2 C_i^2 R_i} \cong \frac{\left(\frac{rR}{r+R}\right)}{(G+1)} \cdot \left(\frac{1}{\omega C'_i}\right)^2$$

where $\omega = 2\pi$. freq.

The exact solution for pure resistance plate load R is:

$$C'_i = C_{gc} + C_{gp}\left\{\frac{(R + r + \mu R)(R + r) + (\omega Rr)^2(C_{pc})(C_{pc} + C_{gp})}{(R+r)^2 + (\omega Rr)^2(C_{pc} + C_{gp})^2}\right\}$$

$$R'_i = \frac{1}{\omega C_{gp}}\left\{\frac{(R + r)^2 + (\omega Rr)^2(C_{pc} + C_{gp})^2}{(\omega Rr)(C_{pc} + C_{gp})(R + r + \mu R) - (R + r)(\omega RrC_{pc})}\right\}$$

This shows that the equivalent parallel resistance of the input circuit is infinite at zero frequency and decreases with the frequency and also with the size of the grid to plate capacitance. Thus, the capacity control tube draws little power from the input voltage source at low frequencies, but considerable as the frequency, the grid to plate capacity, or the gain is increased.

If at a given frequency it is desired to obtain the largest possible variation in input capacity without making the parallel input resistance too small, it will be found that there is an optimum value of plate load resistance and corresponding plate to grid capacity (adjustable external capacity connected from grid to plate). At lower frequencies the optimum value of plate load resistance is greater. The optimum value is best found experimentally, because the mathematical solution is too complicated when all the necessary factors are taken into account.

It should be noted that although very large capacitance variations are possible with a large grid to plate capacitance, a high resistance plate load, and a tube of large amplification factor, the first two conditions tend to make the parallel input resistance small and cause excessive power to be drawn from the input voltage source. At lower frequencies, larger capacitance variations may be obtained.

In passing, it should be remarked that the approximate input capacitance given in the formulas here does not hold true at high frequen-

[*Continued on page 42*]

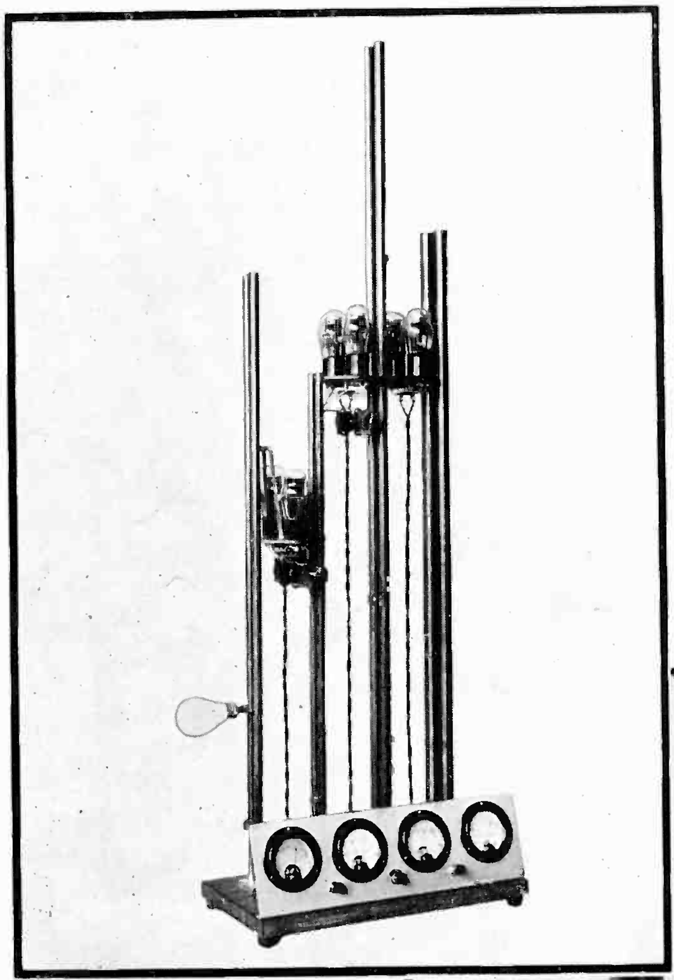
60 Mc M.O.P.A.

Ultra-high frequency transmitters using resonant-line tuning circuits have graduated from the simple self-excited oscillator into the more stable and efficient master-oscillator power-amplifier. The transmitter described herein is a pioneer in appearance as well as performance

By

C. J. FRANKS

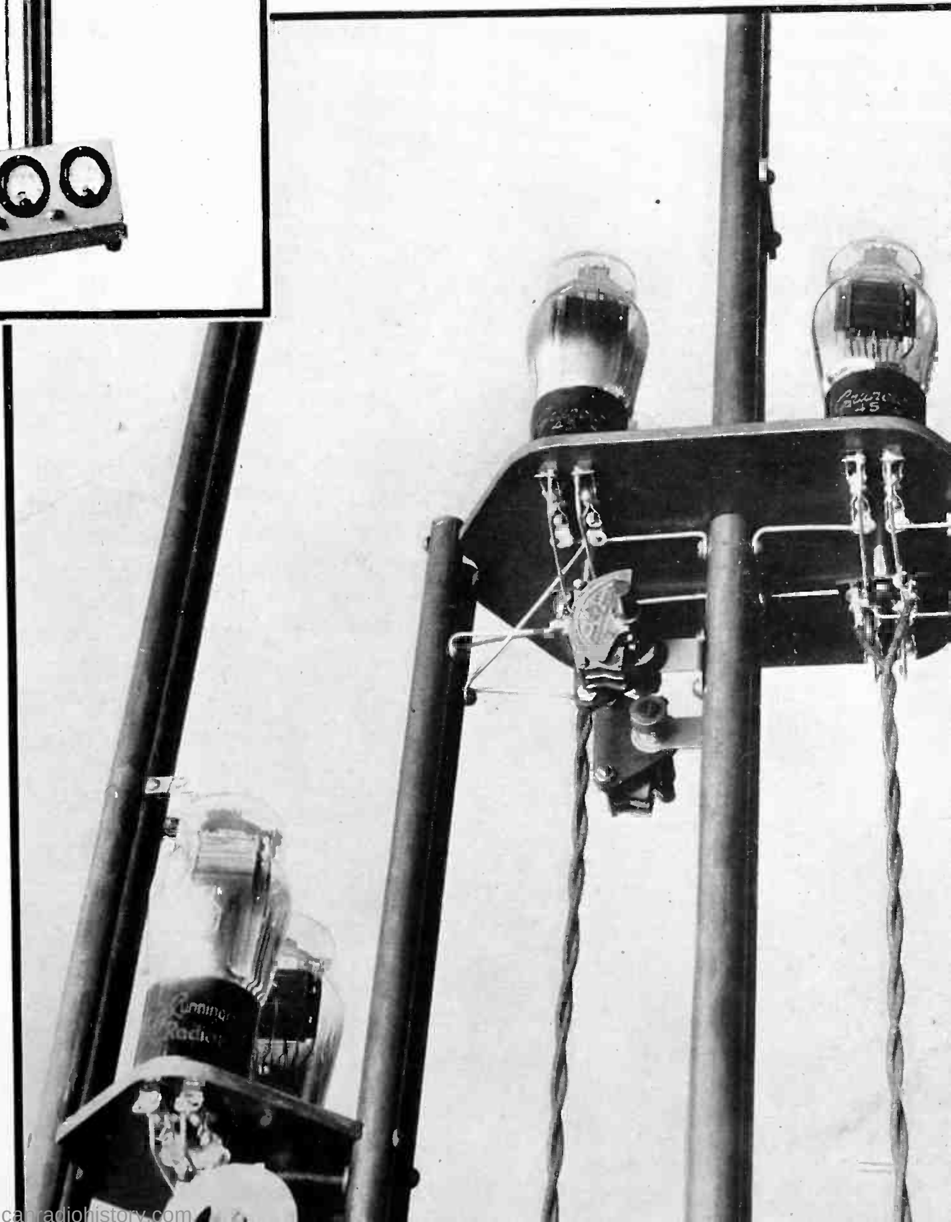
W3CYF



The pipe-like structures in this transmitter are the resonant-line tank-circuits of the oscillator, buffer, and final amplifier. The simplicity of the symmetrical connections is shown at the lower right

APPRECIATION of the possibilities of the ultra-high frequency region is at present somewhat ahead of our ability to exploit this region and turn it to commercial usefulness. The ultra-highs are the private property of the amateur and the experimenter, chiefly because of unsolved technical problems which stand in the way of the building of completely satisfactory commercial transmitting and receiving equipment. Work on the problem is going on in many quarters, however, and amateur and commercial alike are slowly advancing in knowledge and technique; with each advance comes an improvement in performance, or a simplification of method or apparatus. It is the purpose of this article to describe a new and simplified ultra-high frequency transmitter, a step along the road toward the goal of stable, efficient equipment for this frequency region.

Not so long ago, it was quite a trick to get a vacuum tube to oscillate at a frequency higher than 50 megacycles. And when, by overloading the tube shamefully we did make it go, the result was hardly worth the trouble. You might get enough energy to excite a Lecher bridge, or to make a small flashlight bulb glow feebly, but the energy wasn't worth much for practical communication, as listening to the signal with a receiver would conclusively demonstrate. We never did



find out which was the more unstable, the transmitters or the regenerative-detector receivers, but at any rate the signal was hard to find, harder to copy, and next to impossible to hold in tune for more than a few seconds.

These frequencies never were used much for communication until the amateurs took them up, and by using a voice-modulated signal instead of keyed c.w., and a non-critical superregenerative receiver, began proving that this frequency region was of some use after all. By this time better tubes were available, and it was no problem at all to generate 20 to 50 watts of five-meter energy. But, since for simplicity's sake a self-excited oscillator was directly modulated and used to feed the antenna, the emitted signal contained a large amount of frequency modulation. The superregenerator did not object to this sort of thing, however, and all was well. Signals were exchanged over greater and greater distances, knowledge of transmission characteristics was gained, the real usefulness of these frequencies proved, and amateur and commercial alike began utilizing them to an increasing extent.

Then Came Interference

The modulated oscillator transmitters emitted signals occupying several hundred kilocycles of space in the spectrum, due to their great carrier instability, and although there are many kilocycles in the ultra-high frequency region, it does not take many transmitters of this type to use them up pretty completely.

The first thought of anyone confronted with an interference problem is an increase of receiver selectivity. Now it is somewhat harder to build a superheterodyne for ultra-high frequency work than for the lower frequencies, but it can be done. But what a disappointment awaits us when we try to use this selective receiver for actual reception! All but the most stable of the signals prove to be absolutely unintelligible; all that can be heard of the average signal is bursts of noise, as the frequency-modulated signal sweeps rapidly across the receiver pass-band.

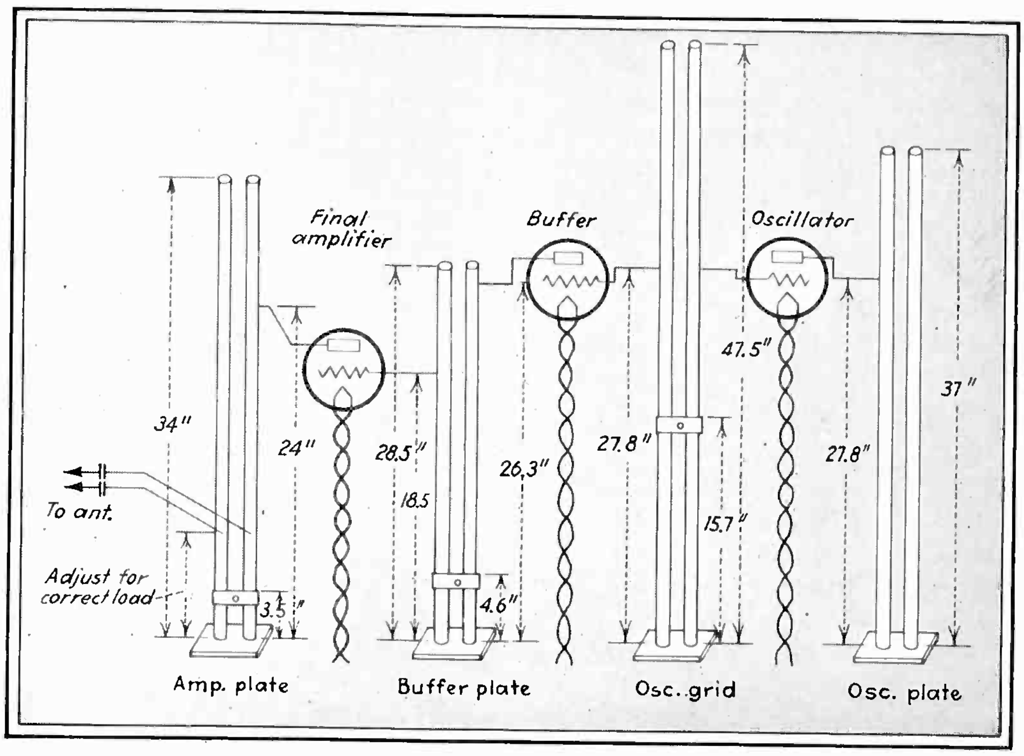
The next step, then, must be to stabilize the transmitter. There is, of course, no reason for having a broad, wobbly signal except the obvious one that this is the easiest kind to have. Excepting special applications, there is no reason why a signal should occupy more than the ten or so kilocycles that are considered normal in the lower frequency bands.

Carrier Stability—Two Solutions

There are several ways of attacking the carrier stability problem; we can divide them into the customary two classes. The first method of attack is an attempt to design, build, and adjust the self-excited oscillator so as to make its oscillation frequency independent of dynamic output variations due to modulation. This is difficult even though the means for doing it are of themselves simple. The trouble lies in the triple requirement of "design, build, and adjust." If we fall down on one or another the result is no good. There is no doubt that by properly utilizing one or more of the many ingenious artifices that have been proposed, (high-Q tank circuits, stabilization of tube impedances, compensation, partial neutralization, and so on), it is possible to come very close to the ideal of a carrier whose frequency is not changed when its amplitude is modulated, although it must be admitted that the ideal is never quite reached. But to approach success by this method you must not only know what to do, you must be able to tell when you have done it and so arrived at the answer. And for this last, few people have the necessary testing equipment or the desire and patience to use it properly, and this is the reason why so many of the supposedly stable oscillators now being used on the air are actually so very bad, and why so few of them can be received on a selective receiver.

The second method, which appears the most complicated, is actually the easiest to adjust to give the desired result. It is the familiar step of employing a lightly loaded oscillator running at constant level, an isolating or buffer amplifier stages to prevent load fluctuations due to modulation from reaching the oscillator, and a modulated amplifier stage. There may also be further amplifier stages of the linear type following the modulated stage. Present design trends, however, are away from the use of linear stages.

When applied to ultra-high frequency transmitters this method runs into serious technical difficulties which have limited its usefulness. Many of these difficulties are traceable to our rather groundless predilection for running the controlling oscillator at a very low frequency, say 5 Mc. This must be multiplied at the output frequency; if the output frequency is high, the multiplication

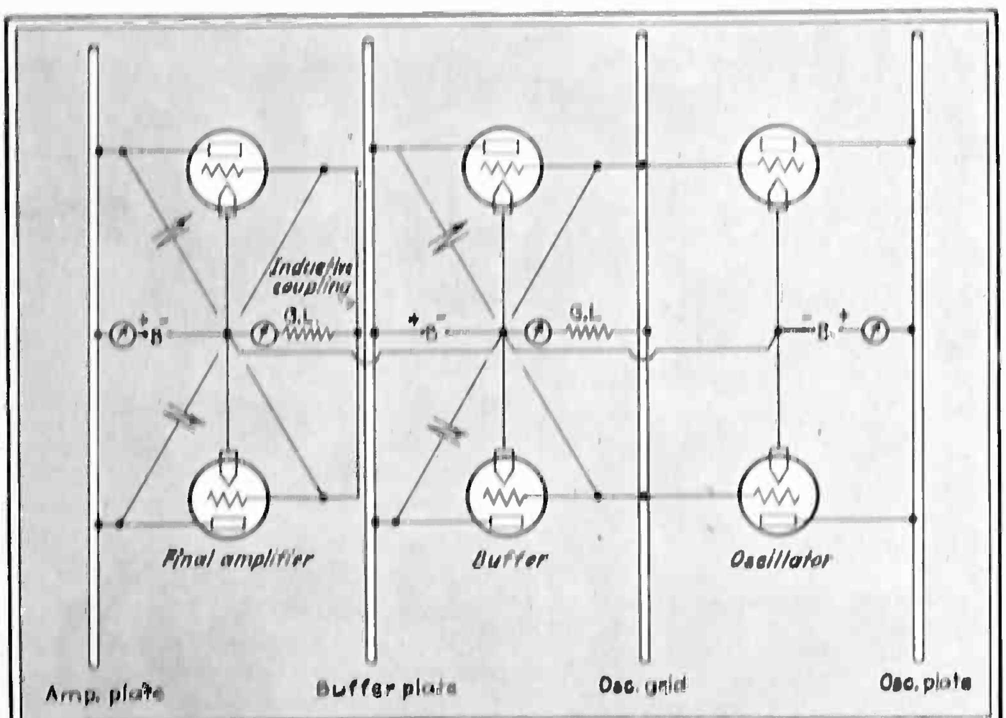


The mechanical layout of the transmitter showing dimensions of resonant lines, position of shorting bars and connections to the plate and grid circuits. Type 45 tubes are used throughout factor is high and the efficiency of the multipliers low, so that a large number of stages is required.

But there is no reason why an oscillator must run at low frequency; high frequency oscillators can be made stable if properly designed and run at constant amplitude. An oscillator of the "brass-hat" or "transmission-line" type gives excellent frequency stability and can be loaded sufficiently to excite a buffer stage without impairing its performance. Engineers of RCA Communications have shown how to compensate such an oscillator against temperature changes and obtain performance comparable with that of a crystal-controlled type. With the oscillator frequency equal to the output frequency the number of intermediate stages is kept to a minimum and a simple and economical transmitter is the result.

In the example shown here, not only are the frequency determining circuits of the resonant-line type, but this type of tuned circuit is used throughout in place of conventional coils and condensers. Its advantages are low cost (all the tuned circuits in the transmitter shown cost less than a dollar), easy, continuous adjustment for tuning and impedance matching, high efficiency, and simplicity of construction and maintenance. The only lumped reactances in the whole circuit are the four neutralizing condensers. An attempt was made to neutralize inductively, using the inductive mutuals between adjacent pairs of rods, but the spacings required were so small as to make adjustment, to say nothing of mounting of the vacuum tubes, extremely inconvenient and mechanically impractical.

