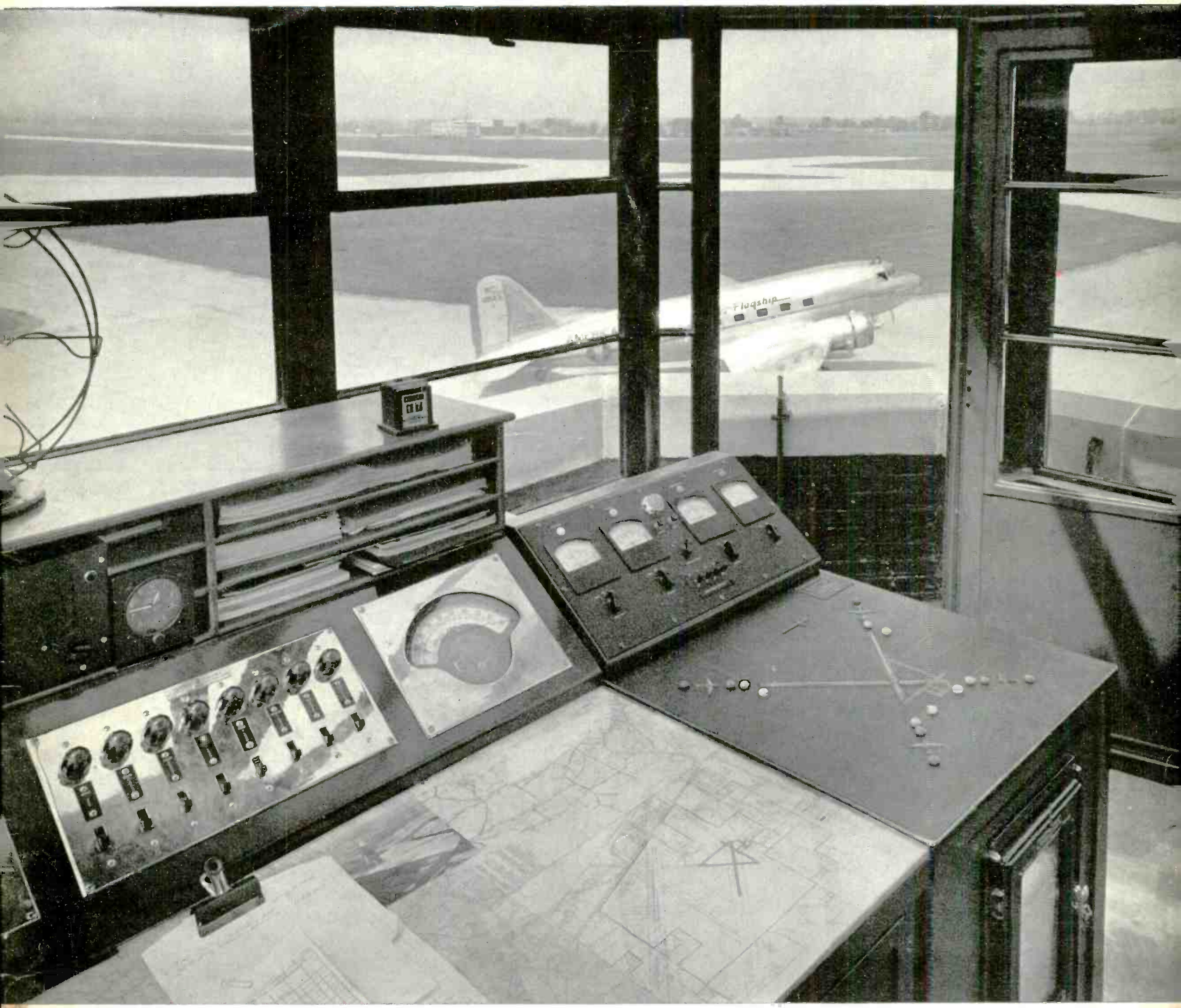
electronics

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



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CONTENTS—DECEMBER, 1939

DEPARTMENTS

RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

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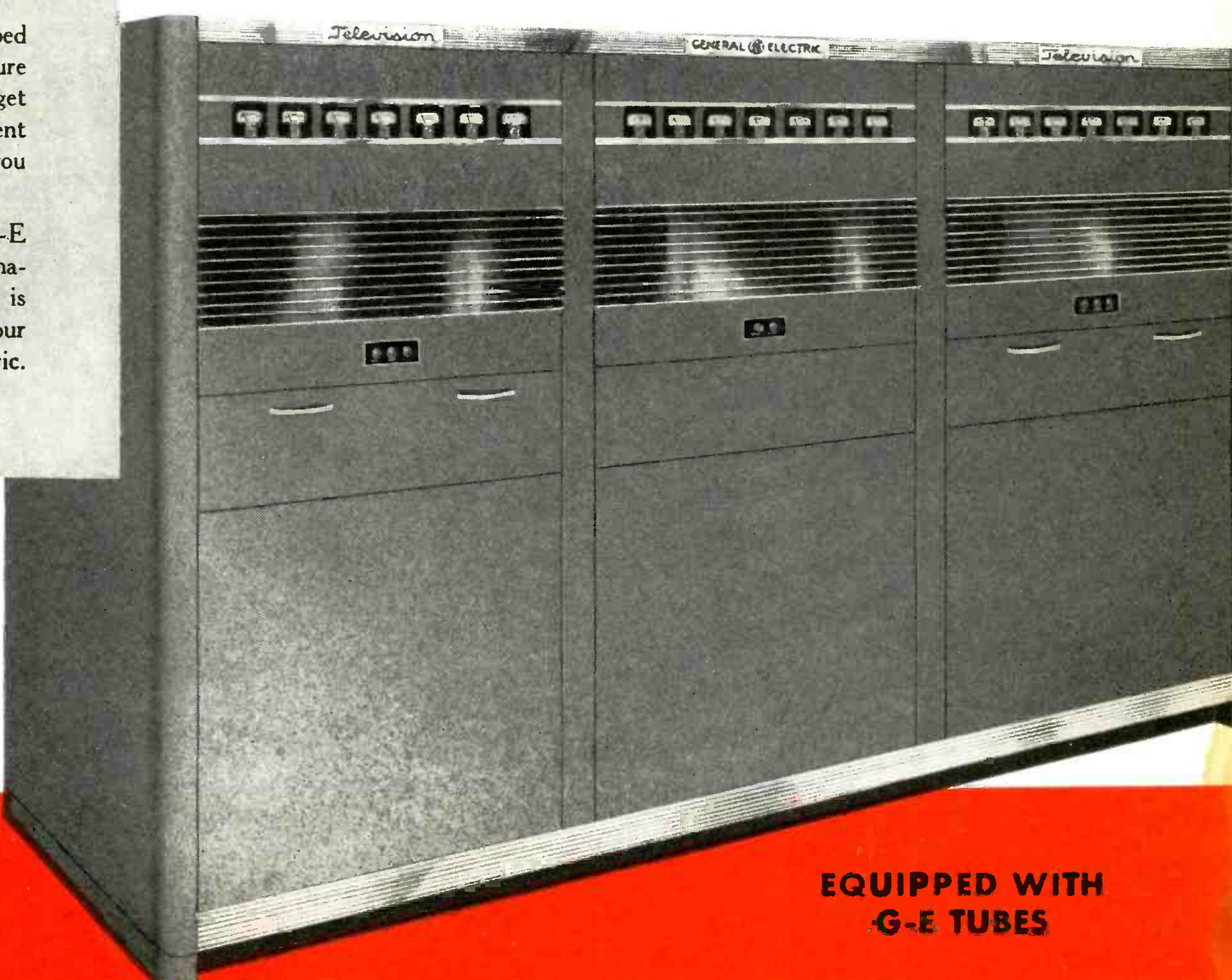

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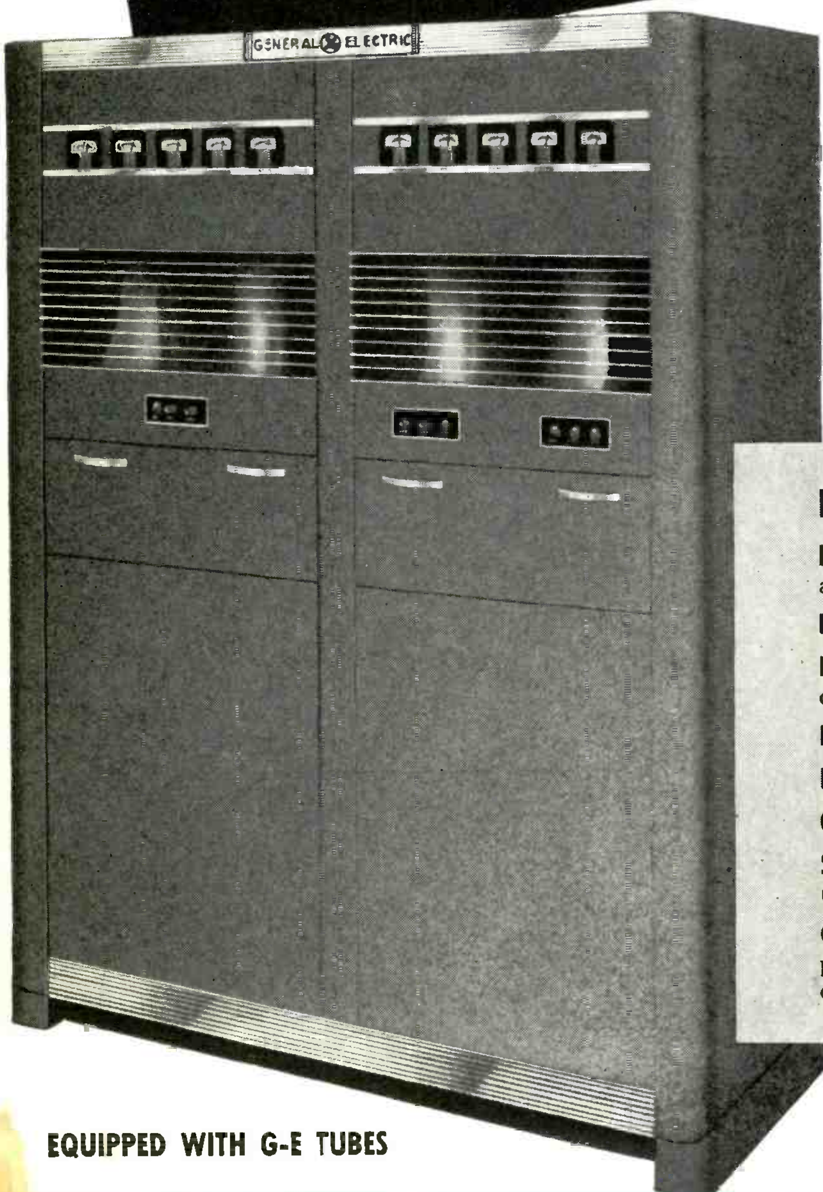

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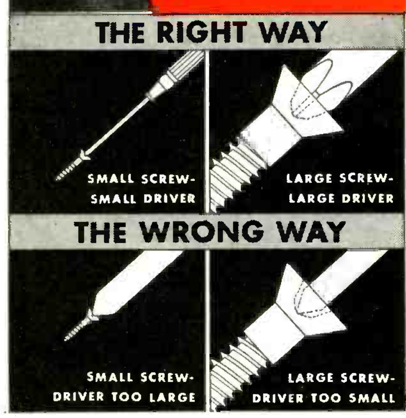

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CROSS TALK

✦ **U.H.F** . . . At the Rochester Fall Meeting Ken Jarvis indulged in quite a bit of speculation as to industry trends and as to what the future had in store for the radio industry. Unfortunately he did not go into what the ultra high frequencies might provide in the way of new or improved services. Present research is pushing back the frontiers on the short waves at a tremendous rate. Not only are ways being developed for generating and detecting power at frequencies in excess of 500 megacycles, but power in considerable amounts will soon be available.