The output frequency of the transmitter shown is 60 Mc. One buffer stage gives excellent separation when properly adjusted and neutralized, the freedom from interaction between oscillator and modulated stages being entirely sufficient for all amateur and probably a good many commercial purposes. All three stages are pushpull, employing type 45 tubes, a type which is very easy to drive. Grid excitation power is of course a prime consideration at any frequency, since this affects directly the power gain of the stage and therefore the number of stages required in the transmitter. Usually it becomes an acute problem at very high frequencies since grid losses increase as the frequency increases, a fact which makes many excellent lower frequency tubes worthless in this high frequency region.



Each vertical bar in the electrical diagram above represents the resonant line unfolded, i.e., the center of each is the shorting bar. The neutralizing condensers connect directly from plate to grid in each case

60-Mc Power

The output stage delivers about 15 to 18 watts to the antenna when the input is 30 watts (300 volts, 100 ma). The oscillator and buffer stages are ordinarily operated with 225 to 250 volts on the plates, the input to the buffer stage being about 13 watts (55 ma). Substitution of type 210 tubes in the output stage permits considerably higher output power to be obtained, since the excitation, with somewhat increased buffer input, is still adequate for these tubes in Class C operation. An additional stage with larger tubes can be added and excited from this transmitter if still higher powers were desired.

The dimensions of the resonant lines are given in the skeleton schematic diagram. For clearness, the lines have been unfolded and extended so as to give more space in which to show the tubes and neutralizing connections; the actual arrangement of the components will be evident from a study of the photographs. The oscillator-buffer circuit arrangement will be familiar to those acquainted with the telephone practice of connecting the grids of these tubes together so that the same d-c and r-f potentials appear on each. Since both stages use the same type tubes, and both are operating under the same conditions (Class C) this gives correct operating conditions with a minimum of parts. Inductive coupling is employed between the buffer plate tank and the final amplifier grids. The load circuit is easily coupled to the final plate tank by clipping on an antenna, or a two-wire transmission line leading to the antenna, sliding the tapping point up or down until the proper load is obtained.

The adjustment of this type transmitter does not differ greatly from the procedure used with lower-frequency rigs, although the tuning is somewhat more critical and the controls interlock to a somewhat greater degree. In particular, the neutralizing adjustments have a considerable tuning effect upon the circuits, which makes it necessary to retune continuously during the neutralizing process.

With all tubes in place and filaments lighted, but with plate voltage applied only to the oscillator stage, the frequency and the excitation are brought to the desired values by adjusting the shorting bars on the oscillator grid and plate tanks. As usual, the plate circuit must be tuned slightly higher in frequency than the grid circuit in order to produce oscillations, the amplitude of the grid voltage being controlled by the amount of this detuning. The buffer stage is then neutralized, using the customary flashlight lamp or thermogalvanometer inductively coupled to indicate the point of minimum energy in the buffer plate tank. If the neutralizing process disturbs the oscillator adjustments, these must, of course, be restored by retuning to the correct values. Plate voltage is then applied to the buffer, and the final amplifier neutralized. It is then advisable to go back over the entire process again, to compensate for any changes which have occurred due to interlocking, after which the final plate voltage may be applied and efficiency tested by connecting a dummy lamp load to its plate tank. The lamp should be used without a socket and preferably also without a base, if a rather discouraging idea of the amplifier's efficiency is to be avoided. It was found that an ordinary porcelain base socket would absorb almost half the output power, leaving barely enough to light a ten-watt lamp.

The antenna or the antenna transmission line may simply be clipped onto the final amplifier tank through two small blocking condensers, sliding the tapping points up toward the tubes until the desired loading is obtained. Inductive coupling may, of course, be used if desired, and is preferable when the load circuit is not balanced to ground.

Cold Filament Leads

Filament chokes were found to be unnecessary in this transmitter provided the leads were made up as shown in the photographs, and carefully located in the neutral plane midway between the plate and grid conductors to avoid reactions between these tank circuits and the filament circuits. So effective is this artifice that no trace of any r.f. can be found on any of the supply leads at the base of the transmitter, and no chokes or bypass condensers of any sort are needed or used in any part of the circuit. Considerable investigation gave enough evidence to permit the formulation of the following somewhat dogmatic axiom: In a balanced circuit of this type, if the addition of a choke or a bypass condenser produces any noticeable improvement, then there is something wrong with the circuit. Further investigation of balance, lead length, lead placement, etc., will invariably disclose faults of construction which, when removed, remove the need for the choke or the bypass.

To put it another way, if from purely theoretical considerations the circuit ought to work in a certain way, if certain definite relationships are called for, and if the anticipated result is not obtained when the circuit is built up and tried, then the fault will be found to be in the manner in which the theory was applied. When the faults of construction are cleared up, the apparent discrepancy disappears and the behavior of the physical embodiment becomes exactly what is called for by theory.

The average amateur, and a great many engineers who ought to know better, are too accustomed to taking the convenient attitude that theory and practice are not always in accord, and that it is not really necessary that they be so. The truth is that when this appears to be so, the job is only half done; when the engineering has been carried out to the end point not only will theory and practice be found to be in perfect accord, but the simplest, most economical final result will have been obtained. Following through a development job on an ultra-high frequency transmitter can teach a person quite a lot about this radio thing, in a very short time.

This design is not presented as the ultimate in performance, but merely as a very simple and economical means of obtaining a fairly good result. Shielding of the oscillator, substitution of a concentric type of line with its higher Q for the oscillator grid line, partial neutralization of the oscillator grid-plate capacitance, would all undoubtedly improve performance and increase stability, at the price of complication and increased cost. But the transmitter as it stands is capable of fulfilling all the present amateur requirements as to stability without further complication. Actual measurements of dynamic carrier frequency shift under modulation have shown that a shift of not more than two or three kilocycles results from complete modulation of the output wave.

Operation on the amateur five-meter band with this stable transmitter has uncovered some rather unexpected and remarkable effects. These effects are being investigated and it is hoped that the tests will yield data for a future report.

REFERENCES

1. Investigation of Antennae by means of Models. J. T. Tykociner, University of Illinois Engineering Experiment Station Bulletin 147. May, 1935.

2. Tower Antennas for Broadcast Use. Gihring and Brown. Proc. IRE. April, 1935.

3. New Methods of Frequency Control. Conklin, Finch, and Hansell. Proc. IRE. November, 1931.

4. Frequency Control by Line Circuits. Hansell, Kroger, and Carter. Paper presented at Tenth IRE Convention in Detroit, July, 1935.

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IRE Rochester Fall Meeting November 18, 19, 20, 1935

The following technical program has been arranged for this year's gathering at the Hotel Sagamore giving evidence that another of those felicitous occasions will take place, occasions which most of the engineering personnel of the radio set industry attends.

"Superheterodyne Oscillator Design Considerations," by W. A. Harris, RCA Manufacturing Company, Radiotron Division.

"Electrical Quality of Radio Components," by C. J. Franks, Boonton Radio Corporation.

"New Problems in Metal Tubes," by Roger Wise, Hygrade-Sylvania.

"Latest Developments in Electron Optics," by W. H. Kohl, Rogers Radio Tubes Company, Ltd.

"Electron Multipliers and New Electron Technique," by V. K. Zworykin, RCA Manufacturing Company, Victor Division.

"A Tragedy in Specifications," by L. C. F. Horle, Consulting Engineer.

"Management's Stake in Standards," by P. G. Agnew, American Standards Association.

"The Status of the Radio Spectrum," by C. B. Jolliffe, Federal Communications Commission.

"European Experiences in Radio," by L. M. Clement, RCA Manufacturing Company.

"Speech with Sound Effects," by David Grimes, Philco Radio & Television.

"Instantaneous Tracing of Tube Characteristics," by O. H. Schade, RCA Manufacturing Company.

"Quantitative Influence of Tube and Circuit Properties on Random Electron Noise," by S. W. Seeley and W. A. Barden, RCA License Laboratory.

"Design of Doublet Antennas," by H. A. Wheeler, Hazeltine Corporation.

"Iron Core Antenna Coil Design," by G. H. Timmings, Meissner Mfg. Company.

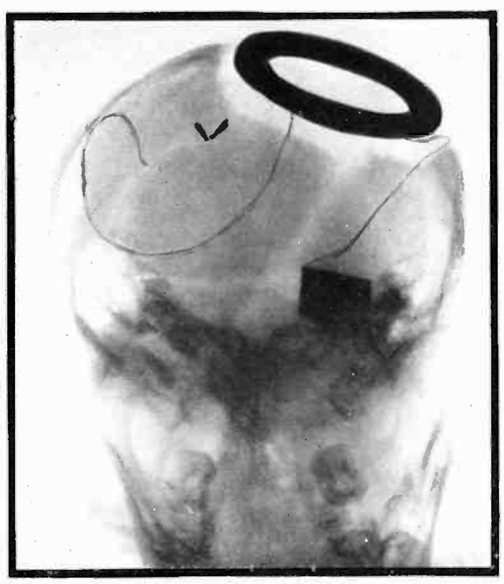
TUBES AT WORK

This month's crop of tube applications includes an unusual use in the field of medical research, a suggested improvement for recording speech and music on disc records, and a resistance-coupled push-pull amplifier of simple design

Discharge Tube Circuit Used in Study of Brain

THE LATEST ADDITION to the list of electronic applications in the field of medicine is a brain excitation device developed by Professor E. L. Chaffee, of Harvard University, and Dr. Richard U. Light, of The Yale University School of Medicine. In the study of the brain it is desirable to apply electric impulses to certain of the brain tissues, in order to trace the relation between those brain tissues and the muscular and nervous reactions associated with them. In order to supply voltage to the tissues of the brain wires have been inserted under the skull of an animal, such as an ape, and connected to a current source. However, the wires greatly impede the freedom of action of the animal and constitute therefore a definite disturbing factor in the investigation.

For this reason it has been suggested that magnetic coupling between the current source and brain might be much more effective. Such a system has been worked out by Drs. Chaffee and Light, as reported in a recent issue of the Yale Journal of Biology and Medicine. A small coil of wire coated with wax and thoroughly sterilized is affixed to the side of the skull (after a trepanning operation) and the two ends of the coil are buried in the desired brain tissues, as shown in the photograph. The ape is then put in a cage to which he has become accustomed and the cage is surrounded by three coils in the three coordinate planes. The coils are connected to the circuit shown and are energized by current from three mercury tubes, which are discharged in rapid sequence by the control circuit associated with them. As a result current impulses of extremely steep wave front are sent through the coils. A voltage is thus induced in the



X-ray photograph of ape's brain, showing coil and wires buried in the tissue

coil buried in the skull of the ape, and the brain tissues are excited thereby. Both the frequency and magnitude of the exciting impulses can be controlled.

Among the many useful results which this research has produced is a check on the technique used in brain surgery, since motor and sensory tissues can thus be definitely located within the skull. Also the relation of frequency of stimulation to the type of muscular reaction produced was easily studied. Muscular tremors, and various other well-defined types of motor reaction were produced, as well as forms of epilepsis. In one experiment drowsiness and sleep was induced after stimulation in the hypothalamus region of the brain.

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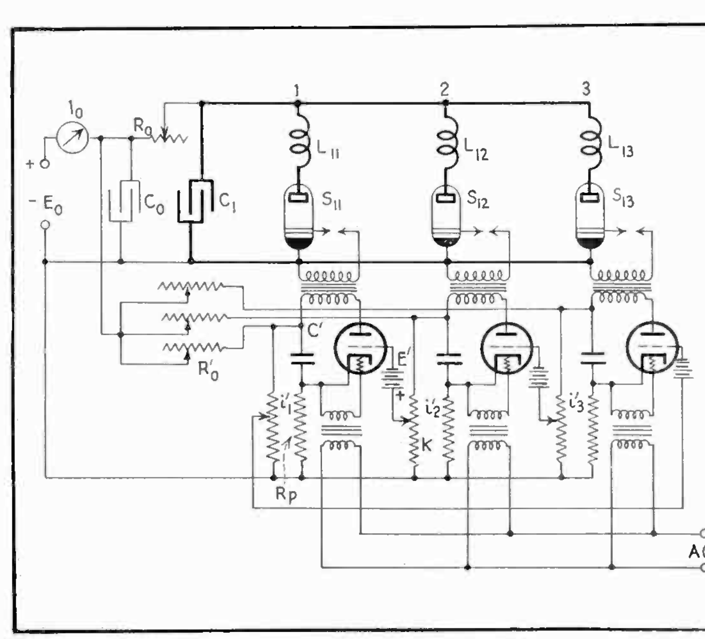
Standard Frequency Broadcast Schedule Revised

BEGINNING OCTOBER 1, 1935, the Standard Frequency Service provided over station WWV, Beltsville, Md., by the National Bureau of Standards has been given on three days each week. On Tuesday and Friday the transmissions are continuous unmodulated waves (CW), while on Wednesday they are modulated by an audio frequency of the order of 1,000 cycles per second. There are no transmissions on legal holidays.

Transmissions are made on three radio frequencies as follows: 12 noon to 1 p.m., Eastern Standard Time on a frequency of 15,000 kilocycles; from 1:15 to 2:15 p.m., 10,000 kilocycles; and from 2:30 to 3:30 p.m., 5,000 kilocycles per second. These three frequencies are intended to serve areas at varying distances from the transmitter.

Announcements on Tuesdays and Fridays (continuous wave transmissions) are made by means of telegraphic code. For the modulated transmissions announcements are made by voice at the beginning of the hour

The ape whose brain tissue is coupled magnetically to the circuit shown at the right, by means of the coils surrounding his cage and a coil fixed in his skull



and include a statement of the carrier and audio modulation frequency. The rated power for the CW transmission is 20 kilowatts; for the modulated transmission the power is one kilowatt.

The accuracy of the carrier frequencies is now better than one part in five million. The modulation frequency may be used with an accuracy of one part in a million by selecting one of the three carrier frequencies which has the least fading. Automatic volume control used in the receiver is helpful in maintaining accuracy of the audio frequency.

Information on this service may be obtained from the National Bureau of Standards, Washington, D. C., which welcomes comments and reports on the use of this service.

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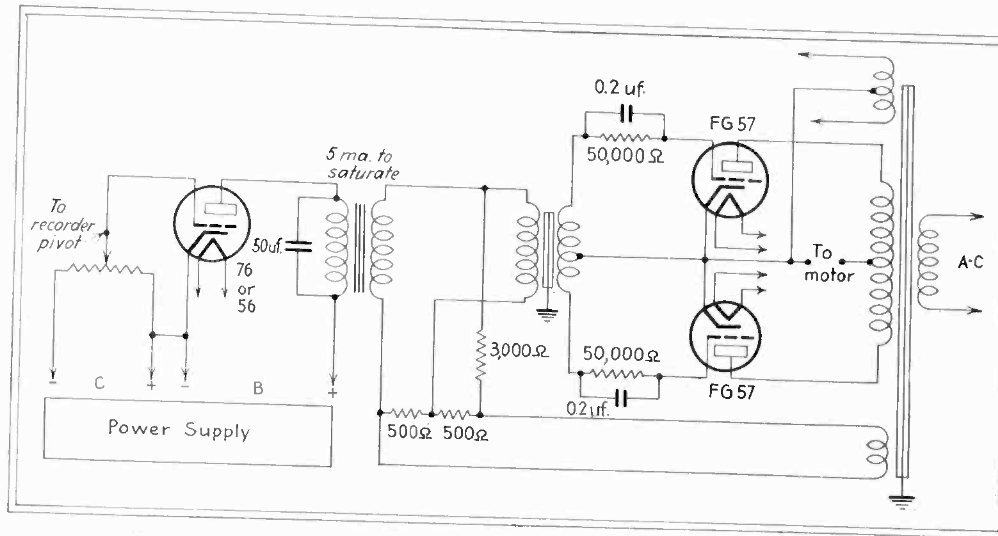


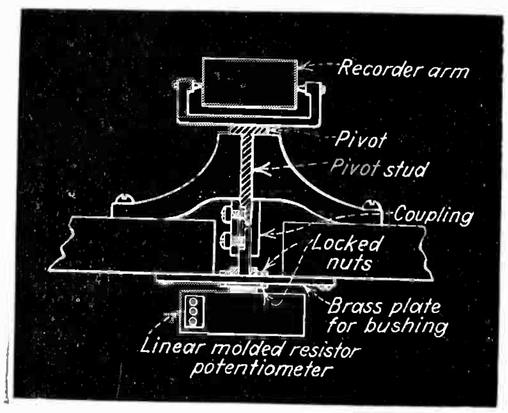
Circuit for turn-table speed control, using grid-controlled rectifiers

Increasing Disc Recording and Playing Time

By Bernard Ephraim

In recording technique, one of the major points is that a certain minimum groove speed must be maintained by the record if the full audio-frequency range is to be reproduced. On recorders having turntable speeds of either 33.3 or 78 revolutions per minute, the inner part of the disc moves slowly with respect to the needle or stylus, while the outer part travels very fast. Hence all present day discs are compromises with the increased outer edge wasting valuable recording space. If, by developing some scheme whereby the turntable speed is gradually increased as the recording or pick-up arm is in transit across the record so that the same relative groove speed would be maintained throughout the entire recording, the maximum efficiency would be obtained.

The figure shows the complete schematic diagram of such a control system. A study of the circuit will disclose that the turntable motor is electronically governed through a grid-controlled full-wave power rectifier. The lateral movement of the recording arm is transmitted through the main pivot to give a rotary movement to the potentiometer shaft fixed to the pivot stud by a coupling connection. Thus, as the recording stylus traverses the record, the resistance will be varied according to the position of the arm in relation to the record. By shunting this resistance across a steady d-c source, and impressing the variations of potential on the grid of a vacuum tube, it will be found that the plate current flowing through a saturable core reactor can be controlled over wide limits; the reactor varying the phase angle between the grid voltage and anode voltage of a pair of Thyratron tubes. In this manner the output energy which is indirectly controlled by the transverse movement of the recorder or pick-up arm, governs the speed of the turntable motor. In the experimental apparatus developed by the writer, a pregrooved sixteen inch disc was used. The turntable speed at the center of the disc revolved at 40 R.P.M., at the outer edge the speed was reduced to 8 revolutions a minute.



Mechanical coupling of recorder arm to resistor

The reproducer or recorder arms will tend to oscillate or wobble if the recording disc is improperly centered upon the turntable. This will cause a fluctuating bias to be impressed on the grid of the auxiliary control tube which, when transduced through the phase-shift device and power rectifier, will make the turntable motor deliver a wavering torque. To eliminate this undesirable effect a 50 μf capacitor can be shunted across the d-c winding of the saturable core reactor.

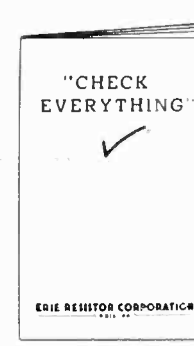
In addition to the above precaution, it would be advisable to drive the turntable or gear-train through twin rubber belts coupled on the motor side to a "Ramsey Pulvis Clutch." This is a special type of pulley which will take up line voltage fluctuations.

The turntable should be heavily weighted and dynamically balanced. This will eliminate mechanical waver or transient motion imparted to the revolving disc by drag during high amplitude excursions of the stylus.

SAFE PROTECTED BY ELECTRONIC SPACE-ALARM

In the Police Department Exhibit of the New York Electrical and Radio Exposition, a capacity-operated relay alarm for safe protection, shown above, was operated by any spectator who got too close

THE proven performance of Erie Resistors under all types of operating conditions has won for them a recognized reputation of quality and dependability. The booklet "Check Everything" tells why Erie Resistors will improve radio receiver operation. Write for your copy today.



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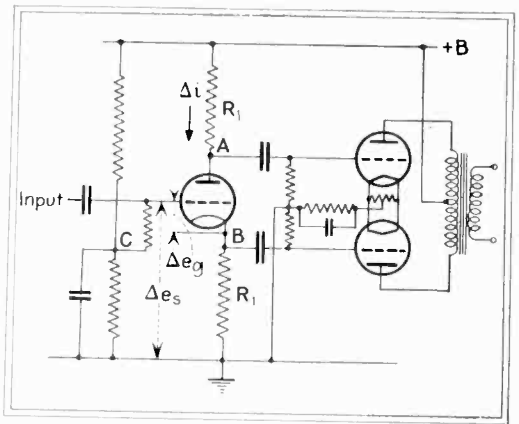
Resistance Coupling For Push-Pull Amplification

By Walther Richter

When it is desired to drive two tubes in a push-pull arrangement, the signal voltages on the two grids must be 180° out of phase, or in other words, when one grid swings positive, measured from the bias voltage, the other must swing negative an equal amount. While this is easily accomplished with a centertapped transformer, a phase inverter tube must be employed when resistance coupling is used. Proper balancing is then necessary, and the changing of a tube might upset this balance.

The circuit shown in the figure overcomes the need of balancing. Two equal resistors R_1 are placed in the plate, as well as the cathode-circuit



Mr. Richter's circuit for coupling a driver to a push-pull stage by a capacity-resistance network

of the triode. Since the plate current of the tube flows in both resistors, it is obvious that the a-c potentials of points A and B are 180° out of phase, since an increase of current, for instance, makes point A swing in the negative direction and point B in the positive direction. These two points are then condenser coupled to the push-pull tubes in the conventional manner.

If resistance coupling is employed throughout, as shown above, it is, however, necessary to realize that the driver stage *does not amplify*, but only serves the purpose of furnishing two voltages 180° out of phase. As a matter of fact, the a-c voltage of point A (or B) is slightly less than the input voltage to the tube. The proof is as follows:

Putting a voltage Δe_g between grid and cathode is equivalent to introducing $\mu \times \Delta e_g$ in the plate circuit; the current Δi in the plate current, due to this voltage, is:

$$(1) \qquad \Delta i = \frac{\mu \times \Delta e_g}{2R_1 + R_p}$$

where R_p is the plate resistance.

If the input a-c voltage Δe_s is introduced with respect to ground or any other point of fixed potential, the actual grid voltage is equal to the signal voltage diminished by the voltage drop caused by Δi in the cathode resistor R_1; it is, therefore,

$$(2) \qquad \Delta e_g = \Delta e_s - \Delta i \times R_1$$

introducing this in (1) gives

$$(3) \qquad \Delta i = \frac{\mu \times \Delta e_s - \mu \times \Delta i \times R_1}{2R_1 + R_p}$$

solving for Δi, we obtain

$$(4) \qquad \Delta i = \frac{\mu \times \Delta e_s}{R_p + (2 + \mu) R_1}$$

Each of the two 180° out of phase output voltages Δe_p is equal to

$\Delta i \times R_1$; therefore,

$$\Delta e_p = \frac{\mu \times \Delta e_s}{\frac{R_p}{R_1} + 2 + \mu}$$

The ratio of the output to the input voltage

$$\frac{\Delta e_p}{\Delta e_s} = \mu^1 = \frac{\mu}{\frac{R_p}{R_1} + 2 + \mu}$$

This value can obviously never exceed unity. Hence the tube does not amplify.

If a 56 type tube is used with μ approximately 14, R_p = 9,500 and coupling resistors R_1 = 20,000 ohms, we have

$$\mu^1 = \frac{14}{\frac{9500}{20000} + 16} = \frac{14}{16.475} = .85$$

Screen grid tubes cannot be very well used, since for their proper working it is necessary that their screen voltage is constant with respect to the cathode. Since in this case the cathode potential varies, the screen voltage cannot be obtained from a voltage divider, but would have to be derived from a battery connected to the cathode. However, screen grid tubes can be connected as triodes (*Electronics*, July, 1934, page 211), resulting in an amplification factor of about 20.

The grid bias for the phasing tube must be obtained from a voltage divider. How the proper voltage is obtained is easily shown in the above example. Assume that a 56 type tube is to be used and 300 volts is available from the rectifier. Let the voltages with no signal be 160 volts across the tube and 70 volts across each resistor; with R_1 = 20,000 ohms, the current through the resistors should then be $\frac{70}{20,000}$ amperes, or 3.5 ma. From the plate characteristics we find that for 3.5 ma. at 160 volt plate voltage, a negative bias of 8 volts is required. Since the cathode with no signal is 70 volts above ground, point C, furnishing the grid bias must be at 62 volts, which determines the voltage divider values.

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This integrating sphere directs the entire light output of a sample lamp, taken from the production line, into a photocell mounted on top, which in turn measures the light output in lumens

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WESTON *Instruments*

R-F Insulator Limits

(Continued from page 12)

tically coincident with the "rms. r-f. volts for 5°C. rise" curve at the lower frequencies, but at 10,000 kc the maximum operating voltage is 3 times the voltage limited by 5°C temperature rise.

Figure 3 is convenient to use when the power loss in the insulator is of no consequence. The peak values of internal stress limit voltage are plotted on the curve "max. peak r-f volts."

Although the r-f peak voltage is limited by different kinds of operation, the heating produced by d-c or audio modulation voltages is negligible, and the temperature rise in all cases, depends only upon the effective r-f amplitude. That is, in the case of CW r-f plus d-c. the temperature rise may be found by use of the temperature-voltage curves of Fig. 2 for the r-m-s r-f voltage only. In the case of modulated r-f voltage, the temperature rise is 1½ times the rise corresponding to r-m-s carrier voltage.

Exceeding the internal stress limit in the case of modulated r-f voltage has a vital effect upon the operation of equipment, entirely apart from the damage done to the insulator. Up to point *A*, Fig. 4, the insulator is a linear impedance. Beyond point *A* it has less impedance than below *A*. More power is thus consumed by the insulator at peaks of modulation if these peaks exceed the peak voltage at point *A*.

The benefit of using corona shields on insulators was observed by running one type of insulator with and without corona shields. The insulators with shields ran at about double the voltage at a given temperature of those without shields, and the voltage at point *A* was materially increased by using shields. It should be pointed out that these shields are not properly corona shields when used on r-f insulators if the term corona is reserved for air alone. The principal benefit obtained by using the shields is a more uniform distribution of the dielectric stress in the insulator, and thus less dielectric loss at any voltage and a higher voltage at which deterioration sets in. The voltage at which corona in the neighboring air begins was actually *lowered* by the addition of shields in 60-cycle tests, because adding the shields decreased the creepage distance between terminals.

Insulators of identical shape and size, but formed from ceramic materials of different power factor were tested simultaneously. The difference in temperature rise was roughly proportional to the difference in power factor (4 to 1). But the internal stress limit was found to be practically the same for both insulators. It follows that the value of power factor ordinarily given for insulating materials is a correct gauge of their utility under conditions where it is important that the power loss be kept low. But the power factor has little bearing upon the maximum operating voltage to which the insulator may be subjected. Instead, the size, shape, freedom from sharp edges, and use of corona shields appear to influence the voltage limit to the greatest extent. In fact, to be sure of correct results, tests of the kind described here should be made for any insulator under the exact conditions for which it is intended.

Tube Capacity Put to Work

[*Continued from page 32*]

cies, large grid to plate capacitance, and large values of plate load resistance; the capacitance variation may be smaller, but its general behavior will be much as outlined above. Also, the input voltage to the capacity control tube must be small enough to avoid overloading its grid circuit with consequent decrease in capacitance variation.

[1]Nichols, Physical Review, vol. 13, page 405, 1919; Miller, Bureau of Standards Bulletin No. 351; Van der Bijl, "The Thermionic Vacuum Tube," page 205; and Peters, "Theory of Thermionic Vacuum Tube Circuits," Chapter 8.

[2]Kolster Radio Company.

[3]This use due to M. P. Wilder.

[4]Electron Research Laboratories, New York City. Developed by J. M. Hollywood and M. P. Wilder, assisted by A. W. Barber.

[5]Jahrbuch der Drahtlosen Telegraphie und Telephonie, vol. 6, page 146, 1912.

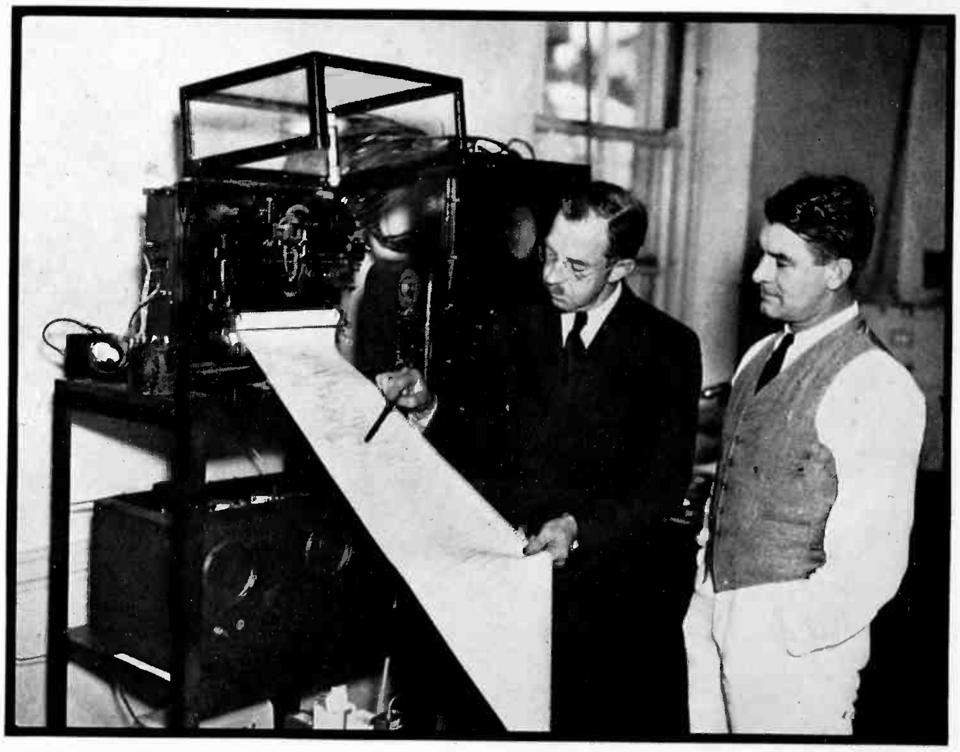
[6]Proceedings I.R.E., Oct., 1932, page 1580.

[7]"Electronics," January, 1935.

[8]Developed by A. W. Barber.

[9]Proceedings I.R.E., August, 1933, page 1182.

RECORDING EFFECT OF MOON ON RADIO



Dr. Harlan Stetson, and Thomas S. McCaleb of Harvard with an automatic signal-strength recorder. The record indicates that the moon as well as the sun causes changes in ionization of the upper atmosphere

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THE ELECTRON ART

THIS month, The Electron Art presents on the three following pages a review of the new radio sets offered in the European markets, particularly in Germany and England, in which countries simplified circuit design seems to be the main item of interest. Immediately below are items gleaned from the daily press, a cross-section of the news of the field.

IN THE NEWS

SENATOR GUGLIELMO MARCONI will direct the telegraph, telephone and wireless communications of Mussolini's army in East Africa, according to reports of his friends, although Mr. Marconi states that he will enter the naval service. Asked about his experiments with micro-waves used to cut off the ignition systems of airplanes, he replied "I have nothing to say."

DURING THE recent maneuvers of the Italian Army, a portable telephone exchange, drawn from place to place by a tractor, was used for the first time. Premier Mussolini expressed great interest in the fact that the Italian cavalry now carries wireless equipment. Radio sets have also been installed in tanks and equipment for transmission of voice over a beam of light is available in case wire communications are interrupted.

MUSICAL PROGRAMS without advertising are being sent over the electric light and telephone wires to subscribers in the Lakewood section of Cleveland, as announced by the North American Company of New York, whose subsidiary, Wired Radio, Inc., has been experimenting with this type of entertainment transmission. The monthly charge for programs is $2.00 and up. Carrier telephony is used.

ALTHOUGH THE New York Police Station can reach its police boats by radio, the fireboats of the Fire Department are not equipped with radio. In order to install a two-way radio system for connecting the nine fireboats with a land station, Commissioner McElligott has asked an appropriation of $37,000.

THE BOARD OF DIRECTORS of the Radiomarine Corporation of America announce the election of Mr. Charles J. Pannill as president of that corporation. Mr. Pannill, who joined the company in 1928, is the holder of the first radio operator's license issued by the American government.

ONE OF THE LEADING manufacturers of radio receiving sets has been using the phrase "super high fidelity" in connection with certain of its receivers offered this fall. There appears to be nothing left for next year's crop, except possibly "super super high fidelity."

FROM THE BOOK REVIEW in the New York *Times* on "North to the Orient" by Mrs. Anne Morrow Lindbergh: "Anne says she has never passed an arithmetic test in her life. She had to be tutored to get through elementary college physics. She was barely able to distinguish a vacuum tube from a toothbrush. Yet in a few weeks time she mastered enough of the technicalities of radio to get an operator's license and throughout the trip she took care of the transmitting and receiving." P. S. we have read this book, and it is grand. Anne, too, had MOPA troubles.

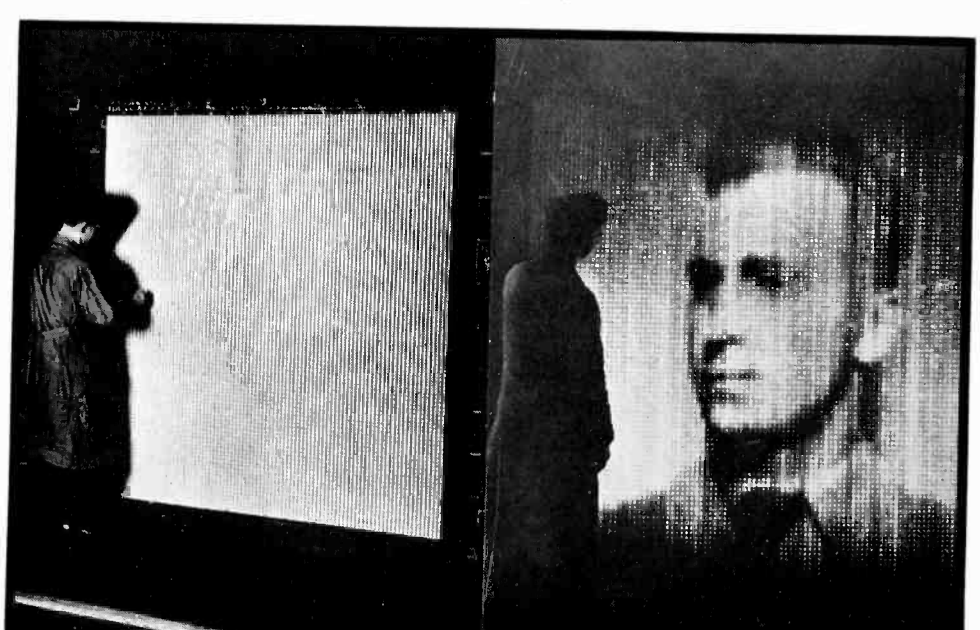
THE RADIO CORPORATION OF AMERICA is nearing the completion of a new 200 kw. short wave transmitter now under construction at Rocky Point, Long Island. This high power output, five to ten times the usual power employed for international communication, is intended to override interference which occurs under abnormal conditions, particularly during magnetic storms. The operating wave length will be approximately 28 meters.

THE CANADIAN PARLIAMENT has extended the life of the Canadian Radio Broadcasting Act for a period of nine months, thus extending the life of the Canadian Radio Commission to March 31, 1936. In the discussion of the bill, it was claimed by several members that a monopolistic trend was developing, in that several of the smaller stations were owned by single company. The Prime Minister replied to this criticism saying that no good will value was attached to a license, which may be taken over by the state at any time.

THE FEDERAL COMMUNICATIONS COMMISSION has requested all radio stations operating above 30,000 kilocycles (10 meters) to report on any experiments which might aid the commission in deciding upon the problem of commercial allocation of the ultra-high frequencies. At present all assignments in this range are on an experimental basis, with the exception of the amateur bands.

ACCORDING TO Andrew W. Cruse, chief of the electrical division of the Bureau of Foreign and Domestic Commerce, Washington, a German broadcast station recently announced that on a certain program an experimetal "odor transmission" would be performed. Listeners were invited to place their Nordic noses near the loud speaker. After the broadcast, thousands of reports were received from German listeners saying that they had detected the perfume of frying sausages, wild violets, lager beer, and a host of others. After the fan mail had been received, the broadcasting authorities asked the listeners to recall the date of the transmission, which was—April 1.

SIX-FOOT TELEVISION SCREEN



The resourceful Germans have developed this 6 by 6 foot television screen, made up of 10,000 electric lamps, each "wired for sight." Moving images of great brilliance are thus produced for use in auditoriums or for large mass gatherings

The manufacturer who supplies his otherwise perfect receiver with an inferior control is skating on "thin ice."