Whatever happens to the present excitement about frequency modulation, it is certain that broadcasting will drift more and more to the frequencies of 40 megacycles and higher. Already, frequency modulation had disproved the theory that line-of-sight transmission is all that may be expected of the high frequencies. Experiments conducted by the Yankee Network indicate that transmission ranges of 75 miles are easily possible, and that within this range service superior to that now attained on standard broadcast waves will be possible. Frequency modulation, of course, offers the advantage over amplitude modulation that all of the power is being used all of the time giving an effective increase in power of four times. The signal-to-noise ratio benefit seems to be about 20 db; and it is possible that work being carried out in one of the large laboratories now will add another 20 db in favor of frequency modulation.

At frequencies considerably higher than 40 Mc the fact that frequency modulation requires a bandwidth larger than amplitude modulation will be of relatively lesser importance.

A signal-to-noise ratio increase of 40 db compared to amplitude modulation must ultimately interest the telephone companies. Crosstalk and noise are the big bugaboos of carrier transmission; and anything that will reduce either or both must have a profound effect upon telephone research. It might easily come about that economic advantages could be effected by space transmision compared to coaxial cable. Such transmission would solve the problem of the farmer who wants a phone but is too far from telephone wires. Pill box repeater stations, unattended, would dot the country, stuck up on poles where power is available, or if necessary, battery powered. These repeater stations might have a range of 10 to 50 miles. Any farmer near enough to one of these pill-box repeater stations might be able to get his signals into it and out of it purely by space radio. Thus the expense of wires and poles would be unnecessary. These repeater stations could radiate entertainment as well as private conversation.

P. S. Ken Jarvis states that he *did* mention the ultrahighs. This is true; he spoke of the wave-guide type of radiations in the 1000-3000 Mc region.

✦ **AWARDS** . . . Twelve outstanding graduates of Columbia University School of Engineering were awarded medals for distinguished engineering achievement at the University on November 27. These awards are in memory of Professor Thomas Egleston, member of the Columbia faculty from 1863 to his death in 1900.

Three of these who received the first awards are well known to the communications industry. They are Edwin H. Armstrong, Gano Dunn, and Irving Langmuir.

✦ **STATISTICS** . . . At the September Annual Convention of the I.R.E. Julius Weinberger of the RCA License Laboratory cited certain interesting data on tube life, receiver production, etc. Among other choice items of interest is the fact that tube life has been increasing steadily until the average tube in the average receiver gives its owner about 6000 hours of useful service. In 1924 the average life was about 1.65 years, now is about 4½ years—longer in fact than many of the sets into which the tubes are placed.

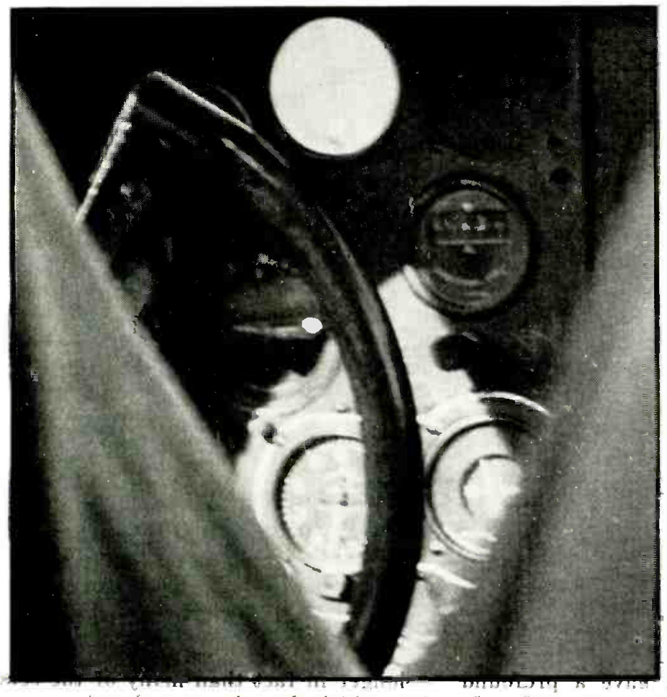
A convenient and illuminating method of estimating the cost of radio tubes is to note that an ordinary incandescent lamp costs fifteen cents and lasts a thousand hours; a radio tube costs about ninety cents and lasts six thousand hours.

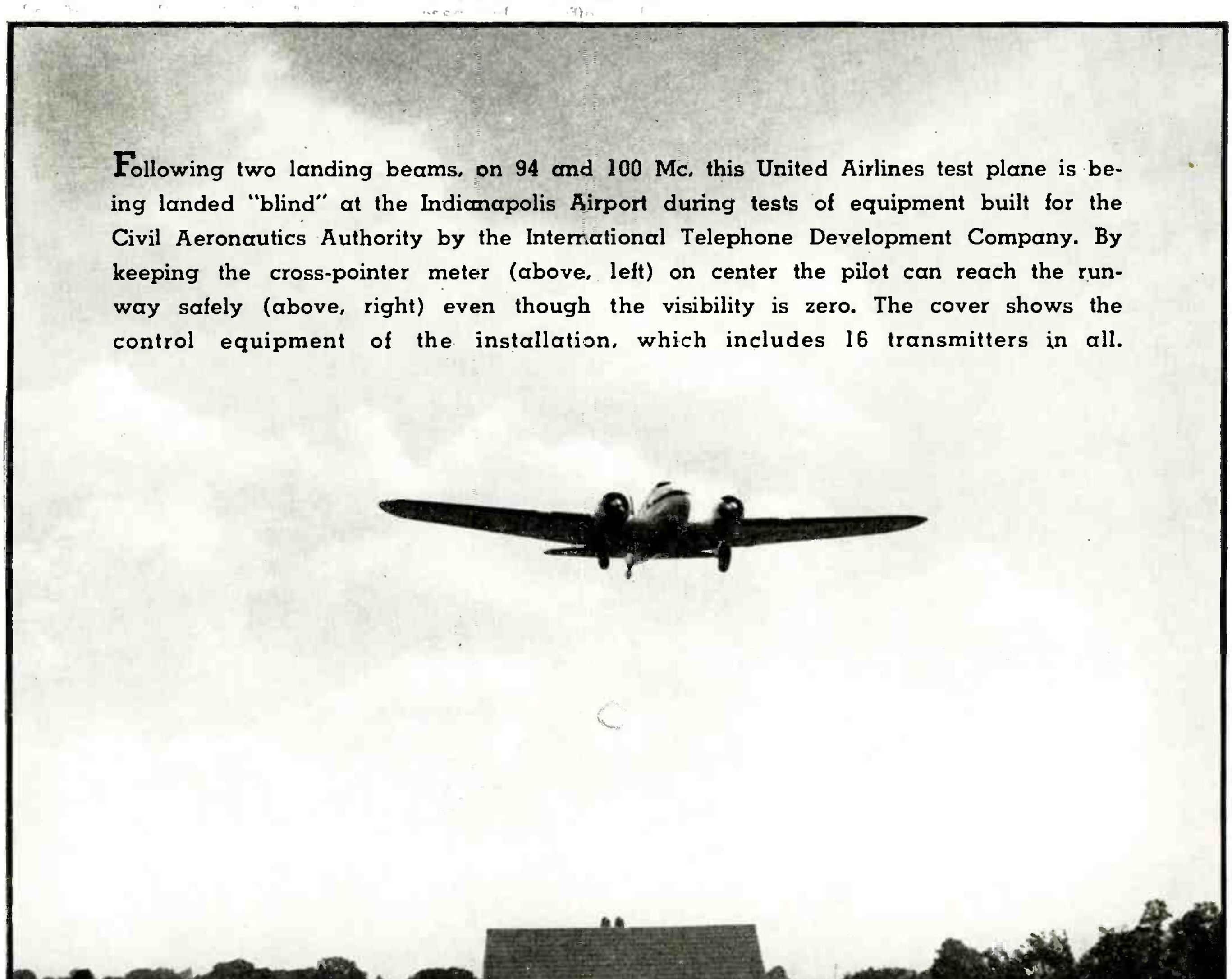
Mr. Weinberger estimated the total tube production for the current year to run to about 94.8 millions of tubes, and felt that in 1947 the annual production would amount to approximately 142 millions.

Speaking of receiver production, statistics seem to show that radios are replaced about once in seven years. Any expansion in the manufacture of receivers during the next ten years will probably come from a growth of the secondary set market and for replacement purposes. Our annual production capacity should be geared to approximately seven to eight millions per year. Ultimately, according to Mr. Weinberger, there may be as many as 25 million secondary receivers in use in this country. At the time of the September meeting it was estimated that an annual export market for five to six hundred thousand sets would be developed. Since that time, of course, war has upset all calculations.

On the matter of television it was stated that the low income groups would not be interested in television for quite a long time; but ultimately this group would provide a secondary replacement market—those who replace sound with sight.

✦ **RAZZ** . . . At the Rochester Fall Meeting Banquet, H. B. Richmond of General Radio took apart in no uncertain terms the antagonism which seems to have grown up between the I.R.E. and the R.M.A. Between a trade group, even one with an active engineering division, and a purely technical society there should be no grudges, no working at cross purposes.





Following two landing beams, on 94 and 100 Mc, this United Airlines test plane is being landed "blind" at the Indianapolis Airport during tests of equipment built for the Civil Aeronautics Authority by the International Telephone Development Company. By keeping the cross-pointer meter (above, left) on center the pilot can reach the runway safely (above, right) even though the visibility is zero. The cover shows the control equipment of the installation, which includes 16 transmitters in all.

MODERN RADIO PLANT PRACTICE

Closeup view of winding operation in voice-coil production

By HERBERT CHASE

IMPORTANT as the design of radio chasses and speakers is, it avails little unless keyed into the efficient production and assembly of the components required. Much can be learned, therefore, by a study of such production and assembly in a plant such as that of the Stromberg-Carlson Telephone Manufacturing Company, which is laid out primarily for such operations and includes highly efficient equipment besides employing modern methods well thought out by competent production executives. Naturally, these methods are in keeping and have much to do with the high quality of product manufactured. The same plant handles production of telephone apparatus which, far from interfering with radio production, really contributes to it not alone through the skill developed by those employed but in keeping them busy during seasons when radio production is slack and thus maintaining continuously a well trained organization. Most telephone work is done during the season when radio production is at a minimum.