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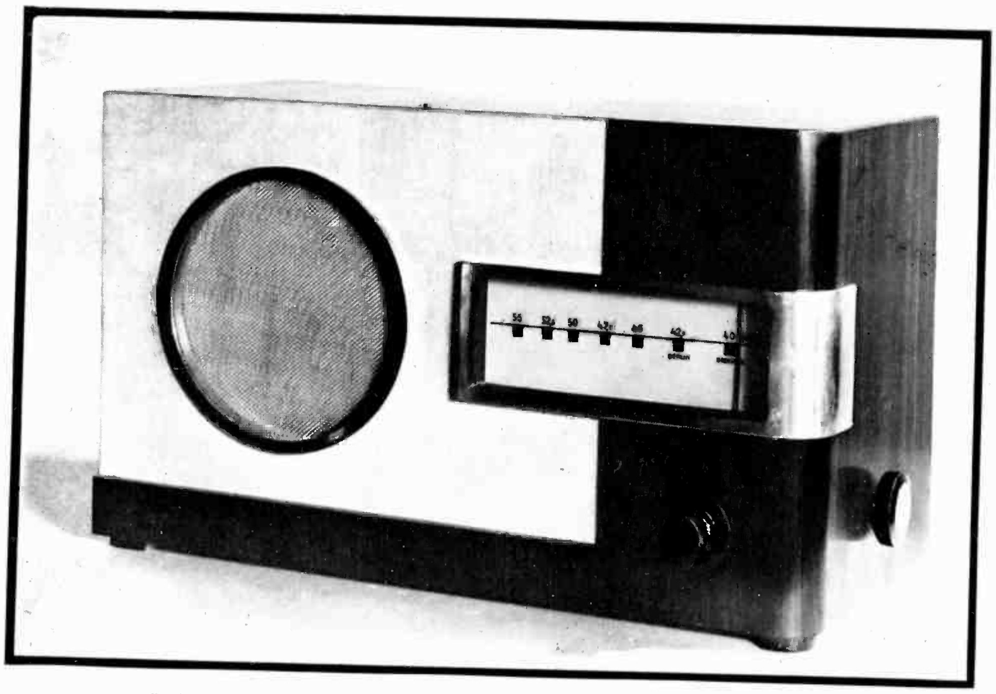


Cabinet design in Germany continues in the modern vein

Developments in German Receiver Design

By W. E. Schrage

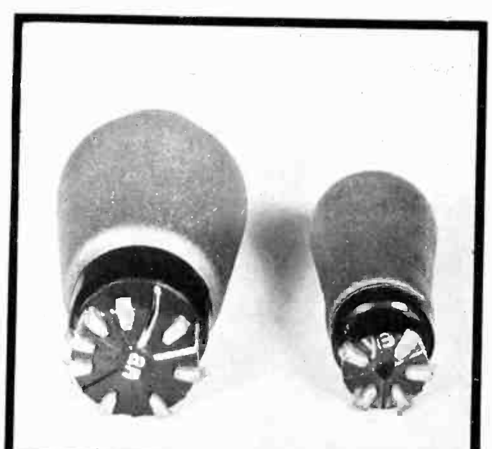
The 12th Berlin Radio Show showed a remarkable trend in German radio engineering towards simplification in circuit design. The radio show of the last year displayed a great many midget receivers with astonishingly complicated reflex circuits; these sets often showed a number of r-f and a-f gadgets which an American radio engineer hardly would appreciate, since an equal efficiency might be obtained much more cheaply by use of one or two additional tubes.

This year the reflex circuits largely disappeared and the few remaining ones are of old design in a cabinet of new pattern. A great many of the 3 tube midget reflex supers, which brought the manufacturers heavy losses, and made the production engineers much trouble, also disappeared. They have been replaced by t-r-f sets furnished with iron-core coils and low-loss tuning condensers designed with ceramic insulation.

Another interesting development on the German set market is the disappearance of d-c receivers. The majority of the manufacturers offer Universal a-c—d-c sets. These sets are furnished with special designed indirect heated tubes of 25 volt heater voltage for the output stage and 13 volt heater voltage for the tube of the other stages. All tubes have a uniform current drain of 200 milliamperes. The heaters of the tubes are connected in series, and the voltage reduction necessary to decrease the 220 volts from the power line (there are only a few 110-volt networks in Germany) is obtained by use of a new kind of ballast lamp.

The new ballast lamps have a relatively straight resistance characteristic compared with iron filament ballast lamps. This uniform resistance avoids the danger of destruction of the heaters in the first instant after the set has been put in operation, during which time (before heating) the heaters have a low resistance. In the new lamp, a small resistor made of Urandioxide has been connected in series with the iron filament. The Urandioxide is a resistor with an extremely high temperature coefficient. Since this characteristic is just contrary to the resistance characteristic of the heater filaments of the tubes and of the ballast lamp of old design, the low starting resistance of these filaments is neutralized.

Since it is inconvenient to supply exciting power to the field of a dynamic speaker in connection with a universal set, advancements in permanent magnet dynamic speakers has been pressed very much in Germany. As result of research work with iron alloys



New German tube bases

there are at present offered dynamic speakers with permanent magnets having a magnetic flux in the air-gap up to 12,000 Gauss. This is a magnetic field strength generally not surpassed by the average dynamics of normal design. The most used alloys are a Cobalt-Titan Iron and an Aluminum-Nickel-Iron composition. Since the new permanent magnetic dynamics are entirely free of any background hum some a-c sets have been equipped with the improved permanent magnetic dynamics. Another feature of the new speakers is the new form of the cones used. The so called "Kelchform" (designed in shape of a cup) is one. Another new cone form has an extremely flat shape which it is claimed delivers a very flat response curve but only for a small acoustical load.

Tuning dial progress

The fondness of German engineers for intricate construction has brought about progress in tuning dial design such as tuning devices fitted with a flywheel. A heavy flywheel drives a gear of ratio 1:150, which in turn is connected with the tuning condensers and drives indicator of the tuning dial. When listener wants to tune in a station on a distant part of the tuning scale, he puts the flywheel into action, and the indicator travels rapidly. If the indicator is near to the wanted scale division, the flywheel must be stopped and the exact tuning is done by use of a large gear ratio which moves the indicator very slowly over the scale.

Since there is no large market for auto receivers, only a few manufacturers offer sets of this kind. One of the best receivers of this kind as shown resembles very much a similar set made by American-Bosch. It has four tubes operating in a superhet circuit, but has a very small permanent magnetic dynamic speaker which has, despite its small dimensions, a magnetic field strength in the air-gap of 6,000 Gauss.

All sets displayed have been furnished with tubes with usual characteristics but of new socket design. Instead of the internationally used pin socket the new tubes have small wings fixed upon the base of the sockets. These wings fit into small slits provided in wafer sockets. Each slit is furnished with contact spring in ribbon form which slides under heavy pressure against the small wings of the tube socket.

• • •

British Radio Show 1935

A typical feature evident in this year's new sets is variable selectivity for tone correction. Tone correction in the audio frequency stages is wasteful since it involves additional cutting of the frequencies received. It is more economical to introduce the correction into the tuning circuits, which are responsible for most of the failings of selective receivers as regards h.f. response. Now since the gain in each stage is equal to the product mutual conductance g by load impedance Z, even when using screen grid tubes in a tuned radio frequency amplifier, and the load impedance consists of the

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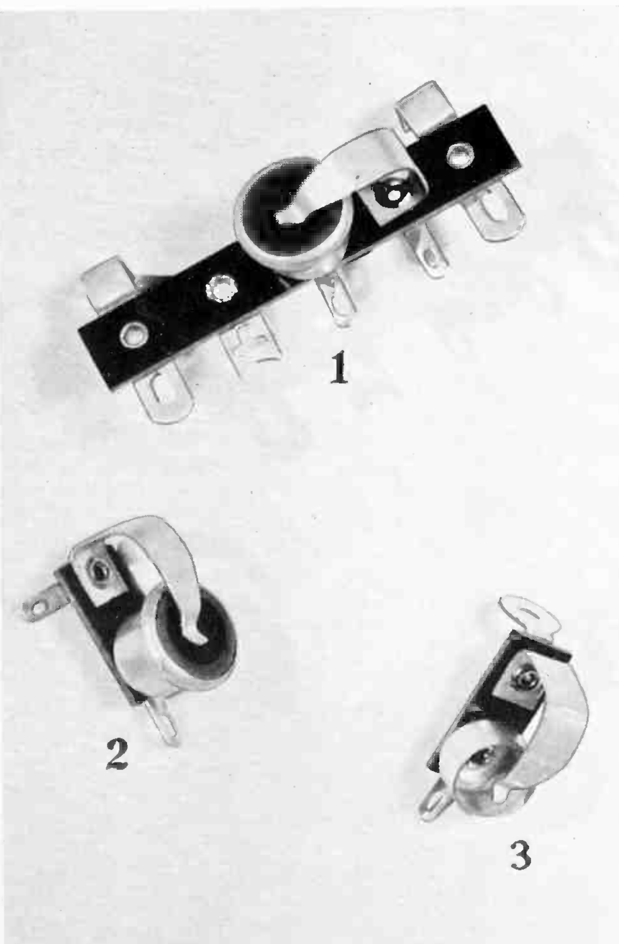
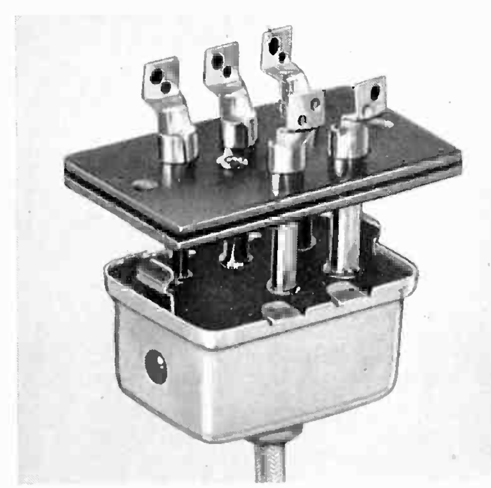
C-Bias Cell Mountings, "Very Satisfactory"—The "Square" Plug—"Cinch" Cable Connecting Plug, "The Size of a Quarter"—Mounting Strip, "Just What Was Wanted"—with these new improved parts "Cinch" contributes much to the profit possibilities of the set. That is the record. Users know that when the part is a "Cinch" so is the problem. Ask us for names of set manufacturers who can tell you about "Cinch" parts—or better still, tell us your problem.



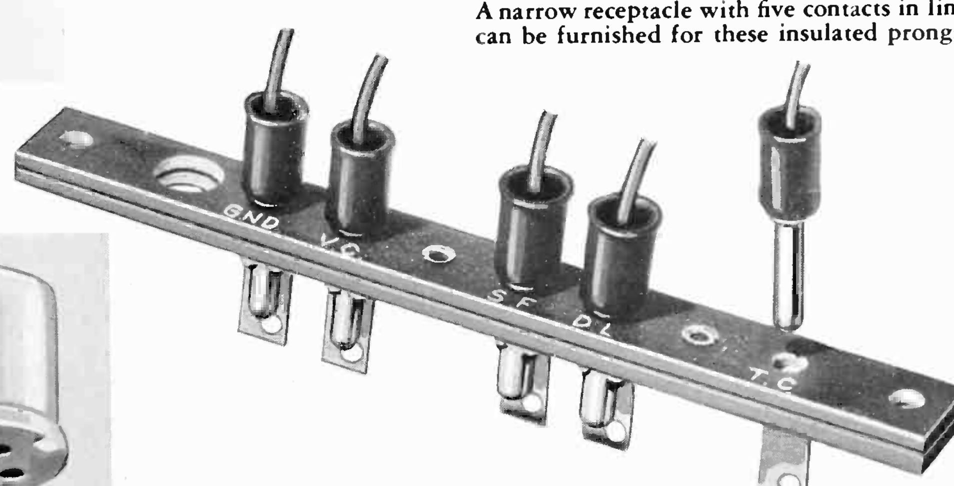
The "CINCH" C-BIAS CELL HOLDERS—Steel cadmium plated cell cup and a phosphorous bronze spring in convenient mounting strips make a doubly efficient unit at a low price. The cell cannot be displaced nor lost under any condition due to vibration. Removal for replacement is easily, quickly and simply made. (1) Several holders can be applied to one strip when more than one cell is necessary. In each case the cup may be had (as illustrated at the left) with a soldering lug attached for quick soldering of connections. (2) Similarly the spring may have an attached insulated, independent lug for wire soldering or (3) may be fastened to the mounting lug for grounding when strip is riveted to the chassis.

Cinch and Oak Radio Sockets are licensed under H. H. Eby socket patents.

A scientifically matched polarized CINCH "SQUARE" PLUG and CHASSIS SOCKET (pictured below). Dependable, completely shielded; interior of shell insulated with sheet fibre, convenient neck on cap for soldering braided cable shield; two bronze spring clips, which snap through chassis when plug is inserted, grounding plug and cable to chassis. This new, serviceable "square" plug and socket can be had from two up to six prongs.



A time-saving, low-cost, "revolutionary" pin for connecting up of accessories where space is limited. The former clumsy method of wiring to binding posts is eliminated—connections are quickly made—and disconnections also, by simply pulling out. The new pin can be plugged in while "hot"—it is insulated with a fibre ferrule—and the slight flare prevents slipping in handling. It fits any contact taking standard size tube prongs. A narrow receptacle with five contacts in line can be furnished for these insulated prongs.



A brand new metal polarized "CINCH" MIDGET PLUG designed and constructed to fill the need of one manufacturer. Perhaps there is something other than the standard plugs that you want. Whatever the need—ask us. We may have something in stock.

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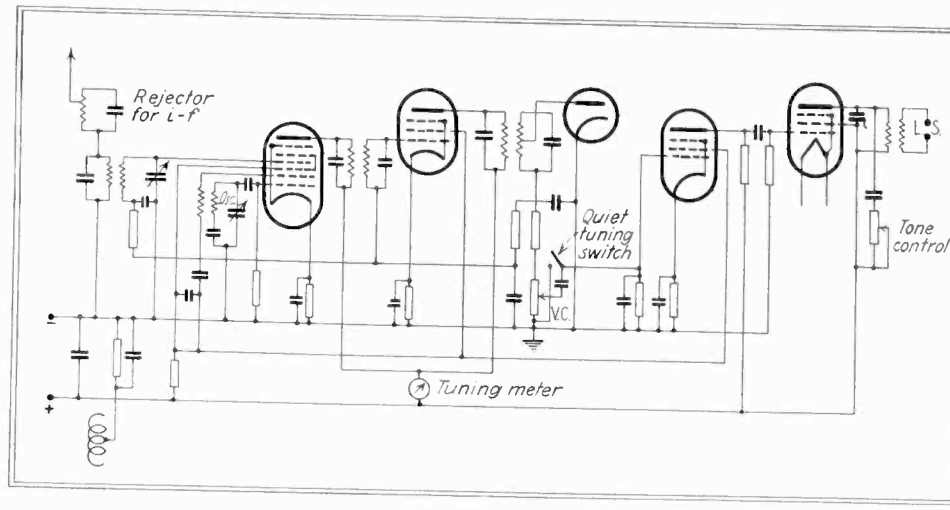
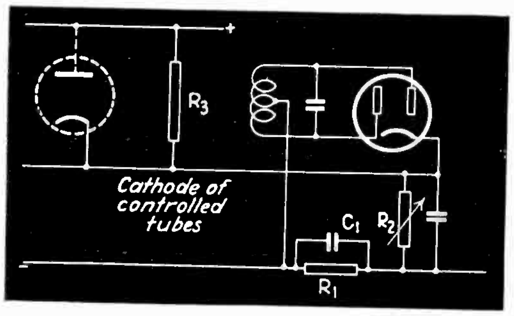
equivalent resistance $R_1 + M^2\omega^2R_2/Z_2^2$ and the reactance $X_1 - M^2\omega^2X_2/Z_2^2$, side band cutting depends in a complicated way upon the incoming angular frequency $\omega = 6.28 f$ which appears in $X = \omega L - 1/\omega C$ and in $Z_2 = R_2 + X_2$. Unless permeability tuning is used, selectivity control over the broadcast band is therefore possible only in the i-f stages of superheterodynes.

The means actually used for obtaining variable selectivity are to vary the coupling between the coils of the i-f transformer by sliding the coils relative to one another, or to mount a third coil shunted by a variable resistance between the two tuned circuits fixed for highest selectivity by varying this resistance the amount of energy taken by the third coil is altered, and with this load, the selectivity. In place of continuous control a variation in steps may be advantageous such as in the first position response up to 9,500 kc., in the second position response restricted to 6,500 kc. or, finally, response cut off at 3,500 kc. A discontinuous change is also obtained by switching out one or two tuned i-f circuits and replacing them by resistance coupling. In many cases an automatic change of selectivity in changing from distant to local stations will be satisfactory (see also *Electronics*, June, 1935).



Circuit of the Philips-Aachen receiver described below



Quiet a.v.c. without additional tubes (Wireless Engineer, Sept. 1935)

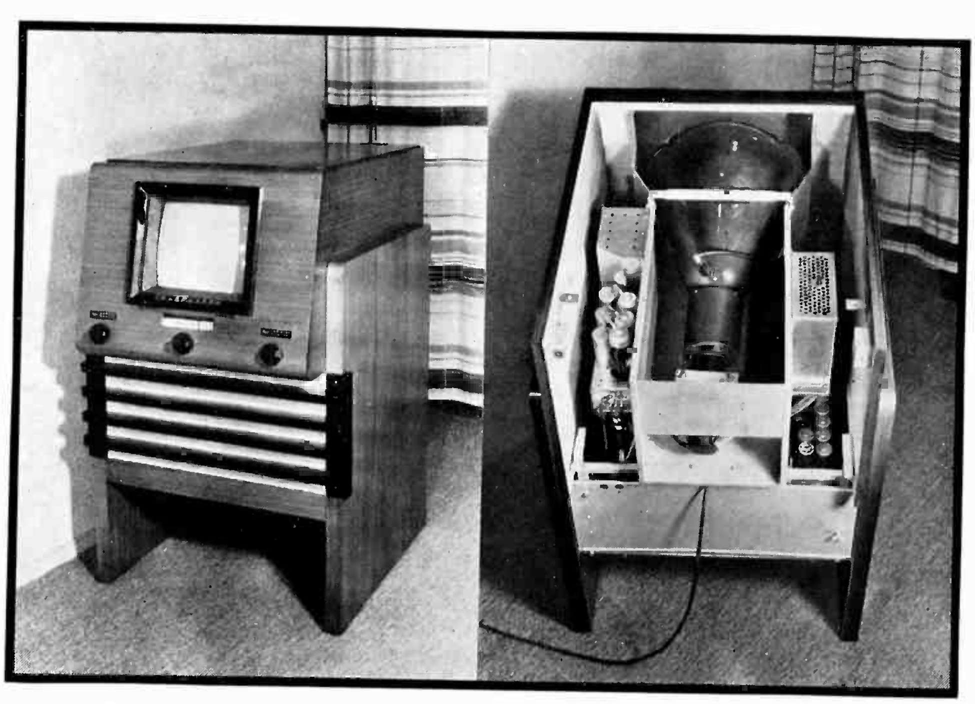
A second feature in evidence this year is quiet automatic volume control. The circuits ensuring quiet tuning are called muting circuits; they give either true Q.A.V.C. or muting between stations, the detector or a tube in the amplifying stages being made inoperative when the set is not exactly tuned to a signal, or they give partial muting or noise suppression, the sensitivity being reduced by a switch while tuning. The muting circuits employed vary a great deal. Either the last i-f tube is biased beyond current cutoff in the absence of a signal, the controlling voltage being fed through very selective circuits, or the cathode of the diode rectifier is biased positively by the current flowing through a resistance R_2 (see figure) between ground and cathodes, this current coming from a resistance R_3 between the highest positive terminal and the cathodes of the controlled tubes and the diode. Or the d-c path from the diode plate is returned to the cathode of the frequency changing tubes, the cathode of the diode being connected to the cathode of the i-f amplifier. Or muting is operated by the a-v-c system and controls the a-f tube, a diode detector providing the initial a-v-c bias which is amplified by the d-c amplifier before being applied to the tubes.

European 1935-1936 Six-tube Superheterodynes

In the Philips-Aachen Receiver the tubes used conform to the established standard: the first tube is an octode, it is followed by an r-f pentode for the i-f (475 kc.), a diode, an indirectly heated a-f pentode and, resistance-coupled, a directly heated pentode. The selectivity is kept within limits in order to improve quality, since station separation is 9 kc. at best. The fourth grid of the octode and the control grid of the i-f pentode are in the a-v-c circuit, which uses simply the voltage drop across the diode. A push switch on the audio frequency side of the same circuit allows silent tuning. The use of a permanent magnet in the dynamic speaker reduces to about 300 volts the potential difference required on the set. The power transformer has 11 steps in the primary for supply potentials between 103 and 253 volts. Removing the rear wall of the set interrupts the power supply to the set. The set is remarkable for its small size, the gang condenser, for instance measures but 6x6x7 cm. (2⅜"x2⅜"x2¾"). Tuning scale and loudspeaker opening are combined.

The superheterodyne "Deutschland" of the Telefunken Company is of special interest because it is used by the German radio administration for rebroadcasts and for measuring the modulation of senders. It consists of an r-f amplifier using an exponential hexode, a frequency changing and mixing stage with a hexode in which the local oscillation is produced between the third grid serving as a plate and the fourth grid as oscillator grid, an i-f amplifier using an r-f hexode, a diode-triode detector and an output pentode. The set covers three ranges: 1961-795 m., 573-204 m. and 50.5 to 19.5 m. A re-

GERMAN SIGHT-SOUND RECEIVER



Excellent artistic and technical design has been employed in this Telefunken television receiver, recently shown at the Berlin Radio Show

GOAT Form Fitting Tube Shields

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Bulletins, samples and prices on request

GOAT RADIO TUBE PARTS, INC. • • • • • 314 Dean Street, BROOKLYN, N. Y.

(A Division of THE FRED GOAT COMPANY, INC., Established 1893)

43 E. Ohio Street, Chicago, Ill. 200 N. Edgemont Ave., Los Angeles, Calif. 500 King Street, West, Toronto, Canada

Variety

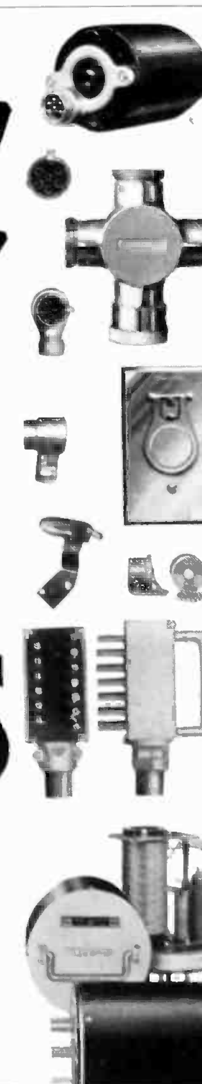
of fittings, Quality of workmanship and materials and Service without limitation—these are the underlying principles that have made possible the success attained by CANNON Plugs.

Over 600 different fittings for special purposes and thousands of stock parts always on hand afford an almost unlimited number of combinations that enable us to supply unusual needs with unusual speed, without sacrificing quality. Any manufacturer can make a plug "down to a price" but such sources of supply do not keep planes in the air nor pictures in production.

The list of Cannon clients constitutes the "blue book" of the airplane and sound-recording industries. And, to use the vernacular of the street, all of these people can't be wrong!

General Plug Catalog or Special Airship Plug Catalog Available on Request.

CANNON PLUGS



CANNON ELECTRIC DEVELOPMENT CO.

MANUFACTURING ENGINEERS

Main Office: 420 West Avenue 33, Los Angeles, California

Eastern Sales Office: Lewis & Sachs Company, 220 Fifth Avenue, New York

REPRESENTATIVES:

CHICAGO: Jenkins & Adair, Inc., 3333 Belmont Avenue
DALLAS: Edward F. Aymond, 3750 Urban Avenue
BOMBAY, INDIA: Eastern Electric & Engineering Company, 175 Hornsby Road, Fort, Bombay, India

CANNON

jector circuit shunts the coil which couples the antenna to the first tube; it is adjusted once for all to eliminate the nearby broadcast station. A resistance is inserted in the grid lead of the first tube in order to prevent oscillations, this lead runs to the center, not to the end of the tuning-coil. A-v-c. is obtained by means of two resistances R_1 and R_2 in the cathode lead of the diode; the potential drop building up across R_1 acts over a time constant circuit upon the third grid of the r-f hexode, and the drop across R_2 and R_1 acts upon the control grid of the r-f and the i-f hexode. A variable 3,000 ohm resistor is in the lead to the cathode of the i-f hexode and helps to suppress noise. The last grid of this tube is used as a plate, the plate proper and the suppressor grid being connected to the cathode. The loudspeaker primary is shunted by a condenser and a variable resistance. An additional loudspeaker may be inserted between ground and primary.

Both sets are table models, the first is described in *Funkt. Monatsh.* No. 8: 323-324, 1935, the second in Onde e'l. 14. No. 163: 470-479, 1935.

• • •

Grounding Coupling Coil and Tuning in Oscillator Circuit

[E. Fischer and H. Dietrich, Stuttgart Institute of Technology.] When a coupling coil is placed inside or beside the tuning coil, the oscillator is thrown out of tune when one end of the coupling coil is connected to ground, the other left open, but can be brought back to resonance by merely changing the position of the tuning condenser. When the end nearer to the ground end of the oscillator coil is grounded and the coils are wound in the same sense, an effect is observed only in a narrow range of frequencies; this result is reversed when the coils are wound in the same direction.

The change may be explained and computed by assuming the capacity between the two coils to be concentrated at the open end, and to be represented by a condenser C in series with the coupling coil L. The current flowing through this branch is either capacitive or inductive depending upon the relative size of L and C, and must be compensated for by an increase or decrease in the tuning condenser. When the coils are wound in the same sense and C is smaller than $1/\omega^2 L$ and the end near the ground is grounded, the correction is large.—*El. N. Tech.* 12. No. 6, 172-175, 1935.

• • •

Onde Electrique

THE recent number 163 of *Onde Electrique*, the organ of the French Society of Radio Engineers, is of particular interest, because it starts with an article on the radiogoniometers by the President of this society, Mr. R. Mesny, professor at the Ecole Superieure d'Electricite and author of several books on radio engineering. The issue contains also a review on quartz oscillators by R. Jouaust, vice-president of the Society, Assistant-Director of the Laboratoire Central d'Electricite, and a description of the Telefunken receiver Deutschland by P. Besson, the General Secretary of the Society. The same number contains in addition an article on probability and radio-communications by H. De Bellescize, and the end of a review: The Actual State of Television by R. Barthelemy whose name is most frequently mentioned in connection with television developments in France.

• • •

A Highly Sensitive Instrument for Measuring Small Coefficients of Damping

[Otto Schutte and G. Weiss, Heinrich-Hertz Institute, Berlin.] The instrument intended for measuring small losses of condensers, coils, oscillating circuits and r-f resistors, consists of a quartz-controlled oscillator and a vacuum tube voltmeter with plate rectification. The circuit to be studied is coupled to the oscillator by means of a small capacity of the order of 1 $\mu\mu$f. The tuning condenser of the oscillator is first adjusted for resonance, and then rotated to one and then the other side until the voltage reading is reduced to one-half. When the total difference in capacity is D, and the sum of the capacity at resonance plus the coupling capacity is C, then the logarithmic decrement, that is the natural logarithm of the ratio of successive amplitudes toward the same side is $d = 0.908$ D/C. The Q of a coil used together with a condenser without losses is $\omega L/R =$ 3.46 C/D. A coil with a high Q may then be combined with a condenser and the condenser losses determined from the difference. High resistances for use at r.f. are measured by placing them in parallel with a condenser. The accuracy of the method is about 1% in the broadcast band.—*El. N. Tech* 12, No. 7, 204-210, 1935.

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Telefunken Zeitung

THE MOST RECENT ISSUE of the *Telefunken Zeitung*, Vol. 16, No. 71 (1935), the organ of the Telefunken Company, contains the following articles:

V. Lolhoffel: "The sound film."

F. Schroter: "Possibilities in the future development of picture telegraphy."

G. Berger: "Oscillators for receiver measurements."

H. Rothe and W. Kleen: "On the possibility of controlling gas discharges."

These articles, each about 10 pages in length, are richly illustrated.

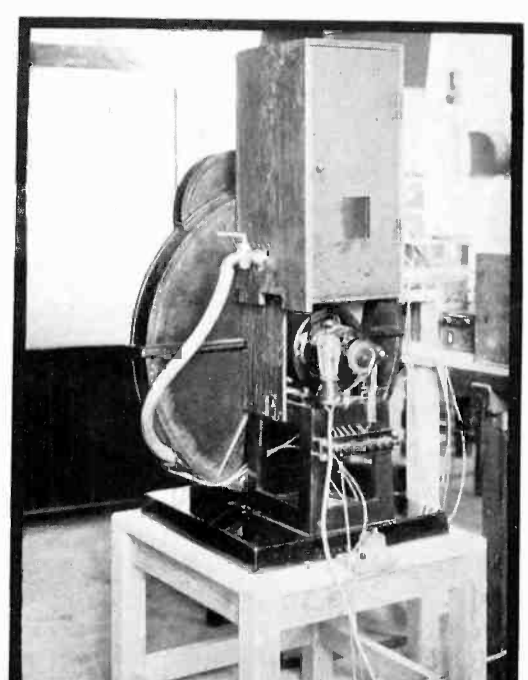
• • •

Disc Television in Japan

THE EDITORS have received from T. Sone, of Tokyo, Japan, two interesting photographs of disk television equipment which he has developed. The transmitter, shown in the illustration, is capable of televising outdoor scenes, according to its inventor, in sunshine, or even in cloudy weather. The use of a high-power objective lens for light concentration permits this direct scanning without high-power illumination.

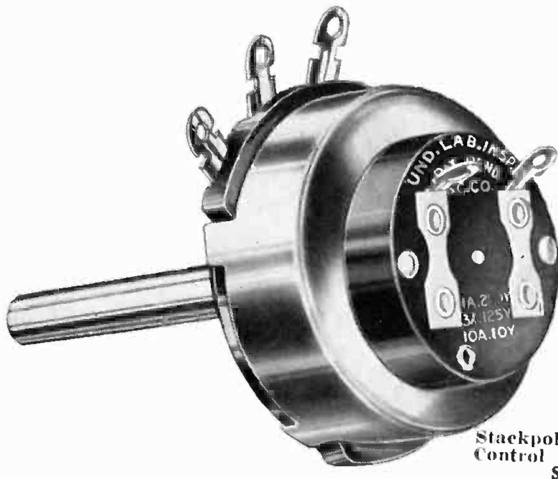
The receiver shown in the picture likewise has a disk of 84 lines, the disk being 60 cm. in diameter. The light source is a high-pressure mercury lamp of special type. It requires a current of 1 amp. The receiver uses a total power of 1 kw. as contrasted with ¼ kw. for the transmitter.

JAPANESE TELEVISION

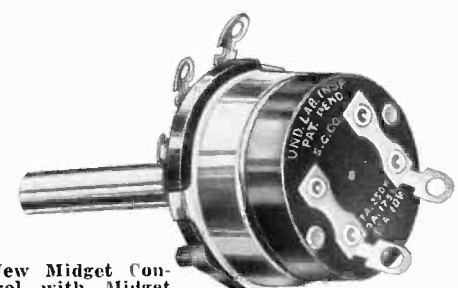


Television transmitter and receiver built by T. Sone of Tokyo. The disc method is used

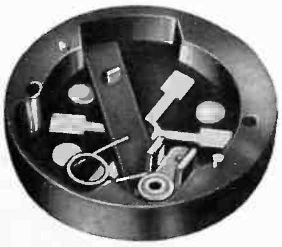
Stackpole Presents a new Midget Control for Auto Radios



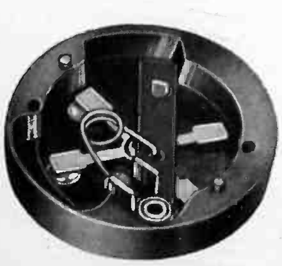
Stackpole Type "C" Control with Midget Switch



New Midget Control with Midget line switch.



Interior Midget Switch (open)



Interior Midget Switch (closed)

On behalf of modern design and engineering, you've repeatedly asked for a miniature control, with a dependable line switch, replete in all known advantages of larger size controls. You asked for it—our engineers went to work—and now after months of experimental work, we have it! A MIDGET CONTROL by STACKPOLE—100% accurate—not a single outstanding point of our larger controls is sacrificed.

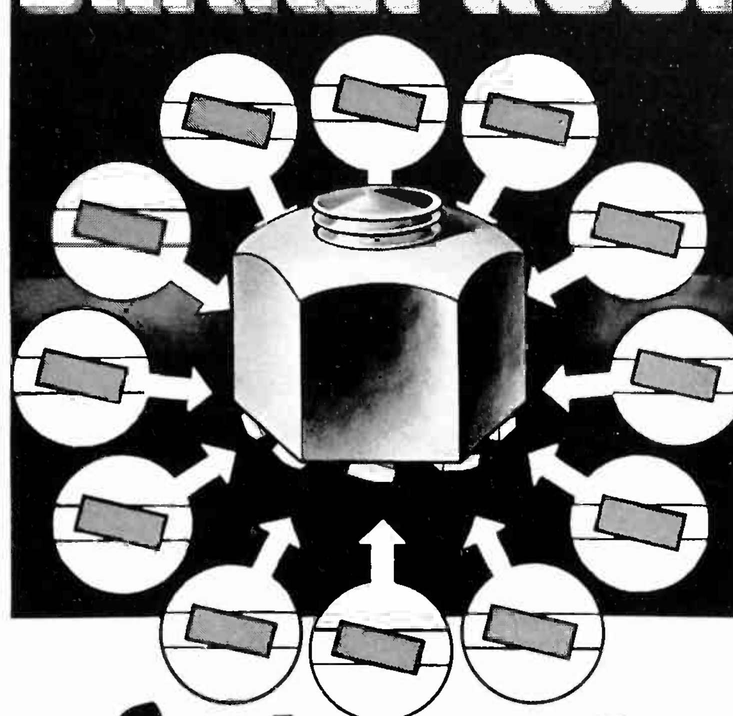
The NEW MIDGET CONTROL is a "natural" for the makers of the new Auto Radios where, at best, space is at a minimum. It's a "find" for the makers of modern household receivers—the line switch carries the APPROVAL of the UNDERWRITERS LABORATORIES.

Each terminal of the switch has two contacts—insuring POSITIVE CONTROL and LOWEST possible CONTACT DROP. MIDGET CONTROLS are available in Types "MB" and "MP." In applications where space is at a premium and our type "C" control is essential—the MIDGET SWITCH is recommended in place of our S-1 Type switch.

Write for detailed data on complete STACKPOLE line.

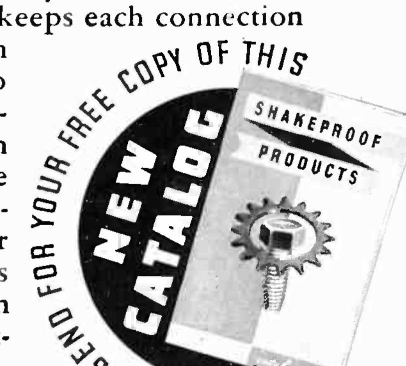
Stackpole Carbon Company
St. Marys, Pa. U. S. A.

SHAKEPROOF



Locked tight—ALL THE WAY 'ROUND!

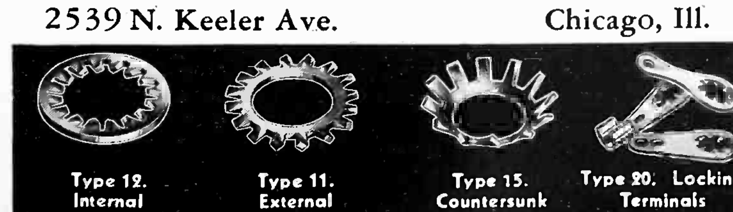
If you are anxious to protect the performance of your product from the damaging action of vibration, you should seriously consider using Shakeproof Lock Washers under every nut and screw. This multiple locking washer provides a positive force against any backward movement of the nut which keeps each connection absolutely tight. Each twisted tooth bites into both nut and work surfaces and, as vibration increases, the teeth bite in deeper. Test this modern lock washer on your own product—see its action with your own eyes—send for free testing samples today!



SHAKEPROOF
Lock Washer Company

Distributors of Shakeproof Products
Manufactured by Illinois Tool Works

2539 N. Keeler Ave. Chicago, Ill.



MANUFACTURING REVIEW

THE Manufacturing Review is intended to serve those readers whose primary interest is the manufacturing end of the radio and allied industries. Sales and advertising managers are invited to submit not only announcements of their new products and catalogs but of the doings of the men in their organization. Descriptions of manufacturing processes, gadgets and pet kinks will likewise be considered for publication, the sole criterion being their usefulness to the industry at large.