Although the plant has a large department in which a considerable proportion of the cabinets required is produced, consideration is given in this article only to chassis and speaker production. In parallel with this phonographs and record changing equipment are manufactured, but they constitute only a small proportion of total production.

As seen in the accompanying floor plan, the plant includes offices along the front and a freight siding with a receiving and shipping platform along the rear. It is all on one floor except for a basement used for storage and has about 14 acres of floor area. All material entering the plant passes over the receiving platform and into storage rooms where it is checked and issued, as required, to fabricating departments occupying the central area of the plant. As fabrication proceeds, the parts move toward the main assembly department and are passed either directly onto the assembly lines or into a finished stock department whence they are issued as needed in assembly. The finished stock department also handles such components as are received from outside suppliers ready fabricated, checking them as necessary to insure that they meet specifications.

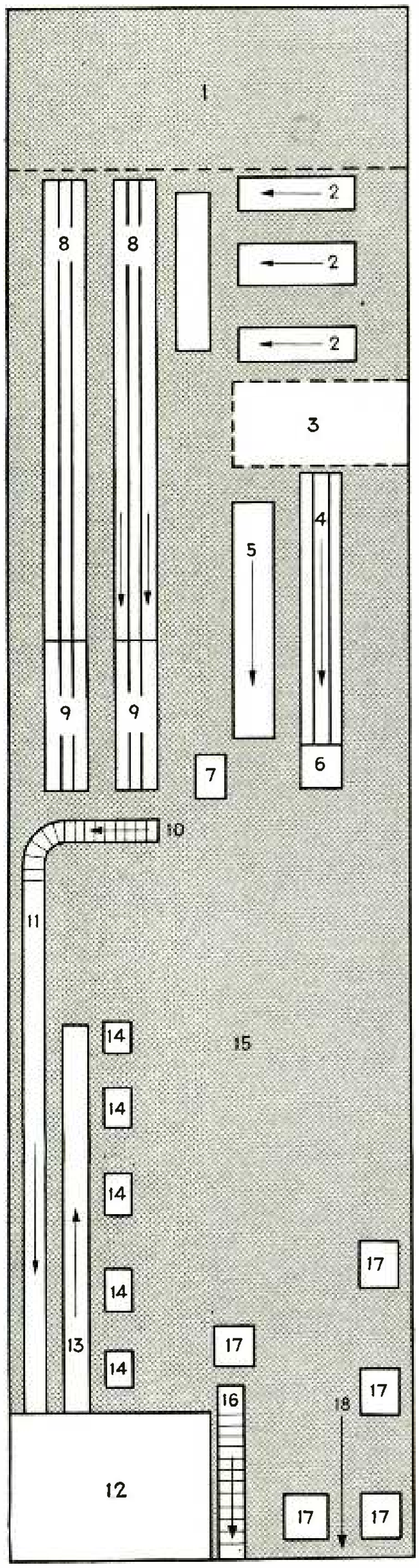
Assembly is done on a progressive basis in a large department at one end of the plant and completed units, after passing suitable tests, enter a shipping department adjacent to the siding. There is thus a general flow from the receiving platform through inspection, stock, fabricating, assembly, testing and shipping departments back to the shipping platform, making an orderly system and one which contributes to efficiency.

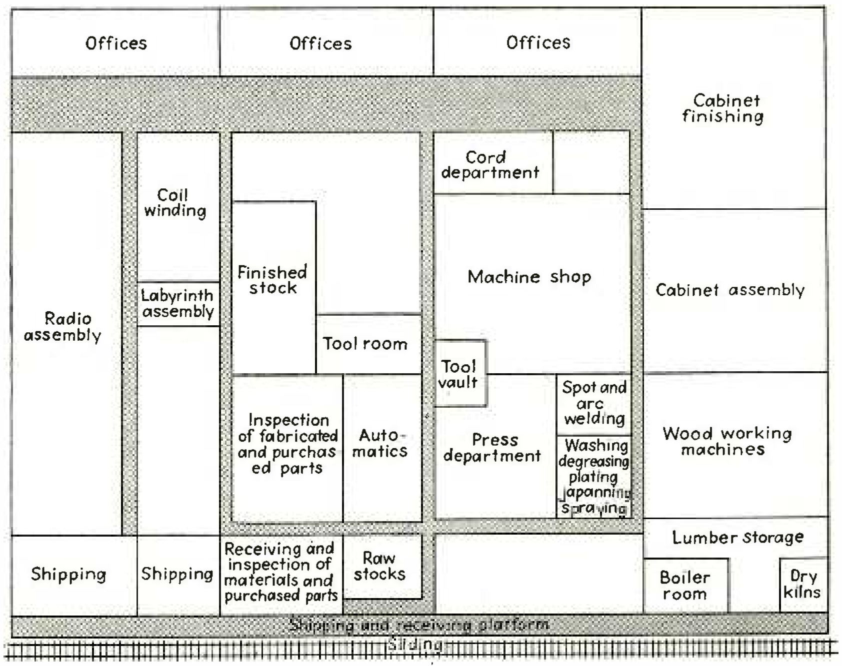
Most heavy stock including sheet steel and bar stock, enters a room devoted to raw stock, some of it being first cut into lengths or strips such as are needed for later fabrication, before being placed in racks. The stock room is adjacent to the press room where sheet metal is formed and to the room marked "Automatics" on the floor plan in which screw and similar machines convert bar stock into screws, bolts and similar forms, or perform other initial machining. Standard screws, nuts and bolts are purchased in finished form, but special screw machine products are mostly made on the automatic machines.

Sheet steel for chassis bases, brackets and similar parts, requisitioned by the press department, is

Speaker cones are assembled on rotating tables equipped with special cementing fixtures

Diagram of main assembly floor. The flow of work is from the store room (1), to sub-assembly benches (2), (4) and (5), to the main assembly benches (8) and (9), to the aligning room (12), to cabinet asembly (14), to final test (17) and to the shipping department (18)





Floor plan of the Stromberg-Carlson plant showing the locations of the various departments. Those areas not marked are used for telephone manufacturing

there cut to length or passed in strip form directly through the blanking dies in some presses and thence, when required, through forming dies, usually in adjacent presses, issuing in a form for further fabrication or for application of finishes. Most parts, however, are first passed through washing or degreasing equipment in the adjacent finishing room, but those requiring spot or arc welding undergo these operations in another adjoining area before being japanned or plated. A separate room next to the press room is given over to finishing, one portion of it being equipped with plating equipment and another to the application and baking of organic finishes. Chassis bases and several smaller parts are cadmium plated to afford a good surface for soldering and to prevent corrosion in service and a few exposed parts are plated in other metals for decorative purposes. Finishing is not confined, of course, to stamped and other sheet metal parts but includes some of those coming from screw machines and some produced by still other means.

A large machine shop is provided for fabricating certain types of parts not adapted for production in stamping presses or screw machines, such as coil cores and field frames. Some riveting and some other assembly work is done in the machine shop, consequently only light assembly operations need be done on the final assembly lines. Next to the machine shop is a tool room in which special tools are produced and kept in repair and a vault in which they are stored when not in service. Adjacent to the machine shop there is also a department devoted to preparing cords with plugs and terminals for later attachment to chassis.

Coils required in the assembly of the chassis are wound in a coil winding department and are carefully tested there before being passed to the adjacent assembly department. Special machines are provided for coil winding and special equipment for inspecting and calibrating them is used. By these means, among others, the management facilitates the making of a high-fidelity product upon which its business has been built up. Next to the winding and assembly department there are built up for installation in the lower portion of certain cabinets labyrinths forming a portion of the sound reproducing system. This assembly consists of non-metallic sound absorbing sheets fastened together largely by adhesive strips.

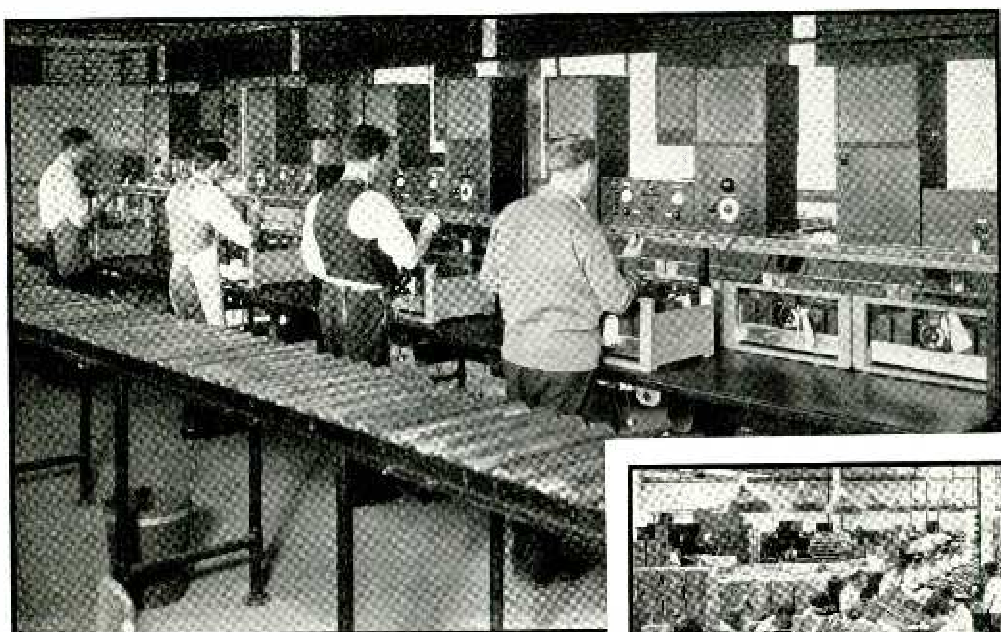
In a second diagram showing the assembly department on a larger scale some details of the assembly layout may be seen. Cabinets are trucked into this department ready to receive the assembled chasses, but the latter and some of their elements are built up from finished stock coming either from the finished stock room or directly from fabricating departments, as already outlined. A few operations which may be classed as fabricating and much testing work are done in the assembly department, but a large part of the area is given over to assembly benches and conveyors so laid out as to facilitate an orderly flow toward the final assembly into finished products.

Racks and floor space for receiving parts entering the assemblies are provided at convenient points. Subassemblies of such units as speakers, terminal strips, variable condenser wires and the like are built up at side benches. One bench is devoted to making up from ready-cut paper segments the cones which form an important part of the high-fidelity speakers. This work is done in metal jigs some of which are on rotating dials and are arranged for clamping the cone while the joint is cemented and parts are fastened to it, one of these being a paper collar supporting a very light aluminum voice coil. When assembled, the cone is sprayed and when the lacquer is dry the cone unit is assembled to a frame which includes the impulse coil and its core. This latter assembly is done on benches between which there is a belt conveyor which carries the assemblies into a booth in which they are tested and checked against a standard before assembly into cabinets.

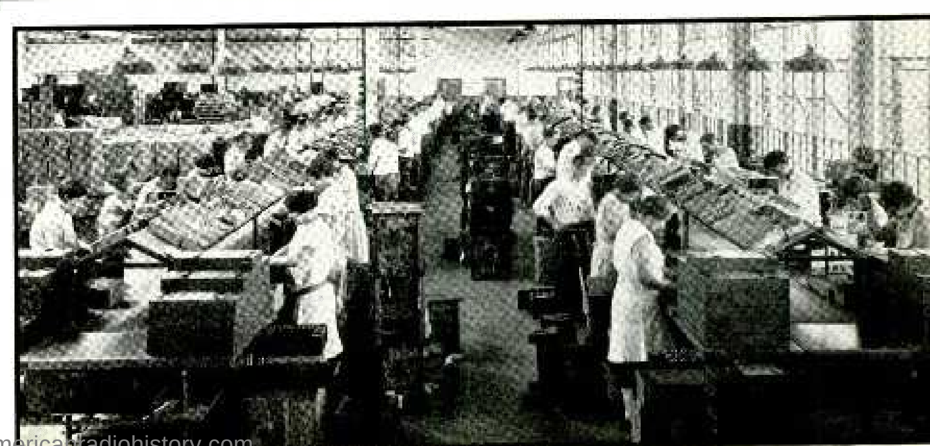
There are two main assembly lines for chasses, each including a double row of benches, one at each side of a conveyor belt which advances the chassis when it is not more convenient to pass it by hand along the bench from station to station. Assembly is done largely by girls most of whom are seated along the benches and are provided with trays or tote boxes of the small parts which they fasten into place, often making one or more soldered joints and using, for the most part, electric soldering irons. Some motor driven hand tools and some machines for setting eyelets or tubular rivets are placed along the lines, but most of the work is done with pliers, soldering irons, screw drivers and similar small tools.

At some stations, special holding fixtures project from the sides of the benches and facilitate the particular operations performed. When possible, duplicate chasses are run through a given line in large batches so that the operations are constantly being duplicated, but as each of the double benches may constitute a separate line, four different chasses for different models are readily produced simultaneously when conditions require this. At the end of each line, there are testing stations at which different parts of the circuit are checked to make sure that the assembly is properly done. Having passed these tests, the completed chasses are placed on a short roller conveyor which carries them to a belt conveyor which, in turn delivers them to an aligning room in which oscillographs and other test instruments are employed to check over-all performance and make such adjustments as may be required to insure the desired quality of performance in service. The aligning room includes several testing stands, each of which has its individual set of testing equipment so that it can keep pace with the assembly lines.

Following this test and adjustment of the chassis, it is set on one of two roller conveyors along which are a series of stations in which the chassis, speaker and labyrinth are set or fastened in place in the cabinet, the latter being taken from an adjacent live storage area. The second conveyor is for table sets which do not include the labyrinth and, of course, are provided with a smaller speaker. This completes the assembly and the cabinets of console type, which are already fastened to the base of a shipping crate and now have all equipment installed. The radios are slid along the floor and are passed through booths in which final tests are conducted and any required adjustments of the assemblies are made. Similar tests are made also on table models which are handled on benches rather than along the floor. The tests include checks in actual reception of broadcasts and are calculated to insure a high quality of performance in the hands of users. Having passed the tests the completed product is transferred into the adjacent shipping department for packing.



The overall performance of each receiver is checked and adjusted in the aligning room. Several stations are provided to keep pace with the assembly line



Main assembly lines on which the chasses are assembled. Each pair of lines has a belt conveyor running between them

A NEW IGNITRON FIRING CIRCUIT

By HANS KLEMPERER
Harvard University

WIDER fields of application of the ignitron as a conversion unit in rectifier circuits[1] could be found if the thyratron could be eliminated from the ignitron starting circuit. The thyratron, which usually is connected in series with the starter electrode[2] of the ignitron, has the double function:

1. To suppress the reversed current to the starter,
2. To interrupt the forward current to the starter immediately after the discharge in the ignitron has been initiated.

Evidently the thyratron is not the final solution of the problem. It is excellent in suppressing the reversed current and in conducting, without distortion and almost without loss, the high starting peak current. But tube life is limited under such peak load conditions even if relatively large and expensive tubes are used. Thus ruggedness and durability, specific advantages of the ignitron, are lost. The function of interrupting the forward current to the starter after pickup of the ignitron requires a higher arc drop in the thyratron than in the ignitron. Inert gas-filled thyratrons which would meet this requirement have a poor life. Therefore, as a simple way of meeting the difficulty, two thyratrons in series are very often used.

Attempts to replace the thyratron in the ignitron starter circuit are as old as the ignitron itself. Dry, disk-type rectifiers and even pool-type rectifiers with a holding arc were used as well as rotating contact devices, and circuits with saturated iron. While the principle of many of these attempts seems to be inferior to the application of a thyratron, the use of saturated iron appears promising. Of course, the connection of a common peaking transformer is not a solution, because the negative peak has to be suppressed, and a combination with other rectifying means makes the scheme expensive and unreliable. In this paper a different solution is presented, based on the superposition of ac and dc in the *same winding* of a saturated coil which results in polarized, narrow, high-current peaks, practically without any reversed current.

The New Principle

The principle of the new circuit is illustrated in Fig. 1. In (a) is shown the saturated iron coil in series with an ignitron starter supplied by both an a-c and a d-c source. Figure 1 (b) gives the iron characteristic of the coil core and (c) shows flux and current in the coil with a sinusoidal voltage on its terminals. With a d-c component added to the original a-c in the coil the flux varies from low saturation in one direction to high saturation in the other direction. Meanwhile the current changes from low values when there is no saturation to a high peak during saturation. This formation of a single-sided current-peak resulting from the addition of a-c and d-c components of coil magnetomotive force is illustrated in (d). The coil current which is distorted to polarized peaks in the described manner flows through the starter and causes the ignitron to fire whenever the peak current reaches the critical value. After pickup of the discharge, an arc burns to the holder of the starter as long as the peak lasts. This is illustrated in (e).

The method thus far described takes care of ignitron firing and subsequently of a short-time holding of the exciter arc, providing sufficient time for the main discharge to develop reliably even under adverse circumstances. However, a considerable residual current would be left between the current peaks and would flow through the starter in the reverse direction unless it was cancelled in some way. In the scheme described this cancellation is effected by a superimposed direct current. If, for instance, the d-c component of the magnetizing current would flow in a separate coil winding and not pass the starter, the average value of the reversed starter

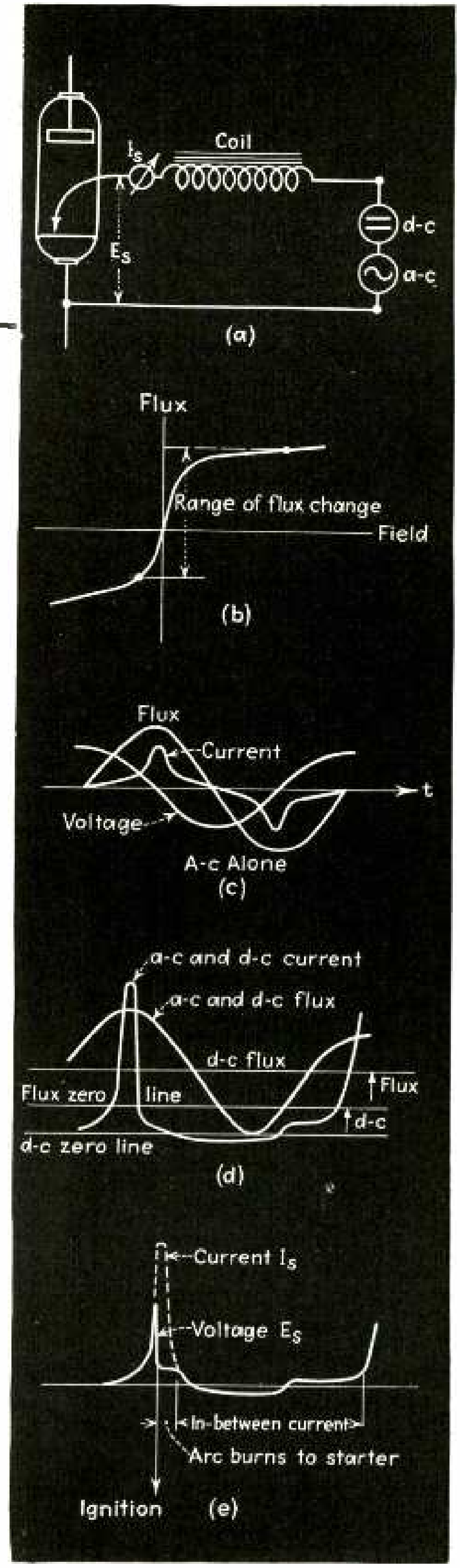


Fig. 1—Development of voltage peaks from saturating core characteristics

The application of direct as well as alternating current to a saturable-core reactor produces peaks of voltage suitable for controlling the firing circuit of ignitron rectifiers. Theory and practice of the method

current would be considerable. Therefore, the flow of the magnetizing dc is directed through the starter in order to cancel the reversed current.

This cancellation cannot be absolute because of the residual undulation and hysteresis distortion of the reversed current. The current that is left uncompensated flowing between the peaks is called "in-between current" in this paper. It is flowing in alternate directions, as also visible from Fig. 1 (e), and is measured oscillographically.

Tests were made with an ignitron, the starter of which had a cold resistance of 30 ohms, dropping to 20 ohms if 0.1 ampere were flowing through it continuously. Using a coil with a common silicon steel, the dimensions of which are derived below, the uncompensated reversed current was about 1 ampere. By applying the described method of compensation, this reversed current was reduced to an "in-between current" of a few milliamperes in average. In addition to this "in-between current" the starter has to stand a "forward current" which flows through it during ignition and thereafter, parallel to the arc, as long as the peak lasts. The sum of both, the actual heating current of the starter, was measured oscillographically and from resistance rise of the starter, and was found to be 0.1 amperes in the described set-up. So far experience does not indicate that this "heating" current is harmful to the starter, since ignitrons have operated in the circuit described for hundreds of hours without changing their characteristics.

Practical Application

A practical diagram of a 6-phase ignitron rectifier with saturated coils to form starting current impulses is shown in Fig. 2. The ignitrons are connected in a 6-phase circuit, as a double-Y connection, for example. A saturable coil and a phase winding of an auxiliary 6-phase transformer lie in series with each starter. The static phase angle between coil voltage and current which appears from Fig. 1(c) and (d) is compensated by proper transformer connection. If continuous phase control is desired, the transformer is built as a phase shifter, for example a wound-rotor type induction motor. The power required is about 30 to 40 watts per phase. Between the auxiliary transformer neutral and common cathode connection of the ignitrons, a rectifier *G* is arranged which should draw its power (about 10 to 15 watts per phase) from the common a-c source. A copper oxide type rectifier (Rectox) is very convenient for that purpose. The rectifier voltage is adjusted by a resistor *R*; the d-c side of the rectifier is shunted by a capacitance *C* to by-pass the alternating current.