Industry Notes

✦ **The S. S. White Dental Mfg. Co.,** Industrial Division, manufacturers of flexible shafts, molded resistors, etc., has moved its offices to larger quarters, on the 23rd floor at 10 East 40th St., New York City. Mr. George T. Latimer is the manager of the division.

✦ **The Commercial Investment Trust, Inc.,** has signed an exclusive contract with the Stromberg-Carlson Telephone Manufacturing Co. of Rochester, N. Y., whereby the former will act as official financing organization for Stromberg-Carlson radio dealers and distributors throughout the country.

✦ **Effective August 2, 1935,** the corporate name of Fansteel Products Co., Inc., North Chicago, Ill., was changed to the Fansteel Metallurgical Corporation, the change in name being made to indicate the nature of the business of the concern, i.e., the refining of rare metals and their fabrication and adaptation to industrial uses.

✦ **The address of the Littlefuse Laboratories,** was changed September 1, 1935 from 4507 Ravenswood Ave., Chicago, to 4238 Lincoln Ave., Chicago.

✦ **Central Scientific Company** announces that all communications to the main office and factory should be addressed to 1700 Irving Park Blvd., Chicago, Ill.

✦ **A quarterly dividend** on the "A" Preferred stock of the Radio Corporation of America, amounting to 87½ cents a share, and payable October 1, 1935, to holders of record at the close of business on the fourth day of September, 1935, was announced by the board of directors of the company.

✦ **The Radio Transcription Co.,** formerly of Chicago, has moved to 1509 North Vine St., Hollywood, Calif.

✦ **The RCA Manufacturing Co.,** Camden, N. J., has completed arrangements with the Trans-Lux Movies Corporation, whereby the RCA Photophone Division will handle the leasing of Trans-Lux rear projection equipment in conjunction with its own "High Fidelity" sound reproducing system, according to Mr. Edwin M. Hartley, Photophone Manager. The Trans-Lux equipment will hereafter be named RCA Trans-Lux.

✦ **A new manufacturer** of loud speakers has entered the business in Chicago, the American Reproducer Co., 3115 Carroll Ave., with Mr. M. E. Paradise, formerly works manager of Grigsby-Grunow, in charge.

✦ **Tech Laboratories,** located at 703 Newark Ave., Jersey City, N. J., announces that it is prepared to manufacture standard and special precision resistance instruments and allied products for laboratory and industrial use. Accuracies as great as one-tenth of one per cent may be provided in impedance values from one to one million ohms on special order.

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Names in the News

✦ **The Muter Company** announces the appointment of Mr. Fred B. Stevens, as Midwestern Sales Manager. Mr. Stevens entered the radio industry in 1924, during which he has been associated with Magnavox, Rola, and Quam-Nichols.

✦ **The new general** works manager of the Westinghouse Electric & Mfg. Co., East Pittsburgh, is Mr. T. I. Phillips, who will serve as central authority for all manufacturing operations in the company. Mr. Phillips has been with Westinghouse since 1915 and has been works manager of the East Pittsburgh Plant until this latest appointment.

✦ **Virgil Graham,** Chairman of the Standards Section of the Radio Manufacturers Association, formerly of Stromberg-Carlson, Rochester, has joined the engineering staff of the Hygrade-Sylvania Corporation, Emporium, Penna.

✦ **John W. Upp, Jr.,** Sales Manager of Swedish Iron and Steel Corporation, has been placed in charge of the Chicago office of that Company, where he will be in charge of sales in the Midwest territory.

✦ **Mr. Robert Hertzberg** has been appointed advertising manager of Wholesale Radio Service, Inc., 100 Sixth Ave., New York, N. Y.

✦ **The appointment** of Mr. Charles L. Glett as production manager of Audio Productions, Inc., New York, has been announced. The Trick Photography and Optical Department headed by Alex Gansell and the Cartoon Animation Department in charge of H. L. Roberts will be under Mr. Glett's jurisdiction. Mr. W. A. Bach, president of Audio Productions, sailed September 11 for London for the purpose of presenting a finished animated cartoon to J. Lyons & Company.

✦ **In the General Electric Company** organization, Mr. Nelson J. Darling has assumed the managership of both the West Lynn and River Works plants of that company, following the retirement of Mr. F. P. Cox. Mr. N. M. DuChemin, formerly superintendent of the West Lynn Works is now assistant manager in charge of operations.

✦ **Mr. Leon Fraser,** vice president of the First National Bank of New York, was elected a director of the General Electric Company at the meeting of the board of directors, September 6. Mr. Fraser was general counsel for the Dawes Plan in 1924, and attended the Paris conference of financial experts which drafted the Young Plan in 1929.

✦ **Ivan Picard,** formerly sales manager for Hudson-Ross, has been appointed Chicago representative of the Quam-Nichols Co.

✦ **The National Union Radio Corp.** of New York announced the appointment of Mr. F. J. Wessner as general sales manager to succeed H. A. Hutchins who resigned to enter the advertising field. Mr. Wessner has been associated with the National Union company since its formation in 1929, and was engaged in sales promotional work.

✦ **The following appointments** have been made in the RCA Organization: Eugene Deacon, to the position of general sales manager of RCA Radiotron; Mr. John W. Griffin, to the position of manager of the RCA Victor Eastern sales division; and Mr. Louis K. Roth appointed in charge of national sales to large retail outlets.

✦ **The following appointments** have been made within the Summerill Tubing Co., Bridgeport, Pa.; Mr. J. P. Boore, to the position of vice president; and Mr. George P. Kraemer, secretary and treasurer, who will continue his connection as assistant manager of the Philadelphia branch of Edgar T. Ward's Sons Company.

New Products

Solar Develops Bridge With Neon-tube Indicator

By NATHAN SCHNOLL
Engineering Dept., Solar Mfg. Corp.
New York

THE alternating current bridge is an extremely useful instrument as is evidenced by its widespread use for laboratory measurements. Undoubtedly it would enjoy even wider application if a very compact and inexpensive model were available for general use. A bridge meeting these requirements was developed by the Solar Manufacturing Co. for use in testing condensers of the paper, mica and electrolytic

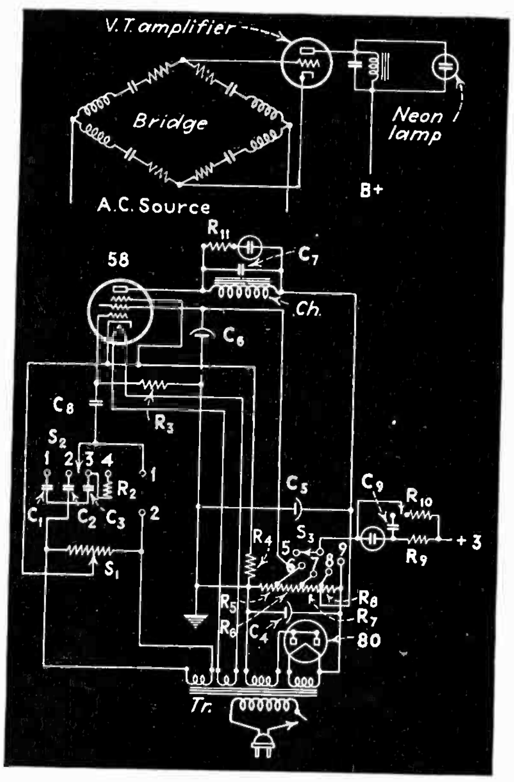

Fig. 1. (A) Above, fundamental circuit (B) Below, complete diagram of analyzer

types, but the bridge itself is suitable as well for inductance or resistance measurements by substitution of the proper standards.

The fundamental arrangement is shown in Fig. 1-A where the four bridge arms are generalized as impedances. The alternating voltage source and the detector are connected to the junctions of the bridge arms. The feature which makes possible the compact and inexpensive construction of the completed instrument is the use of a sensitive neon lamp as the balance indicator. The detector terminals of the bridge are connected to a vacuum tube amplifier in the plate circuit of which is a tuned choke. The neon lamp is connected across the choke.

The neon lamp detector arrangement has the advantage over the ear phone detector often used with bridges in that there is no loss of sensitivity in operations at 60 cycles. A bridge of the type described has been incorporated into a condenser analyzer which is completely self contained in a cabinet 6" x 7" x 9½". The instrument operates directly from the 60 cycle power supply line and is placed into operation merely by connecting the line cord plug to a power outlet. The schematic circuit diagram of the instrument is shown in Fig. 1-B.

The capacity bridge consists of four arms in the regular manner. Two of the arms are resistors, the ratios of which are varied by adjusting S_1, the other two arms are made up of a standard condenser and the condenser under test respectively. The instrument is provided with three capacitor standards selected by the switch S_2 and corresponding to the three calibration scales of the instrument. An extra setting is provided on switch S_2 whereby a resistance is placed in series with the highest capacity standard so that a good balance may be obtained with high power factor electrolytic condensers.

The a-c source voltage for the bridge is obtained from the a-c power line through a winding on the power transformer. The detector arms of the bridge are connected to the grid and cathode of the 58 amplifier tube, in the plate circuit of which is a tuned choke. The neon lamp is connected across the tuned choke.

The advantages of this arrangement are independence of measurements from line voltage variations, freedom from the errors and changes of calibration usually associated with rectifier type meters and the inherently high degree of accuracy usually associated with the bridge type of circuit. The capacity range of this particular bridge is from 20 microfarads to 70 microfarads. A satisfactory balance may be obtained with electrolytic condensers having power factors as high as 50 per cent.

The leakage tester which is also incorporated in the instrument consists of a source of d-c voltage provided by the transformer and 80 rectifier tube and a neon lamp used as a current indicator. The voltage required for condensers of various ratings is selected by the proper setting of switch S_3. For electrolytic condenser tests the circuit arrangement is such that the neon lamp will extinguish when the leakage drops to a nominal value such that proper operation of the condenser in the ordinary radio receiver will be obtained. For paper and mica condenser tests a flasher circuit arrangement is used permitting measurement of high leakage resistances.

The d-c voltage supply for both the leakage tester and bridge amplifier tube are obtained from a conventional transformer, 80 tube rectifier and filter system.

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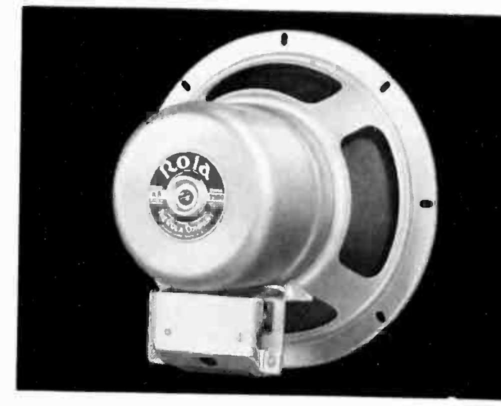
Components

Radio Fuses. A metal shielded fuse designed for use on new metal tube radio sets, approved by the Underwriters Laboratories. Manufactured by the Littelfuse Laboratories, 4238 Lincoln Ave., Chicago, Ill.

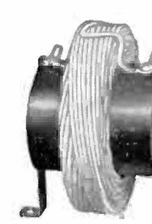
Tobe Condenser Kits. Kits containing an assortment of widely used replacement condensers for the use of radio servicemen and dealers, the assortment being provided with a heavy steel cabinet section. Price including free metal cabinet is $5 net. Manufactured by the Tobe Deutschmann Corp., Canton, Mass.

Two new Rola speakers. New dynamic speakers of 8-in. and 10-in. diameters, models No. K-8 and No. K-10, weighing 4 lb. 12 oz. and 5 lb. 8 oz. respectively,

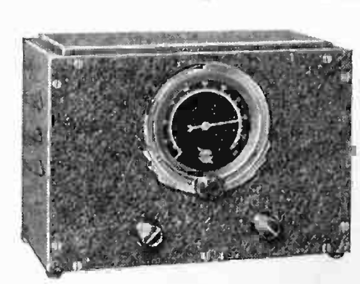


available in dustproof or non-dustproof models, curved or straight design cones optional. Manufactured by the Rola Company, 2530 Superior Ave., Cleveland, Ohio.

Line Filter Choke. A choke for eliminating high frequency disturbance from power supply lines, duo-lateral wound in wire sizes from 2 to 20-am-



pere carrying capacity, ranging in price from $1 to $4. Manufactured by the J. W. Miller Company, 5917 S. Main St., Los Angeles. Also a pre-selector for short wave receiver, consisting of a high gain two-stage radio frequency



amplifier, designed to cover full frequency bands from 12 to 200 meters. List price of all parts including tubes approximately $35. Manufactured by the J. W. Miller Company.

Dial Lamp. A radio dial lamp with a bayonet type base said to eliminate noise from loose contacts, and to provide easy replacement. Manufactured by the Westinghouse Lamp Company, Bloomfield, N. J.

The SHURE

"Spheroid"

1. HIGH-OUTPUT
2. NON-DIRECTIONAL
3. HIGH-FIDELITY

CRYSTAL MICROPHONE

—for the first time in the history of sound reproduction, a crystal microphone with ALL these features!

Through radically new acoustic engineering principles, the "SPHEROID" provides the highest Output Level (minus 55 db) ever attained in combination with true High-Fidelity response (within 5 db from 40 to 10,000 cycles) and Non-Directional (360°) pickup! New "Grafoil" Bimorph Crystal element lowers cable loss.

For complete technical data, write for Bulletin 131M.

Licensed under patents of the Brush Development Company. Shure patents pending.

The superlative performance features, together with the beautiful, distinctive, modern appearance and low cost, make the "SPHEROID" the ultimate crystal microphone for high-quality sound reproduction.

List price, Model 74A, complete with improved connector as illustrated, only . . . **$37.50**

SHURE BROTHERS COMPANY

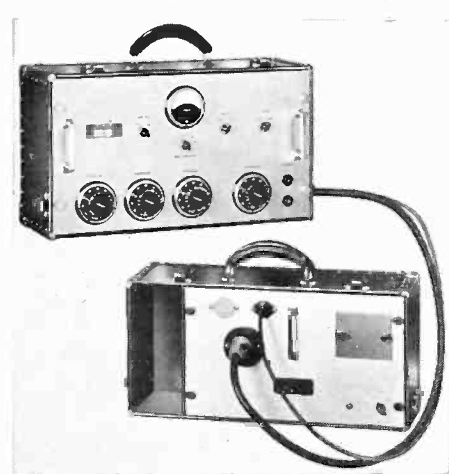
Manufacturers Engineers — *Microphone Headquarters* — *Cable Address "SHUREMICRO"*

215 WEST HURON ST. CHICAGO, U.S.A.

New

REMLER AP3-18

MODERNIZES REMOTE PICK-UPS



- High Gain
- High Fidelity
- Compact
- Portable
- No Batteries
- Attractive
- Moderate Price

High gain Remote Amplifier and Power Supply, designed for use with three Dynamic, Velocity or Inductor microphones and also in a type for operation with the above in combination with condenser microphones. Compact, high fidelity system incorporating refinements ordinarily associated with studio equipment. Three channel input with individual attenuators and master gain control. Feeds two broadcast loops simultaneously. 50 or 200 ohm input units connected by 6′ cable and lock-type plugs. AC or battery operation. Overall gain 95 DB. Tubes 2-77; 1-79; 1-6A6 and 1-80. Used and endorsed by leading broadcast stations. Write for catalogue sheets. List price $365.00.

REMLER COMPANY, Ltd.
2101 Bryant Street San Francisco, Calif.

REMLER—THE RADIO FIRM AS OLD AS RADIO

Midget Condensers. A line of ultra high frequency variable condensers of extremely small size, having maximum capacities of from 15 to 75 mmfd. and ranging in price from 75 cents to $1.11. Manufactured by the National Co., Inc., Malden, Mass.

High Resistance Units. A line of accurately made carbonized resistors ranging from 100 ohms to 100 megohms plus or minus 3 per cent, in 1, 2 and 3 watt sizes, prices from 20 cents to $1.20. Manufactured by Morrill and Morrill, 30 Church St., New York, N. Y.

Tubular Condensers. A new tubular condenser impregnated in oil and vacuum-pumped sealed with high melting wax. Manufactured by the Dumont Electric Co., Inc., 514 Broadway, New York, N. Y.

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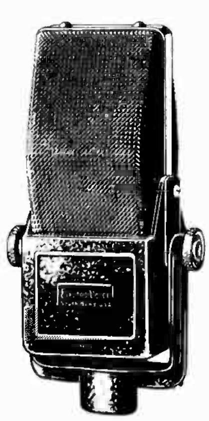
Microphones and Equipment

Microphone Stands. The Amperite Corp., 561 Broadway, New York, announces a series of microphone stands, having a smooth, pneumatic action and obtainable in either a chrome or black finish.

Velocity Microphones. The Electro-Voice Mfg. Co., 324 East Colfax Ave., South Bend, Ind., announces a new series of velocity microphones having frequency response substantially flat



from 30-14,000 c.p.s. Available in either low or high impedance output. The ribbon assembly is protected by a shock-proof mounting and a heavy screen.

Non-Directional Microphone. A non-directional microphone of the dynamic moving coil type has been announced by the Western Electric Company, 195 Broadway, New York City. It responds equally to all frequencies in all directions, from 35 cycles to 10,000 cycles.

Microphone Equipment. Universal Microphone Co., Inglewood, Calif., announces three items of equipment for police departments: A hand set telephone supplied with clip leads for use by police in tapping of telephone lines; a phone line coupler provided with phone tips, for coupling inductively to telephone lines without direct connection to them; and a microphone stand for automobile dashboards for use in police radio installations.

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Materials

Insulating Lacquers and Varnishes. Q-Max hy-frequency coating materials for coating and impregnating insulation forms of various sorts. Has low power factor and high stability at radio frequencies. Manufactured by Communication Products, Inc., 245 Custer Ave., Jersey City, N. J.

Flexible Lacquer Finish. Roxalin flexible finish for coating metals, having permanent resistance to chipping, flaking, peeling, etc. Air dried after application to bare metals. Manufactured by the Roxalin Flexible Lacquer Company, Inc., Elizabeth, N. J.

Iron Core Material. A new core material known as Crolite Magicore providing a selectivity 2¼ times as great as that provided by air-core coils, and suitable for use in I.F. and R.F. transformers and coils. Standard core is ½ in. long by ⅜ in. diameter with a ⅛ in. center hole. Each piece has a smooth, shiny, metallic finish; does not rust or corrode. Manufactured by the Henry L. Crowley & Co., West Orange, N. J.

Luminous Compounds. Luminous and fluorescent compounds for cathode ray tubes, X-ray screens and neon light tubes. Imported by Pfaltz & Bauer, Inc., 300 Pearl St., New York City.