The connection of the d-c and a-c components of the starter current to the same power source has the advantage that with failing a-c supply the dc would stop automatically. Otherwise, with dc alone, the starters would burn out in a very short time. Ignitron firing can be interrupted by opening the d-c supply; the high a-c impedance of the coils that exists without d-c magnetization would allow only a small fraction of an ampere, ac, to pass (0.1 amperes in the circuit analyzed below, where the alternating voltage was 120 volts) which generally is not harmful to the starter. However, much more rapid control is secured by directly connecting the starter lead to the cathode of every individual ignitron by means of relay contacts or by a thyratron, for example. (10 volt drop of a thyratron is too low to fire a starter). Such control does not involve magnetic inertia, as does the opening of the d-c circuit, and therefore would be the right control in connection with protection relays.

A practical value for the capacitance shunt *C* is 25 μf which corresponds to about 100 ohms leading impedance of the a-c by-pass. A larger capacitance would involve the danger of building up resonance

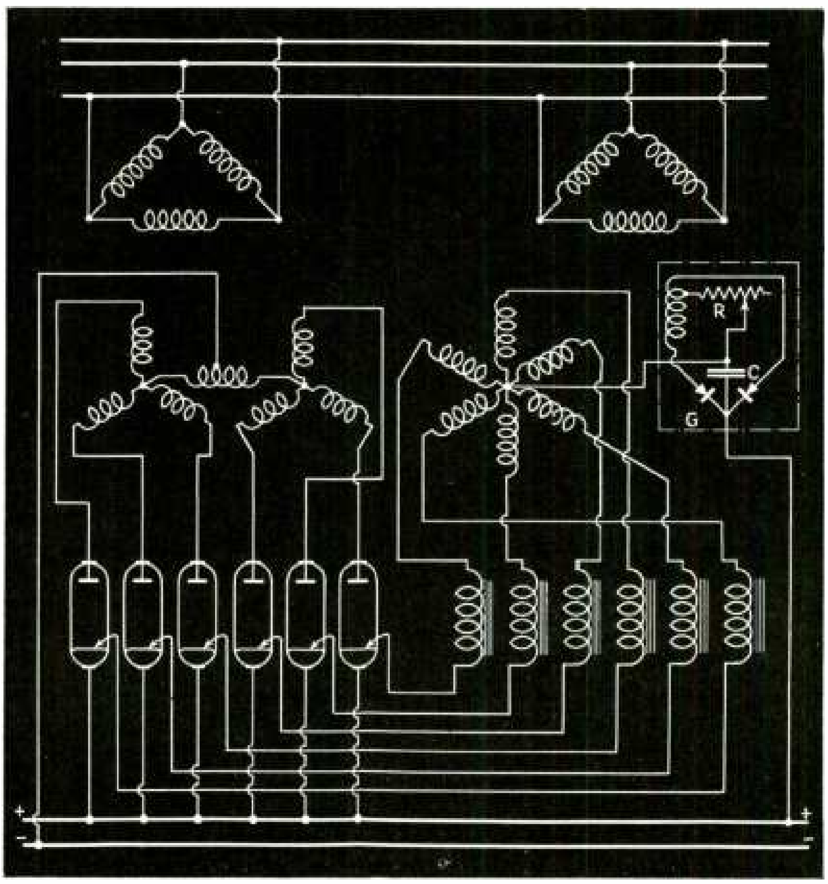
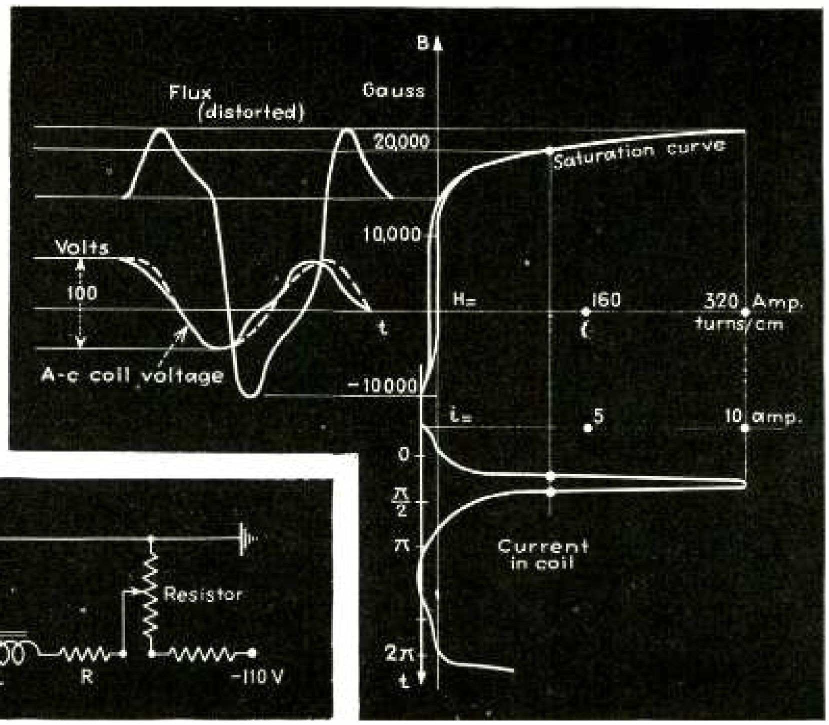


Fig. 2—Six-phase ignitron rectifier with saturating-core firing circuits

Fig. 3 — Right, design data for typical "peaking" coil based on saturation at 23,000 gauss



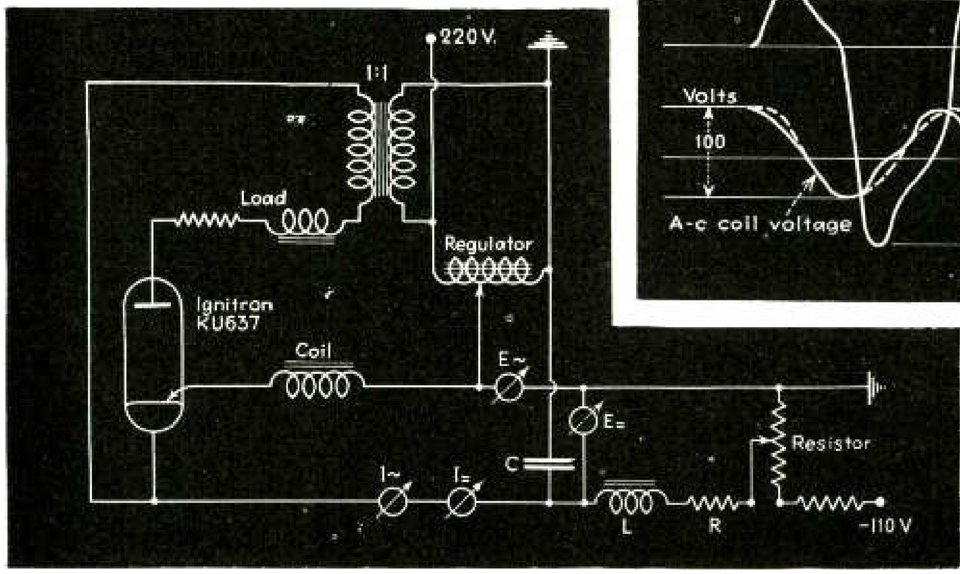


Fig. 4—Experimental rectifier circuit used by the author in testing the "peaking coil" method. Coil designed by Fig. 3, experimental data in Fig. 5

peaks with the coils if dc is removed since, below saturation, the inductance of the coils reaches about 1 henry, as shown below.

The design of a starter circuit of the foregoing type and its complete analysis is a graphical problem because it involves the magnetization characteristic of the iron core of the coil. Iron of the permalloy type which shows high permeability at low field strength and followed by a sudden saturation, would be best adapted to the purpose. Common silicon steel transformer sheet was used with excellent results in the experiments and the following analysis is based on such a transformer core. It is expected that much sharper peaks at lower power consumption will be obtained with a permalloy core.

The magnetization curve for the iron core of the "peaking" coil is given in Fig. 3. It shows saturation at about 23,000 gauss. The greatest curvature occurs at 13,000 gauss, corresponding to a field strength of 31 gilberts per cm (25 ampere turns per cm). This is the proper range for the d-c flux. The average ignitron starter[3] needs from 500 to 1000 watts (instantaneous) to start an arc. In general the initiation of the cathode spot is effected during a very short time, but still it is advisable to hold the excitation arc to the starter electrode for a somewhat longer time in order to facilitate the maintenance of the cathode spot at low initial anode current (inductive circuits). Considering this additional power, 50 watts seems to be a proper rating for the peaking coil. With the heat dissipation factor $h = 0.0015$ watts/cm²/°C. and permitting a temperature rise of 100°C, the heat dissipating surface of the coil is

$$A = \frac{50}{100 \times 0.0015} = 333 \text{ cm}^2 \text{ or } 52 \text{ square inches}$$

To obtain a coil with this surface area an iron core of $l = 15$ cm (average) length, on which $n = 500$ turns of wire are wound in a single winding, is used. The ohmic resistance of the winding at 20°C. is 6.5 ohms increasing to 9 ohms at 120°C. The field strength $H = 31$ gilberts per cm, referred to above, is obtained by a direct current of

$$i = \frac{H \times l}{0.4\pi \times n} = 0.75 \text{ amp}$$

This is supplied to the coil by a rectifier, for example, as shown in Fig. 2. In superimposing the a-c excitation, care has to be taken to avoid saturation on the lower branch of the saturation curve, since this would cause a negative peak. Limiting the flux density in the lower branch to about 10,000 gauss, at which value the curve starts to bend, an alternating flux with an amplitude of about 23,000 gauss as an upper limit can be superimposed on the above-calculated d-c field.

The relation between the maximum flux ϕ and the exciting sine wave voltage E (rms),

$$\phi = E \sqrt{2}\, \frac{10^8}{\omega\, n} \text{ (volt sec.)}$$

gives $\phi = 90{,}000$ with an exciting voltage $E = 120$ volts, $\omega = 377$/sec, and $n = 500$ turns. Thus a proper flux density of $B_{max} = 22{,}500$ (volt-sec/cm² or gauss) is reached with 120 volts on the coil if 4 cm² is chosen as the cross section of the iron core. The superposition of this flux on the flux caused by the d-c magnetization of 25 ampere-turns per cm is affected by the characteristic shape of the magnetization curve and a non-linear response results. A distortion of the original sine-wave excitation voltage is caused by the transformer reactance and the drop in the lines. An oscillogram of the distorted excitation voltage is shown in Fig. 6 and this wave shape was used in the graphical derivation of Fig. 3. This derivation takes into account hysteresis effects due to the comparatively high saturation. The resulting magnetizing current has a peak of 10 amperes with an approximate width of 60°. This current shape agrees well with oscillographic results of Fig. 6, including distortions caused by hysteresis. Drawing the zero line through the "in-between" current, the d-c average of the peaks is 0.8 amp. as illustrated in Fig. 3. This means that with a d-c coil magnetizing current of 0.75 amp flowing in the same line, 94 per cent of the dc has been concentrated in the peak and only 6 per cent (or 50 ma) is left as "in-between" current, which probably is too low to damage the starter.