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Transmitting Equipment

R-F Power Pentode RCA-803. A pentode transmitting tube of the filament type used as oscillator and r-f amplifier, suppressor- or grid-modulated. 125-watt maximum plate dissipation; plate volts 2,000; 41 watts carrier output with suppressor grid modulation. 210 watt output for class C telegraphy. Manufactured by the RCA Manufacturing Co., Inc., RCA Radiotron Division, Harrison, N. J.

250-Watt High Fidelity Transmitter. A new 100-250 watt high fidelity radio broadcast transmitter announced by the Western Electric Company having stabilized feed-back for controlling production of audio harmonics and noise, automatic delay circuit for mercury vapor rectifiers, low temperature coefficient (AT cut) crystals, and surface-cell construction placing all these elements within the technician's range. Manufactured by the Western Electric Company, 195 Broadway, New York City.

Power Switching Equipment. Metal-clad power switches suitable for use in high power broadcasting stations, manufacturing plants etc. Manufactured by The Delta Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

P.A. Amplifier. A 15-watt high gain dual microphone public address amplifier having 4 channels and using nine tubes capable of supplying two large dynamic speakers. Manufactured and sold by the Radolek Company, 601 West Randolph St., Chicago, Ill.

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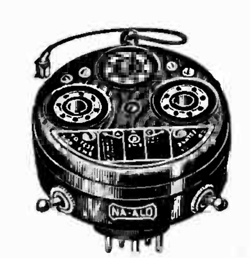
Miscellaneous Items

Electric Transcription Wax. The Allied Phonograph & Recording Co., of Hollywood, Calif., announces "Velvalac," a wax substance for electrical transcriptions, having minimum surface noise and light weight.

Illumination Analyzer: The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces a new illumination analyzer consisting of a light meter and a combination volt-

meter-ammeter with cable extensions, switches and plugs for illumination engineers who wish to analyze voltage and current in addition to light intensity and distribution.

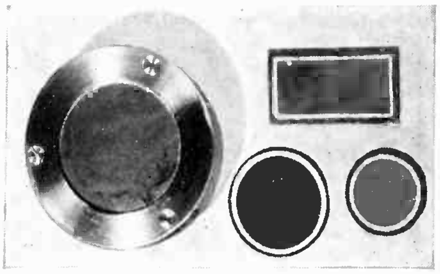
Metal Tube Adapters. A wide selection of various adapters suitable for converting receivers and tube checkers for the tube new metal tubes. Twenty-



five different items in all, ranging from a grid cap listing at 5 cents to a complete adapter kit listing at $11.50. Manufactured by the Alden Products Co., 715 Center St., Brockton, Mass.

Vacuum Tube Voltmeter. A vacuum tube voltmeter for radio servicing has been announced by the Western Electrical Instrument Corp., Newark, N. J. The voltmeter, known as model 669, operates directly from 115-volt, 60-cycle a.c. line and has six scale ranges from 1.2 to 16 volts maximum. The instrument uses two tubes, a type IV and a type 78. The weight is 6½ lbs.

Dry-disc self-generating photo-cell: "Electrocell" dry-disc photoelectric elements, in standard sizes from 1" to 2⅜" dia. Sensitivity: 350 microamperes/lumen in 500-ohm external resistance. A cell 1¼" dia. yields 20 ma., with a maximum emf. of 0.6 volt in direct sunlight.



Wide color response from infra-red to ultra-violet. Frequency response sufficient for home sound-picture work. Unusual properties claimed due to new manufacturing and ageing process which minimizes resistance changes. Distributed in U. S. by Dr. F. Loewenberg, 10 East 40th St., New York City.

D-C to A-C. The Hartman Electrical Mfg. Co., Mansfield, Ohio, announces a new line of d.c. to a.c. converters, designed for users of P.A. equipment, the 6-volt unit provides 75 watts of 110

volts a.c., while the 12-volt unit provides 100 watts. A 32-volt converter of 85-watt output is intended for use on farm installations. Models retail from $15 to $18.

Sensitive Relay. A sensitive relay rated at 13.7 milliwatts for positive operation and having contacts rated to carry 1½ amp. at 110 volts a.c., especially adapted to photoelectric service, is announced by the Kurman Electric Co., 241 Lafayette St., New York, N. Y. This company also manufactures a magnetic inspector and various forms of hearing devices.

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Literature

THE following manufacturers' bulletins, catalogs, and descriptive literature have been recently received:

✦ **Electric Power Conductors.** Conductor Data-Rural Electrification, Bulletin RE-1 of the General Cable Corp., 420 Lexington Ave., New York.

✦ **Parts and Accessories.** Bulletin 936 of the General Radio Co., Cambridge, Mass. "Parts and Accessories" for radio, electrical, and electronic applications.

✦ **Radio Noise Eliminators.** Elim-O-Stats Catalog issued by the Solar Manufacturing Corp., 599 Broadway, New York, N. Y., describing noise suppressors for all-wave receiving sets, etc.

✦ **Stop Nuts.** "Elastic Stop" a catalog of the Elastic Stop Nut Corp., Elizabeth, N. J.

✦ **Electrostatic Voltmeters.** A folder from the Ferranti Electric, Inc., 130 West 42nd Street, New York, N. Y., giving technical data, prices, etc., on the new Ferranti Electrostatic Voltmeter.

✦ **Radio Parts.** Catalog "35" of the Hammarlund Manufacturing Co., 424 West 33rd St., New York, describing variable condensers, coil forms, etc.

✦ **Research Service.** "Calibron Notebook" No. 1, published by Calibron Products, Inc., West Orange, N. J., descriptive of research service.

✦ **Volume Control.** Volume Control Guide issued by Electrad, Inc., 175 Varick St., New York City. Also 1936 general catalog of the same company.

✦ **Field Rheostats.** Bulletin 60A of the Ward Leonard Electric Co., Mount Vernon, N. Y., descriptive of variable resistances for field control.

✦ **Resistance Units.** Catalog No. 14 of the Ohmite Mfg. Co., 636 North Albany Ave., Chicago, Ill., describing resistors and rheostats of wire-wound and carbon types, switches, chokes and attenuators.

✦ **Piezo-Crystal Products.** The August, 1935, issue of Brush Strokes, issued by the Brush Development Co., 1090 East 40th St., Cleveland, Ohio.

✦ **Synthetic Rubber Material.** "Koroseal," a bulletin describing a new rubber-like material suitable for molding or applying as a solution, issued by B. F. Goodrich Company, Akron, Ohio.

✦ **Fiber Insulation.** A leaflet from the Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y., describing fiber insulation products.

✦ **Communication Equipment.** The September, 1935, issue of The General Radio Experimenter, including a description of A-C operated resistance-coupled voltage amplifiers.

✦ **Parts and Accessories.** Catalog No. 188 (1936) of the Insuline Corp. of America, 25 Park Place, New York, N. Y., describing coil forms, R-F chokes and various other parts and accessories.

✦ **Alloys.** Issue No. 3 of the Alloy Pot, issued by the New Jersey Zinc Co., 160 Front St., New York City, describing the use of zinc alloys for die castings, radio chasses, etc.

✦ **Plugs and Connectors:** Catalog called "Cannon Airship Cable Connectors and Specialties," issued by the Cannon Electric Development Co., 420 West Avenue, 33, Los Angeles. Sales office 220 Fifth Ave., New York, issued June, 1935. Data sheets and list prices of various electrical connecting plugs for use in aircraft and general electrical and radio use. Also catalog entitled "Cannon Plugs and Receptacles."

✦ **Mica Insulation:** Catalog entitled Electrical Insulating Materials issued by the Mica Insulator Co., 200 Varick St., New York, N. Y., with offices in Chicago and Cleveland. A 32-page booklet describing the electrical and physical properties of super micanite, micanite, micanite plates, cut mica, mica washers, lamacoid insulation, and similar insulating materials, including price list and discounts.

✦ **Iron-Nickel Alloys:** Nickel cast iron data sheet, issued by the International Nickel Co., Section I, Number 5. A reprint of an article entitled "The Properties of Nickel Alloy Cast Iron," with applications in the petroleum industry.

✦ **Communication Equipment:** July issue of the General Radio Experimenter describing wide range transformers, beat frequency oscillators, networks and volume controls manufactured by that company.

✦ **Radio Transmitters:** Western Electric 100-250 Watt Radio Transmitter, a pamphlet describing a new transmitter having high fidelity characteristics. Described elsewhere in these columns.

✦ **Electrical Instruments:** Weston Aircraft Instruments, a pamphlet issued by the Weston Electrical Instrument Corp., Newark, N. J., describing various instruments used in aircraft, including temperature meters, speed meters, radio compass meters and the like, including connections and dimensional diagrams.

✦ **Volume Controls:** The Yaxley Replacement Manual and Service Guide, a new edition of the manual first issued in 1934, listing over 5,000 set models and the type of replacement volume control required for each.

✦ **Speech Input Equipment:** Western Electric speech input equipment, a pamphlet issued by the Western Electric Co., 195 Broadway, New York City, describing equipment for use in broadcast stations.

Zero Level

(Continued from page 21)

noise. Some fun with a cathode-ray tube to watch on peaks, and a meter on the soft sounds. Keep you busy, eh?"

"You bet, Joe, or maybe someday we'll have automatic volume compressors at the studio and expanders at the receiver which will give the listener a break."

Then seeing that his supervisor had his eye on the clock, finger on the switch to change to the next program, his attention on the monitor speaker from which was coming the closing announcement of the last program, Jim started out into the corridor. To his surprise, Joe called after him.

"Hey, wait a minute. This next program is salon music from the orchestra in Studio 1, and I think that it will illustrate several points we have been discussing. That is, if you have time before your next show." Looking out of the corner of his eye at the program schedule, he saw that Jim had fifteen minutes before setting up Studio 4, so Smith, hearing the local announcement, took Studio 2 off the air, and after a five second pause, put Studio 1 and its salon program on.

The "commercial" wants it loud

"Now listen to that opening announcement, Jim. Its average was —2, with half a dozen peaks of —1 and 0. Then the orchestra started on their first number playing very softly —10 to —20. If you had been listening in at home, with your receiver adjusted so that peaks of plus 1 would give you 15 watts into the speaker, which would be OK for music, what would you have thought of that roaring announcement at the beginning? You wouldn't have liked it a bit, I know, and neither do a lot of people. All those who listen at a fair level dislike the idea of the announcer's voice being only a couple of db below peaks of the orchestra when 30 or 40 men are sawing away as hard as possible. So either one of two things happens. If the listener is sitting near the set, and if the announcement is of any length, he will turn down the volume control. Of course, if he is sitting across the room from the set, and if it doesn't happen to be equipped with remote control, he will probably listen for some time, suffering, wanting to know why in blazes the announcer has to roar like a bull. The answer to this problem, as to the one of high average modulation, lies in the desire of the advertiser to insure that the listener—who may have a set with a 71 output tube and a magnetic speaker, 20 to 40 miles from the transmitter, in a spot where the noise level is high—may hear every word of the commercial announcement about Finkelstein's Pants. To me it is disgusting, and one of the greatest drawbacks to the enjoyment of hi-fi receivers and listening at a level where the music sounds natural and rich."

"You're right, Joe," and a blast from the monitor cuts him short.

"That last announcement was worse than the first. Think I'll call Frank and see if he can't keep those announcements down. That guy MacNamara is sure going to town today."

Picks up phone and says "Hey, Frank. Can't you do anything about those announcements? Wrecks the effect of a swell musical program to have Mac bellowing like a bull. He sounds twice as loud as the orchestra and the soprano put together."—— "What's that? You say he's only kicking —2 on your VI? Well, well, these VI's sure work for you. Whenever anything's wrong, your VI is always OK. The trouble must be in the one here at Master, I suppose. Sure is easy for you guys to pass the buck. Well, try to keep him down to —4 or —6. And Frank, just because that number they're playing now is soft and dreamy, you don't have to pull it up so that you kick zero every few seconds. Leave the fader where you had it for the first number. OK, Frank, I'll take the responsibility. If anybody says anything send 'em to me."

Keep 'er Up to Zero, Boys

"Well that's another thing I can't stand, Jim. Most of the men and most of the supervisors like to see the pointer hover around zero even if it's a lullaby soft and smooth with no peaks, and with its average down 10 db compared with preceding march or dance. However, they treat 'em like just another hot-dog."

"Hey, Joe! Which phone is that, the one from the transmitter?"

For several minutes Joe listens to a kick from the man in charge at the transmitter: During the last number the VI didn't even hit zero for several minutes. Also, the last two announcements were down 2 to 4 db below where they should kick. After carefully explaining his theory that on a program of classical music, the announcements should be kept down well below the music—low enough so that if the orchestra ends up a number with a soft passage, the listener won't be knocked out of his chair by the following announcement. Also, that the faders should be set so that the orchestra will kick to zero on a peak; and then more or less left alone. In other words, if the number happens to be down 6, 8, or 10 db—why let it stay there, the next one will be back to normal. After several minutes more of silence, punctuated by several—"but Al's," Joe with a final sad "OK, Al" hung up the phone. Then, picking up another phone and plugging a patch cord into the board, he rang Frank in the control room of Studio 1.

"Say, Frank. Forget what I just told you about keeping the announcements down, and letting the soft music stay soft. Ride everything up to zero."——— "What's the matter with me? Oh, nothing. Just changed my mind, that's all."

"Jim, after arguing with Al at the transmitter for 15 minutes, what do I get? He's sorry, but the VI wasn't kicking zero. What can you do with a guy like that? And Al isn't a bad egg. In fact he's very conscientious, but what can you expect of an ex-ship operator.

"Sure is tough. Well, if the compressor arrives, that will solve some of our programs, and once it has been adjusted, it should always work the same—regardless of the fellow at the Master, and the guy at the transmitter. That will sure stop a lot of arguments and buck passing. Well, time for me to set up Studio 4, if the kiddies are going to have their Uncle Willie at six. See you later." And Jim goes down the hallway, leaving behind a problem that will never be settled until new policies, new monitoring apparatus, or best of all, the compressor-expander are put into use.

EDITOR'S NOTE: *The reader may guess from this piece that Mr. Weeden understands the control operator's problems. He does. On the expander, see* Electronics, *June, 1935.*

PATENTS REVIEW

Patents indicate trends. Next year's radio circuits, applications of electron tubes for non-communication purposes, new tube types, new materials, may be discovered by following United States and British inventions.

Electron Tube Applications

Motor control. Arrangement for starting an electric motor provided with several phase windings from a source of direct current by grid control rectifiers. C. H. Willis and P. M. Currier, G. E. Co. No. 1,995,876.

Regulator system. Apparatus for use on a dynamo-electric machine, A. E. Drobish, W. E. Co. No. 2,008,855.

Starting circuits. Use of a rectifier and triode as starting control for mercury pool tube. Lloyd Smede, WE&M Co. No. 2,008,730.

Egg grading. Two patents to R. R. Haugh, assigned to the Kraft Egg Machine Co. for grading eggs by photo-electric means. No. 2,007,195 and 2,007,196.

Magnetic testing apparatus. The object to be tested is placed to form a magnetic core, a detecting coil is placed in inductive relation to the tested object, and the occurrence of a flaw is indicated by a loud speaker. J. A. Sams, G. E. Co. No. 2,007,772.

Microoscillograph. Alfred Siteli, assigned to Ernst Leitz, Wetzlar, Germany. No. 2,007, 017.

Multiple signaling. Use of a single circuit by means of different voltages applicable to remote control, teletypewriter operation, etc. M. D. Sarbey, No. 2,008,563.

Hygrometer. A pair of electrodes spaced by a section of electrically non-conducting material, impervious to moisture, said material having a smooth, hygroscopic, continuous surface. Between these electrodes is passed a gas whose moisture content is to be determined. H. S. Polin, assigned to Polin, Inc., New York. No. 2,015,125.

Folding device. Sheet-folding apparatus comprising a conveyor for transmitting the material and a second conveyor with photo-sensitive means for reversing the direction of motion of the second conveyor after a predetermined length of the sheet has been transmitted from the first to the second conveyor. R. S. Elberty, WE&M Co. No. 2,015,550.

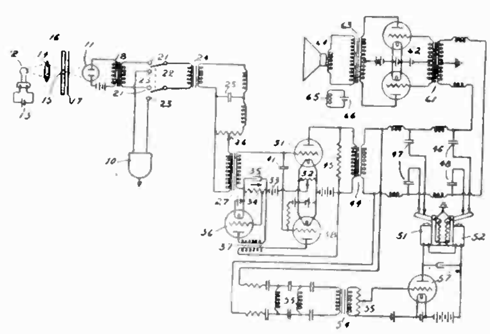
Electrical musical instrument. A vibratory magnetic sonorous body with a means for magnetizing it, including a coil of wire, a source of direct current and an automatic time delay means for connecting the source and the coil. A. F. Knoblaugh, the Baldwin Co. No. 2,015,363.

Protective system. Four patents to WE&M Co. on electron tube methods for protecting electric converters. Nos. 2,015,537; 2,015,538; 2,015,586 and 2,015,551.

Regulating system. A speed regulating system comprising electron tubes. S. A. Staege, WE&M Co. No. 2,015,539.

Recording, etc.

Sound reproducing. A series of patents to John Hays Hammond, Jr., Gloucester, Mass., on circuits for reproducing sound from sound records. No. 2,008,824; 2,008,825; 2,008,698 to 2,008,712, inclusive, and 2,009,229.



These involve methods for separately amplifying high and low frequencies, for discriminating against certain frequencies when the volume is small and against certain other frequencies when the volume is large, etc.

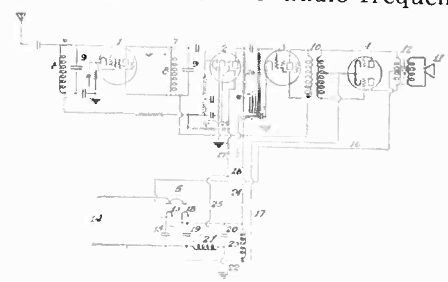
Telegraph printer system. W. G. H. Finch, New York, N. Y. No. 2,008,389.

Frequency equalization. Attenuating the low frequency response of a light sensitive cell, etc. H. G. Tasker, United Research Corp. No. 2,004,253.

Colored picture transmitter. Apparatus for simultaneously transmitting colored moving pictures or scenes and sounds by breaking up the picture into its spectral components and passing them through a series of photo cells, etc. A. A. Ahronheim, assigned one-half to William Sparks. No. 2,004,-360 and No. 2,004,359.

Sound recording. Apparatus for recording sound on a light sensitive member comprising a cathode ray tube having means for producing a pencil of cathode rays provided with a metal window forming a slit having inclined surfaces through which the cathode rays are ejected from the tube in the form of X-rays. Watanabe, Japan. No. 2,004,453.