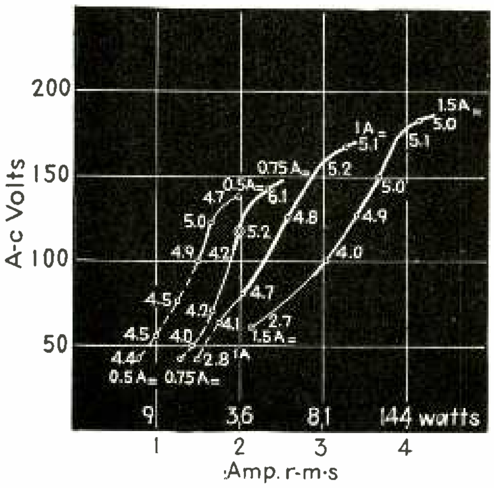


Fig. 5—Experimental data showing r-m-s current flow as function of applied alternating voltage

Experimentally, the amount of "in-between" current is checked with an oscillograph, connecting the deflection plates directly, or with a reversed current meter. Such instruments, for example, would consist of a d-c instrument through which only the reversed current flows while the forward current is bypassed by a rectox combination. Practically, adjustment towards zero "in-between" current is accomplished by regulating the amount of direct current by means of resistor *R* (Figs. 2 and 4). As will be discussed below, the effect of such d-c variation is mainly a variation of width of peak, provided iron saturation on the negative side is not reached.

A coil was built according to the above specifications and some of the results are shown in the diagram, Fig. 5. The experimental circuit corresponded to Fig. 4 with the exception of a 0.5 ohm resistor inserted in series with the starter for oscillographic reasons. The resistance of the starter element of the ignitron (Westinghouse KU637) was 30 ohms for the cold starter and 20 ohms at average operating temperature, as mentioned above. The starting voltage varied at random[4] between about 100 and 200 volts. No failures in starting were observed during hours of continuous running with an electronic counter when the circuit was providing peaks of 10 amperes, the current value on which the above calculations were based.

Figure 5 shows the r-m-s value of the current flowing in the circuit as a function of the alternating voltage impressed, for different values of direct current. Copper losses in the coil corresponding to r-m-s current at high coil temperature are given in the upper abscissa scale in watts. Peak-current values were measured with the oscillograph and peak-factor values (peak factor = peak/rms) are written beside each measured point. The curves are dotted where the ignitron did not pick up; they are thin lines for values where the ignitron flashed and they are thick lines at the points where the ignitron conducted without any failure. With rising direct current the peak factor decreases and the peaks become wider. They also become wider with decreasing alternating voltage. With rising alternating voltage the peaks become higher and narrower until the flux swings into the region of the saturation on the lower branch of the iron characteristic. This fact, which was mentioned above, is indicated by the appearance of a negative peak in the oscillogram and by a greater rise in r-m-s. current (bending of upper part of curves) in the diagram. The operating point for which the coil was calculated is indicated by a circle. At this point the coil temperature rose to 110°C. during continuous operation, with the additional iron losess included, indicating that the 50-watt dissipation limit was nearly reached. If higher peaks were desired, which may be the case with the older type ignitrons, artificial cooling means should be added or larger coils should be built.

References

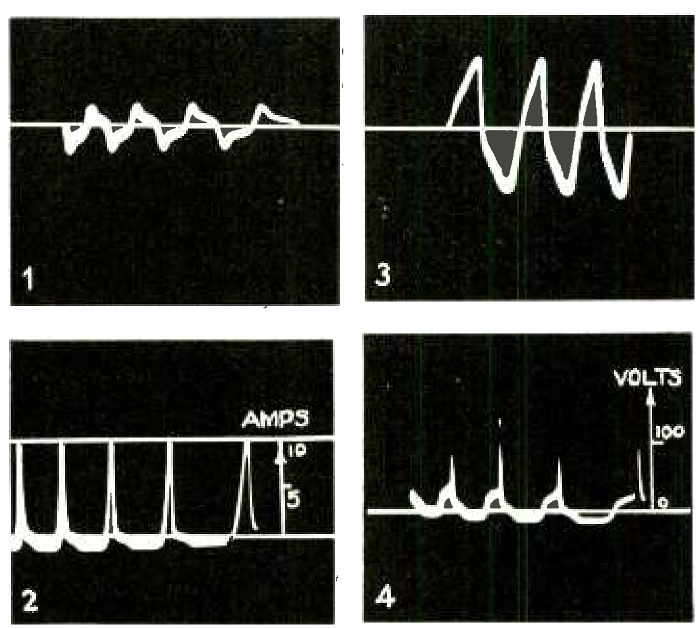
1. This paper does not consider the application of ignitrons for welding circuits, where entirely different conditions prevail. Such conditions are discussed by D. Packard and J. H. Hutchings, *Elec. Eng'g.,* Vol. 56, (1937), p. 37.

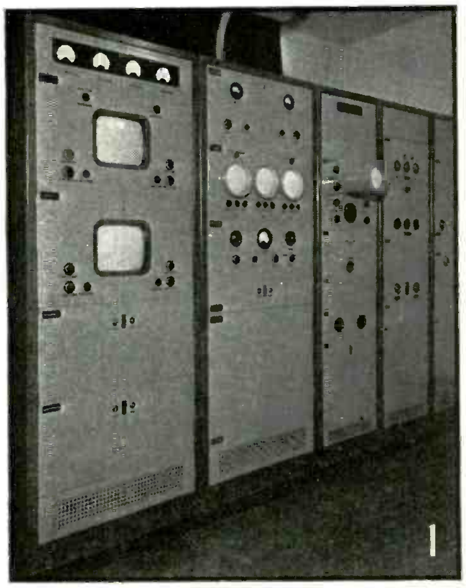
2. D. D. Knowles, *Electronics,* Vol. 6 (1933), p. 164. Another circuit was described by C. B. Foos and W. Luttemann, *I.R.E. Proc.,* Vol. 24, (1936), p. 977.

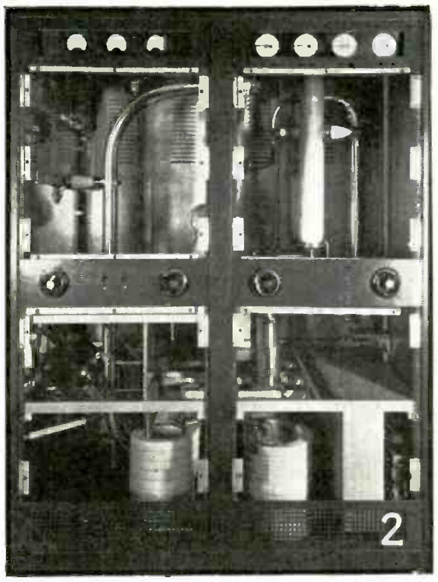
3. Slepian and Ludwig. *Elec. Eng'g.,* Vol. 52 (1933), p. 605; *A.I.E.E. Trans.,* Vol. 52.2 (1933), p. 643. See also discussion by O. K. Marti, *A.I.E.E. Trans.,* Vol. 52,2 (1933), p. 699.

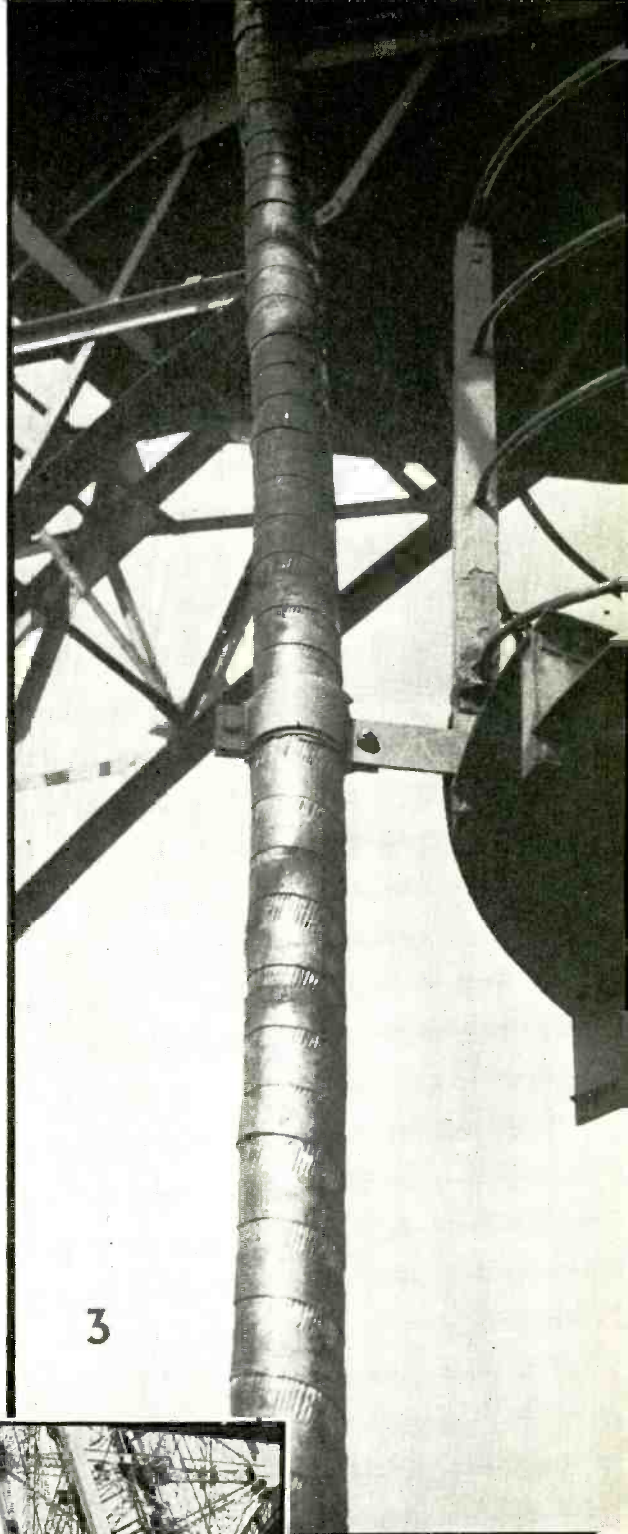
4. There does not yet exist a generally accepted theory of the rather complicated starting mechanism of the ignitron. Slepian and Ludwig (3) make the electric field strength on the mercury surface responsible for initial emission, while G. Mierdal, Wiss. Veroeff. Siemens, Vol. 15, part 2 (1936), p. 36, develops a thermal theory. For experimental values of starting voltage and current, see: J. M. Cage, *G. E. Review,* Vol. 38 (1935), p. 464; and A. H. Toepfer, *Elec. Eng'g.,* Vol. 56 (1937), p. 810.