Power supply system. Power supply apparatus for a radio receiver in which the power stage has substantially zero plate current with no audio-frequency



input voltage. Alfred Crossley, Johnson Laboratories, Inc. No. 2,004,368.

Electron Tubes

Discharge tube. A pair of electrodes with a discharge between, an auxiliary electrode and anode adapted to receive electrons from the discharge path and a load circuit. Ernst Lübcke, WE&M Co. No. 2,007,542.

Phototube manufacture. A portion of the interior surface of the tube is provided with a coating of alkali metal, bringing heated hydrogen into contact with the coating to form a finely grained coating of the hydride of the alkali metal. Samuel Wein, R.C.A. No. 2,006,850.

Rectifier. Substance for initiating discharge in a gaseous device and for removing residual gases comprising a fused mass containing caesium chloride and potassium chloride and a reducing agent. P. L. Spencer, Raytheon Mfg. Co. No. 2,006,488.

Tube tester. Method of determining the plate resistance of a tube, producing an induced secondary current from a primary current, energizing the filament and the grid of the tube by the said induced current, etc. R. L. Triplett, Bluffton, Ohio. No. 2,007,989.

Audio frequency oscillator. A discharge tube for use as an audio oscillator. A method is applied for removing undesired scratching notes during the production of these sounds. Gunther Dobke, G. E. Co. No. 2,008,545.

Phototube. A light-sensitive device having several collecting electrodes capable of being maintained at independent potentials. T. H. Long, WE&M Co. No. 2,000,705.

Electron tube. A voltage reducing electron tube. F. E. Terman, Wired Radio, Inc. No. 2,000,673. See also 2,000,304 to F. E. Terman.

Light sensitive tube. A tube comprising primary and secondary cathodes. W. F. Tedham, E&MI, Ltd. No. 2,005,059.

Radio Circuits

Direction finding. A loop circuit for aircraft, comprising a condenser, a loop, and a pair of loading coils all connected in series and tunable to the frequency to be received. The loop is mounted in proximity to the metallic portions of the wing structure of the craft, and the loading coils are connected between each side of the loop and the condenser, having sufficient inductance to maintain the voltage of the loop at a relatively small value with respect to the voltage on the condenser whereby the loop is substantially unaffected by the metallic portions of the craft. L. A. Taylor, G. E. Co. No. 2,008,522.

Modulating system. Method of modulation permitting a higher per cent modulation by the higher frequency portions of the sound wave and on reception amplifying the demodulated wave in an inverse proportion with the frequency for producing a substantially uniform response over the sound frequency range, and for eliminating local and static disturbances. S. W. Seeley, Jackson, Mich. No. 2,007,985.

Diversity reception. Utilizing the rectified energy from each of several antennas for reducing the strength of signal from the other of the antennas in such a manner that the weak signals are further weakened more than proportionally. H. O. Peterson, R.C.A. No. 2,004,127.

Adjudicated Patents

(C. C. A. N. Y.) Ruben patent. No. 1,891,207, for electrolytic condenser, claims 1, 5, 7, 9, 13, 19 and 22, Held invalid. *Ruben Condenser Co.* v. *Aerovox Corporation*, 77 F. (2d) 266.

Patent Suits

1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,-374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system, filed July 3, 1935, D. C., N. D. Calif. (San Francisco), Doc. E 3895-L, *R.C.A. et al.* v. *Schwacher-Frey Co.* Doc. E 3896-S, *Radio Corp. of America et al.* v. *C. Silverman.* Doc. E 3898-S, *R.C.A. et al.* v. *Kahn Dept. Stores, Inc.*

1,403,475 (*a*), H. D. Arnold; 1,403,-932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round; Re, 18,579, Ballantine & Hull, D. C., S. D. Calif. (Los Angeles), Doc. E 550-C, *R.C.A. et al.* v. *J. L. Misrach (United Radio Stores)*. Decree for plaintiff for injunction July 25, 1935. Same, filed July 3, 1935, D. C., N. D. Calif. (San Francisco), Doc. E 3894-S, *R.C.A. et al.* v. *C. Silverman.* Doc. E 2897-L, *R.C.A. et al.* v. *Kahn Dept. Stores, Inc.*

1,403,475 (*b*), H. D. Arnold, 1,403,-932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, filed July 3, 1935, D. C., N. D. Calif. (San Francisco), Doc. E 3893, *R.C.A. et al.* v. *Schwabacher-Frey Co.*

1,713,726, H. Vogt et al. Device for phonograph with linear phonogram carrier, D. C., M. D. Pa., Doc. 971, *American Tri-Ergon Corp. et al* v. *Altoona Publix Theatres, Inc., et al.* Patent held valid Nov. 24, 1933. Mandate from C. C. A. affirmed judgment of D. C. Mandate from Sup. Court reverse judgment of C. C. A. (notice July 28, 1935). Doc. 972, *American Tri-Ergon Corp. et al* v. *Wilmer & Vincent Corp. et al.* Decree as above.

1,815,768, A. Georgiev, Electrolyte, filed July 3, 1935, D. C., S. D. N. Y., Doc. E 80/354, *Aerovox Corp.* v. *Solar Mfg. Co.*

1,710,073, 1,714,191, S. Ruben, Electrical condenser, filed July 5, 1935, D. C., E. D. N. Y., Doc. E 7678, *Ruben Condenser Co. et al.* v. *Micamold Radio Corp. et al.* Same, D. C., S. D. N. Y., Doc. E 80/358, *Ruben Condenser Co. et al.* v. *Solar Mfg. Corp. et al.*

1,507,016, L. de Forest, Radio signaling system; 1,507,017, same, Wireless telegraph and telephone system, filed May 25, 1935, D. C. Del., Doc. E 1117, *RCA et al.* v. *Collins Radio Co.* Same, D. C., E. D. N. Y., Doc. E 7634, *Radio Corp. of America et al.* v. *H. E. Van Thijn et al.* Consent decree for plaintiff July 22, 1935.

1,382,738, M. C. Latour, Amplifying apparatus; 1,405,523, same, Audion or lamp relay or amplifying apparatus; filed July 5, 1935, D. C., S. D. N. Y., Doc. E 80/359, *Latour Corp.* v. *B. Abrams et al.*

1,297,188, I. Langmuir, System for amplifying currents; 1,334,118, C. W. Rice, System for amplification of small currents, filed May 25, 1935, D. C. Del., Doc. E 1116, *G. E. Co.* v. *Collins Radio Co.*

1,789,949, A. Georgiev, Electrolytic cell, 1,815,768, same electrolyte, filed June 25, 1935, D. C., S. D. N. Y., Doc. E 80/339, *Aerovox Corp.* v. *Cornell Electric Mfg. Co., Inc., et al.*

1,297,188, 1,313,094, I. Langmuir, System for amplifying variable currents; 1,316,967, D. M. Moore, Gaseous conduction lamp; 1,614,214, O. Steiner, Means for supporting and driving films; 1,646,249, C. A. Hoxie, Narrow light aperture; 1,756,863, same, Method of making motion picture films; 1,729,048, G. F. Myers, Method of making talking motion pictures; 1,854,159, L. T. Robinson, Sound recording; 1,920,789, C. L. Heisler, Film driving apparatus, filed June 25, 1935, D. C., S. D. Calif. (Los Angeles), Doc. E 691-M, *RCA et al.* v. *Balsley & Phillips, Inc., Ltd., et al.*

1,356,178, C. H. Thordarson, Machine for cutting magnetic circuit laminae; 1,482,591, same, Method of making polysided coils; 1,482,592, same Machine for winding coils, D. C., N. D. Ill., E. Div., Doc. 9864, *Thordarson Elec. Mfg. Co.* v. *Transformer Corp. of America.* Dismissed without prejudice June 3, 1935.

1,403,475 (*a*), H. D. Arnold, 1,403,-932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,095, H. D. Round; Re. 18,579, Ballantine & Hull, D. C., N. D. Ill., E. Div., Doc. 14258, *RCA et al.* v. *International Trading Corp. et al.* Decree pro confesso holding patents valid and infringed Mar. 25, 1935.

1,203,190, C. E. Fritts, Recording and reproduction of pulsations or variations in sound and other phenomena; 1,213,-614, same, Record of pulsations of sound and analogous phenomena and process and apparatus for producing same; 1,316,967, D. M. Moore, Gaseous conduction lamps; 1,223,496, I. Langmuir, Electrostatic telephone system; 1,297,188, 1,313,094, same, System for amplifying variable currents; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,729,048, G. F. Myers, Method of making motion pictures; 1,756,863, C. A. Hoxie, Method of making motion picture films, D. C., S. D. Calif. (Los Angeles), Doc. E 24-J, *R. C. A. Photophone, Inc., et al.* v. *Balsley & Phillips, Inc., Ltd., et al.* Dismissed without prejudice June 24, 1935.

1,244,217, I. Langmuir; Re. 15,278, same; 1,374,679, J. B. Pratt; 1,718,206, I. Mouromtseff; 1,852,865, C. B. Upp; 1,865,449, J. L. Wuertz; 1,879,514, Round & Picken; 1,880,937, H. M. Elsey; 1,893,466, R. F. Gowen; Des. 79,947, F. T. May, D. C., N. D. Ill., E. Div., Doc. 13965, *RCA et al.* v. *F. J. Hajek (Taylor Tubes).* Consent decree holding claims 1 and 3 of 1,865,449, claims 1, 2, and 3 of 1,852,865, and claims 1 and 2 of 1,879,514 valid and infringed June 17, 1935. Dismissed without prejudice as to certain patents May 13, 1935.

1,251,377 (*a*), A. W. Hull; 1,273,627, I. Langmuir; 1,297,188, 1,313,094, same; 1,631,646, C. W. Rice; 1,707,617, 1,795,214, E. W. Kellogg; 1,899,561, H. G. Dorsey, D. C., N. D. Ill., E. Div., Doc. 13873, *RCA et al.* v. *Enterprise Optical Mfg. Co.* Dismissed without prejudice Mar. 15, 1935.

1,251,377 (*b*), A. W. Hull; 1,297,188, I. Langmuir; 1,707,617, 1,795,214, E. W. Kellogg; 1,894,197, Rice & Kellogg; 1,573,374, P. A. Chamberlain, D. C., N. D. Ill., E. Div., Doc. 14259, *RCA et al.* v. *International Trading Corp. et al.* Decree pro confesso holding patents valid and infringed Mar. 25, 1935.

1,251,377 (*c*), A. W. Hull; 1,297,188, I. Langmuir; 1,573,374, P. A. Chamberlain; 1,728,879, Rice & Kellogg; 1,894,-197, same; 1,707,617, 1,795,214, E. W. Kellogg, D. C., N. D. Ill., E. Div., Doc. 14267, *RCA et al.* v. *Regal Radio Mfg. Co., Inc., et al.* Decree pro confesso, holding patents valid and infringed Mar. 25, 1935.

1,403,475 (*b*), H. D. Arnold; 1,403,-932, R. H. Wilson; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,-095, H. J. Round; Re. 18,579, Ballantine & Hull; Re. 18,916, J. G. Aceves, D. C., N. D. Ill., E. Div., Doc. 14266, *RCA et al.* v. *Regal Radio Mfg. Co., Inc., et al.* Decree pro confesso holding patents valid and infringed Mar. 25, 1935.

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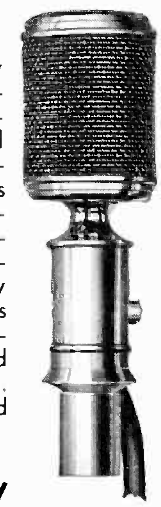

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British Patents

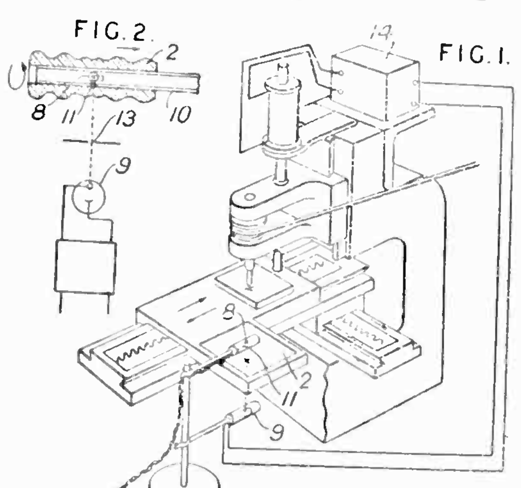
Electron Tube Applications

Power supply. An arrangement in which a load containing inductance is supplied from a d.-c. source through a tube in which means are provided for absorbing the transient voltages produced when the current is suddenly interrupted in the tube, comprising a resistance having a negative impedance voltage characteristic connected in parallel with the load. British Thomson-Houston Co., I. Langmuir. No. 424,022.

Vitamin production. A gaseous discharge tube circuit for the production of vitamin D in foodstuffs, such as milk. The tube is operated at light intensity amounting to 60 to 80 per cent of the maximum obtainable intensity and the applied voltage is increased as the lamp deteriorates to maintain constant light emission. A written record of the light intensity is obtained by means of a light-sensitive tube and a recording microammeter. By this means the voltage increase may be performed by a completely automatic system. Hanovia C&M Co. No. 424,541.

Vehicle propulsion. Electric power is supplied to a vehicle through an arc converter such as a rectifier or inverter mounted on the vehicle and the electrodes of which are adapted to be swept by a stream of gas wherein, upon failure of the normal supply of gas, the compressor of the pneumatic braking system automatically supplies air to the converter. G. E. Co. No. 424,664.

Light control. In apparatus controlled by variations in an electric current produced by controlled variations in intensity of light, translucent element molded, cast, or otherwise formed of varying thickness from point to point in a predetermined manner is traversed across the light beam to produce the desired modulation in light

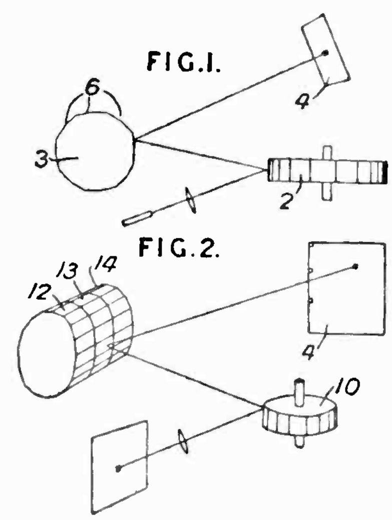


intensity and thereby of the output current. For example, a replica in paraffin wax, celluloid, gelatine, or other translucent material is used for modulating the light intensity for controlling a cutting machine to reproduce a three-dimensional object. J. Dorn, C. E. Duits and A. Gore. No. 424,802.

Television

Synchronizing circuit. In a cathode-ray tube receiver in which the vertical and horizontal scanning movements are controlled by separate devices for producing saw-toothed wave-form, both line and frame deflections are synchronized at the receiver by means of a single series of synchronizing impulses whose frequency is a submultiple of the line frequency and a multiple of the frame frequency. These are derived from apertures or slots in the scanning disc. Nakashima and Takayanagi. No. 424,773.

Scanning system. Employs two moving members, one of the members comprises several series of optical elements of which each series is adapted to



produce interdigitation of the sets of lines traversed by light-beams dealt with by the elements of the other scanning members. J. L. Baird. No. 423,854.

Scanning frequency oscillator. In a grid-controlled glow discharge relaxation oscillator, the period of discharge is kept constant by inserting a resistance in the discharge circuit of the grid-controlled discharge tube. In addition an auxiliary control voltage may be employed. No. 423,394. No. 423,-427 on method of reducing distortion due to current between the cathode ray and the deflecting-plates by means of energizing the deflecting-plates in opposite phase. No. 423,583 in which variation in the extinction potential in a relaxation oscillator is prevented by the provision in the grid circuit of means which prevent grid current from flowing. No. 423,599, applies to electric impulses of constant shape and amplitude which are produced independently of the shape of the received signals by the use of a relaxation oscillator. D. S. Loewe, K. Schlesinger.

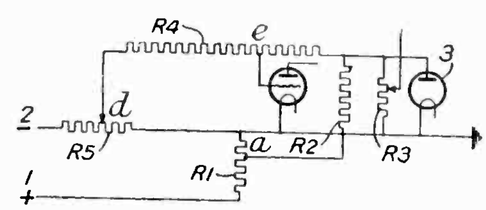
Film system. System in which the film is the intermediate picture carrier, an endless film moves continuously or intermittently through a series of chambers in which it is treated by spraying. At a receiver the film is sprayed with emulsion, cooled, exposed to the scanning spot, sprayed successively with developing, rinsing and fixing fluids, dried, projected optically, and finally deprived of emulsion by scrubbing-rollers. A. Banfield, Baird Television. No. 424,887.

Oscillator. Electric oscillations of saw-tooth wave form are set up in the output of a tube. In the same output circuit is a variable negative feed-back composed of resistance and a resistance shunted by a capacity. The output wave forms appear across an inductance. E&MI. No. 424,221.

Synchronizing circuit. A thermionic tube is used to separate two differing sets of synchronizing signals which are applied to an input circuit between the control grid and cathode; two oscillators, controlled respectively by the two sets of signals, are associated with different electrodes of this separating tube. M. Manifold and W. S. Percival, Middlesex. No. 423,685.

Modulation. A high-frequency carrier is modulated symmetrically about a mean value by a sub-carrier modulated by picture signals; synchronizing signals which alternate with periods of picture transmission, reduce the transmitted current to zero. The synchronizing apparatus at the receiver is actuated only when the unidirectional current from the detected high-frequency signals is zero. Telefunken. No. 423,765.

Amplifier arrangement. The grid bias of one or more of the tubes of an amplifier is caused to vary according to the strength and the frequency of the signals to which the amplifier is tuned. As shown, the grids of the controlled tubes are connected to a point *e* on a resistance R4, one end of which is connected to the load resistance R3 of a diode which rectifies the signals and the other end is connected to a variable tap *d* on a potentiometer. The potential of the point *e* is depend-



ent on the strength of the rectified current in the resistance R3 and on the position of the slider *d* which is ganged to the tuning control of the amplifier. The anode of the diode never becomes negative whatever the position of the slider *d*. Philips. No. 424,735.

Frequency compensation. In a system having re-insertion of low frequency components, the attenuation of the low frequencies at the reinsertion point, due, for example, to imperfect rectification or after reinsertion, due, for example, to imperfect regulation of the high voltage source, is compensated by decreasing the amplitude of the high frequencies relative to that of the low frequencies. E&MI. No. 425,177.