Fig. 6—Oscillograms of peaking system: 1, current in coil, ac only; 2, current with d-c component added; 3, voltage, ac only; 4, voltage with d-c component added









Paris Television —Waiting for Peace

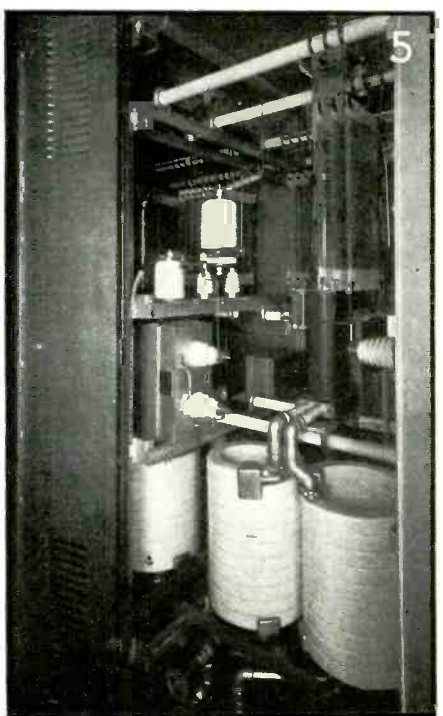
1 Monitor equipment of the new television transmitter at the base of the Eiffel Tower, ready for a public program service before the outbreak of the War. Virtually all television activity in Europe (London, Paris and Berlin) has since come to a standstill

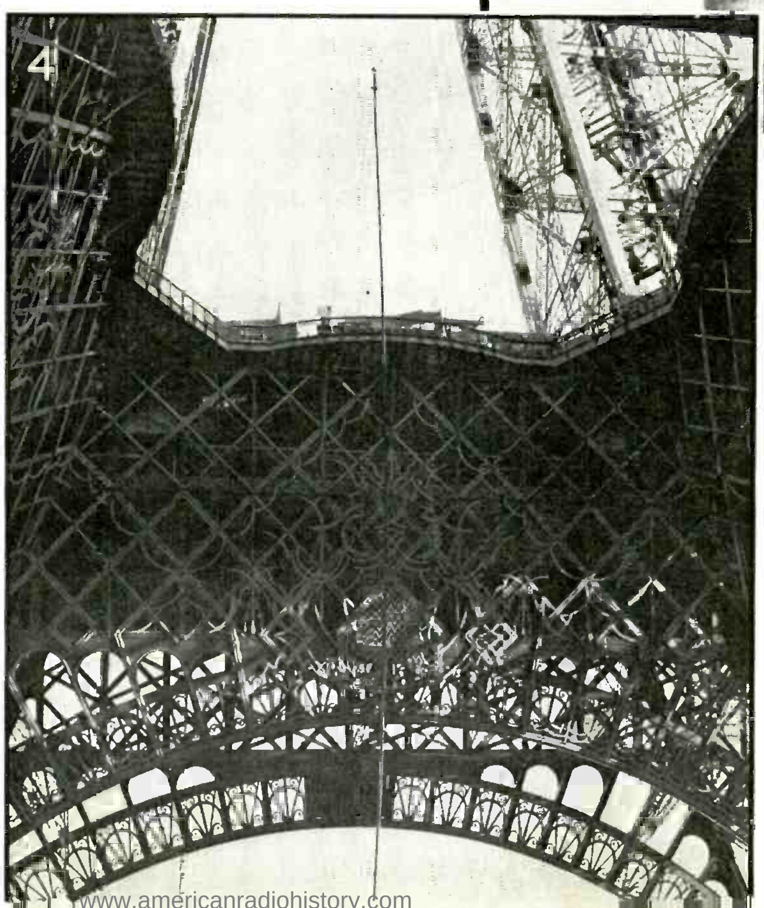
2 The final output amplifier stage of the transmitter, power output approximately 25 kilowatts. Reports from Europe indicate that all research work in television (except possibly in military applications) has ceased, leaving the United States alone in the field

3 A heavy coaxial cable, 1200 feet long and weighing 12 tons, connects the transmitter with the radiators at the top of the tower

4 During the installation, the coaxial transmission line was hoisted on a steel cable to the top of the tower. A heavy wind caused the cable to bow out despite its great weight

5 Output stage of the modulator. Note the fabric type resistors (upper right) used for coupling to the modulated r-f stage



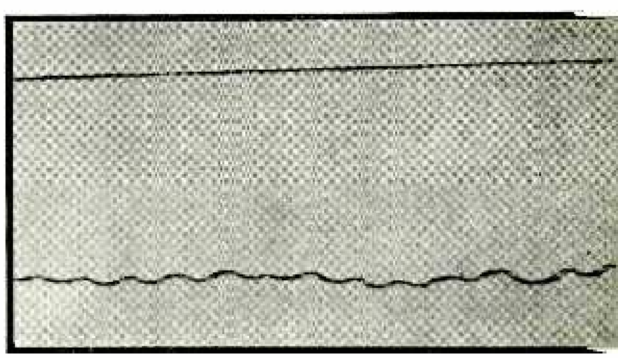


DISC-CUTTING PROBLEMS

By C. J. LEBEL
Recording Consultant

THE solutions of the problems which face the instantaneous-recording organization change with the materials available. Since the writer's last article there have been fundamental changes in the field, new materials, different requirements. The effect of these changes on the following subjects will be discussed: high frequency response, harmonic distortion, disc durability, noise level.

Above, record showing vibration pattern. The curved radial spokes (upper left portion of the record) show the effects of non-synchronous vibration sometimes introduced by roller drives



Right, two types of cutting thread: the straight thread indicates proper cutting, while the "kinky" thread arises from improper cutting angle

The "Dry-cut" Problem

Only too often recordists go to their disc suppliers with an angry look, muttering about dried-out coating, old stock, and so forth. The trouble simmers down to a very kinky thread, a very noisy surface, or, in other cases, a very faint whistle, or a tendency to cut light and heavy intermittently. These are too often interpreted as signs of a dried-out coating.

This complaint started several years ago when coating formulas were poor and when air conditioning was not used in the disc-coating plants. It was impossible to coat during the summer, so a large stock was built up during the winter. By the late summer the remnants of the stock were pretty dry and brittle. Real trouble resulted. But the better manufacturers have long since remedied the basic difficulty. Some formulas do not dry out at all. Others dry out slowly in the open air. None dries out in sealed cans. Discs are made in summer as well as in winter. There simply is no longer any dry material. What, then, is the difficulty?

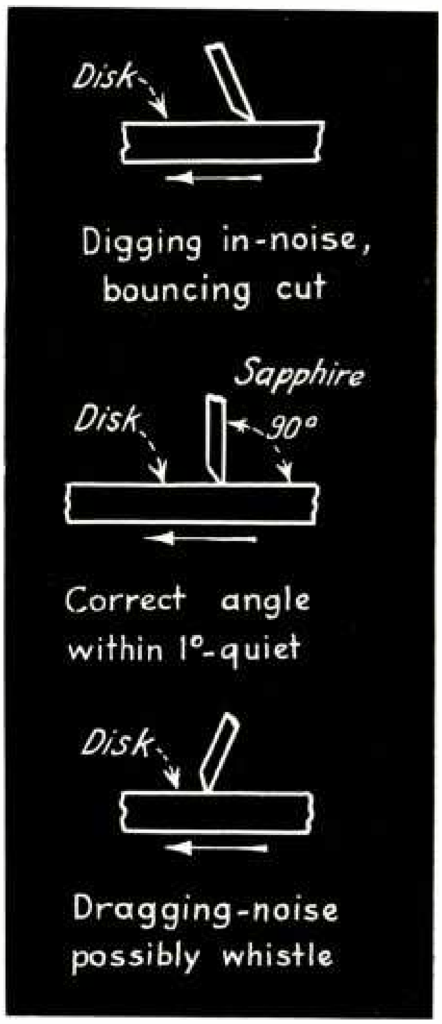
In general, a very kinky thread and noisy cut are due to wrong cutting angle. Be sure that the cutting angle of the stylus as actually used is within 1° of vertical (for most formulas). A tendency to whistle at very low level while cutting is usually caused by wrong angle, though occasionally the fault is with the stylus itself.

Now, curiously, changing to another make of blank is not a conclusive test. Some makes are much softer than others. An inferior formula has to be soft to keep the surface noise down, even though thereby the higher frequencies are attenuated badly. Now a soft coating is not at all sensitive to cutting conditions—the angle may be all wrong and the stylus like a rusty nail—yet the noise level will not be raised much. If, therefore, one tries to check on the correctness of cutting conditions by using another make or formula, the new discs should display the proper hardness.

As another point, be sure that the pressure on the stylus is right. Some formulas require more pressure to cut a groove of proper depth, others require less. Curiously, all seem to impose about the same load on the driving mechanism, even though the pressure may differ in the order of two to one. There has been no published explanation of this, though it probably has to do with the relation between hardness and coefficient of cutting friction. Shallow cut, then, means wrong pressure, not necessarily a dried-out coating.

Most recording machines have a certain amount of residual vibration. The resulting record has a visible vibration pattern—radial spokes with a synchronous drive mechanism, a moiré (watered silk) effect with the usual rubber roller drive non-synchronous mechanism. If the carriage mechanism is badly designed or out of adjustment, this effect is accentuated and the cutter head is thrown into an oscillation which may even make the stylus bounce clear off the record. A digging-in cutting angle can also cause this trouble. In the latter case, a firm coating will accentuate the trouble. The remedy is to change the cutting angle, not to use a softer coating.

Worn out from educating their customers in these matters, some disc manufacturers have intermittently resorted to softening their coating. This makes a product which is easy to use and hence easier to sell, but which may have a response down 10 to 20 db at 5000 cycles—a very poor product. It is a good idea to compare the 1000 and 5000 cycle response from your discs occasionally. Of course, the test is truly comparative only if the stylus is good and the comparison made at the same diameter on each disc, using the same stylus for all cuts.



The cutting stylus should be vertical, within one degree. Otherwise the effects shown above may be produced

Grit in Recording Blanks

There is another common complaint. A recordist uses more styli than usual for a given recording time, and advances as an excuse that the blanks are full of grit.

This complaint was justified in 1934. Coating dopes were badly filtered and the resulting film was full of both large and small particles. Today's coatings are extremely well filtered, and the surface irregularities observed on most discs are not, in most cases, abrasive grit. They may be minute bubbles, surface imperfections due to unevenness of the aluminum core, or particles of soft cotton lint from the filter.

This is not to imply that discs no longer contain coarse grit particles. Occasionally grit will get through filters or will settle on the disc even in an air-conditioned factory. But not one-tenth of the "grit" complaints are justified at present. Some coatings contain extremely fine abrasive material — quite invisible under any condition. The effect is to hasten stylus wear somewhat, but not to break it down instantaneously or even rapidly. The complaints of sudden wear, then, are more likely the result of a careless recorder dropping his cutter too hard and damaging the sapphire by cutting momentarily into the aluminum.

Harmonic Distortion

A number of large radio stations have made unsuccessful attempts to break into the transcription field. Although processed by the same firms as handle masters from wax recording studios, their instantaneous masters have lacked cleanness and naturalness. How far is this inherent in instantaneous masters and how far is it remediable? Why does the average instantaneous studio's product show the same fault whether processed or not?

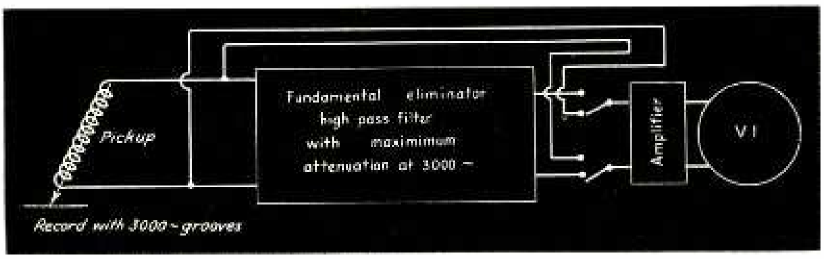
This defect shows up as a certain wooliness or lack of cleanness—an effect of the artist standing behind a heavy curtain. It can exist in spite of wide frequency range. Many engineers pay little attention to it, yet it is quickly recognized by customers.

Actually it is a form of non-linear distortion. Due in part to magnetic non-linearity in an overloaded cutter, it has a much different sound from that of an overloaded amplifier and so is not as easily recognized. Most instantaneous cutters today are readily overloaded. Although most cutters do overload in some cases at as little as +3 db, they are often operated at +18 db. Now such overloading will produce a loud record, admittedly, but that is all that can be said for it! In many cases there is a reasonable compromise between high level and high distortion. In other cases a record of reasonable loudness and reasonably clean can be made only by some attenuation of bass, thus cutting down the power input for a given loudness. On the other hand, the standard wax cutter (worth several hundred dollars) has virtually no non-linearity even at maximum input.

There is another source of distortion which, though serious and very common, is virtually unknown to most engineers. It is coating distortion. When cutting from outside to in without the aid of a suction apparatus it is convenient to have the thread jump out of the groove (as cut) and throw some distance toward the center. Strictly speaking this is not vitally necessary, since a skilfully wielded brush will do the same thing, but it is a convenience and saves intensive work.

The disc maker makes the thread "throw" by using a coating which dries under tension. The thread then shortens instantly when cut free and thus tends to jump toward the center. This is convenient, but serious cause of distortion. The trouble is that the tension causes the groove walls to deform immediately after cutting—which is another way of saying that distortion results instantly. This can be heard by ear very easily by this test: Record oscillator tone—any frequency in the middle of the audio range (say 1000 or 2000 cycles)—at *average* recording level (usually about 10 or 15 db under maximum level). Listen to the tone as played back. With a coating under no or very slight tension the quality will be the same as the original. With a

Basic method of measuring disc noise level, using a high-pass filter to eliminate low frequency effects



Basic method of measuring distortion introduced by cutter or by the use of disc material which has dried under tension

coating under fair tension the quality will be nasal—very definitely unlike the original. Judging by ear, the offensiveness of this distortion can be accounted for only by its being rich in higher order harmonics, which are known to be serious even in very small proportion. Wax recording, of course, does not have this defect.

To the writer it seems obvious that the answer is to restrict the "thread-throwing" formulas to the larger and cruder portions of the field, such as home recording and recording for artists for home reproduction. There, outside-to-inside recording is necessary at low cost and without complications. For uses where quality is at a premium—for processing, for audition, and for rebroadcast adopt a procedure which does not depend on thread throwing. In the simplest case this means inside-to-out recording. For processing where outside-to-in cut may be necessary a suction mechanism is the answer. As a matter of fact, too many organizations have changed to outside-to-in recording for 16″ discs for the sake of a slight improvement in appearance, simultaneously sacrificing quality. The writer does not believe that customer pressure brought about the change in these instances.

There is another type of distortion which has become more common lately. This is due to a growing tendency to the use of pentode and beam power amplifiers not designed to stand the violent mismatch occurring at most frequencies when facing a cutter. Serious cross modulation results.

The mismatch exists both in magnitude and phase angle. A recent English publication states that the pentode is less sensitive to phase angle mismatch than is the beam power tube. Whether this is also applicable to American tube designs would be an interesting matter for some student to explore. Terman discusses reactive loads briefly on pages 168 and 169 of his book "Radio Engineering". (McGraw-Hill, second edition).

Wide Frequency Range

Again the writer must emphasize the recording truism that the ear is the final judge of tone quality. This means that a frequency characteristic with wide range but a strong peak in the middle will not sound like high fidelity—that old devil "masking" is at work again. Fortunately wide and uniform frequency response is easy to obtain with equalizers, as has been discussed more fully in previous articles. It should be pointed out that non linear distortion due to cutter or disc coating can exert an equal masking effect.

Coming back to discs, there is considerable difference between various makes in respect to high frequency response. This difference tends to be accentuated at $33\frac{1}{3}$ rpm when cutting near the center. Incidentally the lower surface noise of the modern formulas can be utilized to counteract this. Cutting at finer pitch and slightly lower level, it is possible to avoid cutting so near the center, thereby avoiding extreme attenuation of highs and so improving fidelity.

It is interesting to note that it is very easy for the coating chemist to get good high frequency response at the expense of high noise level or vice versa. A real triumph has been achieved by some who have been able to get good high frequency response and low noise level simultaneously.

Disc Life

There has been a great deal of interest expressed in the question of instantaneous disc durability. In the uncut condition all discs can be made to keep for quite a while. Some formulas have been found unchanged after four or five years. The others will keep very satisfactorily if the containing can is kept taped.

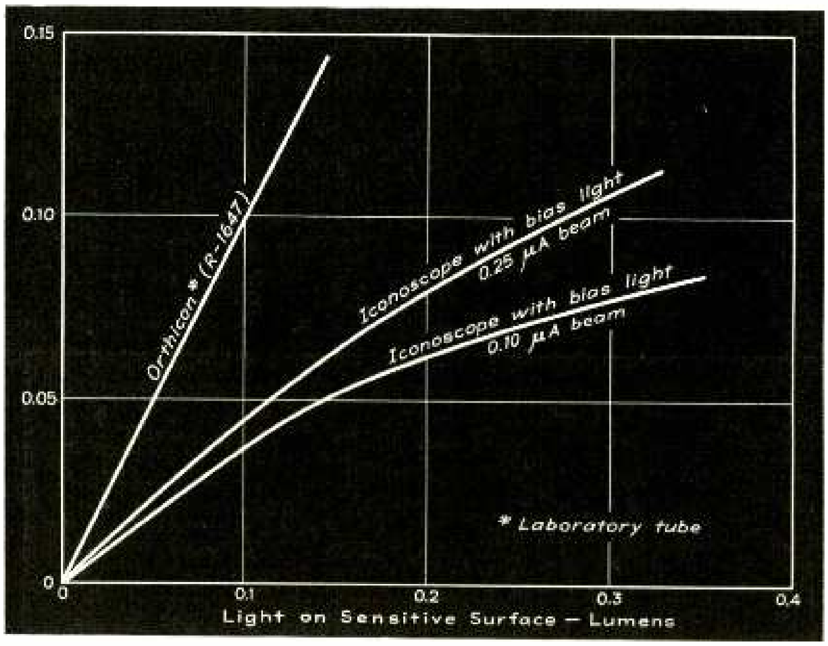
In the cut condition a disc has three enemies: dust, wear, harmonic distortion. Dust will raise the noise level instantly. Never use discs in a room with open windows, or with dusty surroundings. A valuable disc should be stored in a cellophane envelope, which is both dust-proof and free from lint.

The following precautions will reduce wear: Use shadowgraphed steel needles with a radius to fit the bottom of the groove. Needle pressure should be as low as possible—not over 2 ounces if possible. Some formulas are durable only with even less pressure—about an ounce. Some pickups are worse than others. The crystals *as a class* do not have the merit attributed to them by many. In other words, buy a pickup for good construction rather than as a member of a class of construction. Avoid non-metallic needles. The coefficient of friction is very high and instantaneous discs will be ruined in a few playings. Much surface noise is due to dust rather than actual wear, so keep the turntable clean.

As regards tendency to develop distortion, any drying type of formula will inevitably develop distortion in time. Older formulas developed as much as 15 per cent in a matter of weeks. Present formulas, of course, are much improved and serious distortion will take months to develop—apart from that inherent in a coating under tension.

ROCHESTER

I.R.E.-R.M.A. speakers reveal prospects for renewed activity in the set-design field, particularly in superportable sets, frequency modulation and television. Other branches of electronics show similar activity in prospect for 1940



Progress in television pick-up tubes. Curves shown by DeVore and Iams showing output current (microamperes) of the iconoscope and the orthicon camera tubes

THE Rochester Fall Meeting, traditionally the meeting place for radio receiver engineers, showed this year all the signs of renewed activity in the set design field, which for the past year or two has been characterized chiefly by new cabinet designs and new tube socket types, but by few basic engineering advances. Three topics seemed to have the center of attention: the development of very small tubes and batteries for "pocket" radio receivers next year, the prospect of greater activity in the television field, particularly looking toward lowered prices, and finally a great influx of interest in frequency modulation transmission and reception. The registered attendance at the meeting was about 475.

In all, some 19 papers were delivered, and a demonstration made of the newly installed Stromberg-Carlson frequency modulation transmitter. Two innovations in the presentation of the papers appeared: in the first place the chairman of each meeting made it his business to give a short biographical sketch of each speaker, which focussed attention on the engineer who, too often in previous meetings, has been subordinate to the subject of his paper. In the second place, the final paper of the meeting, delivered by Dorm Israel of Emerson was a summary of the practical significance of the papers presented at the meeting. This was a masterly piece of interpretation, and one very welcome to those who could not attend all the sessions, as well as those whose attention to details robbed them of a broader outlook. It is hoped that these innovations will be perpetuated in future meetings, at Rochester and elsewhere.

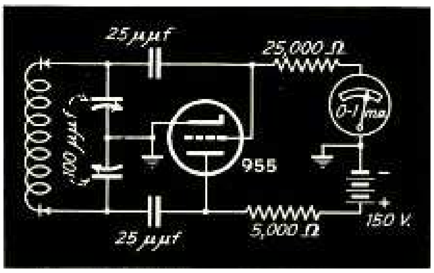
Glover on Phototube Response

A paper of particular interest to electronic engineers was "Spectral Response of Phototubes to New Illuminants" by A. M. Glover of RCA Radiotron. The popular cesium phototube was developed particularly to have high sensitivity to the light given off by tungsten lamps, but with the coming of fluorescent "daylight" lamps and of high intensity mercury arcs, it has been found that the cesium tube is not necessarily the most sensitive. The light output curves of several sources are shown in the accompanying diagram together with the response curves of cells made with rubidium, potassium and cesium oxides on silver. Thus with tungsten light the relative sensitivity is 4, 2 and 1, for cesium, rubidium and potassium, whereas with daylight the sensitivities are nearly equal in the three cases. The rubidium phototube is somewhat more sensitive to fluorescent daylight lamps than are the other two types. The high pressure mercury arc lamp is specially suited to the rubidium surface, being more than twice as effective on this surface as on the others. An interesting example of the effect of differing color responses was that of an advertisement in color, scanned for facsimile transmission in one case by a cesium cell and in the other by a rubidium cell. A tolerably good reproduction of tones was achieved with the rubidium scanner, but with the cesium scanner all the reds (including the advertiser's name) disappeared because the white paper and the red printing excited the same degree of photocurrent in the cesium cell.

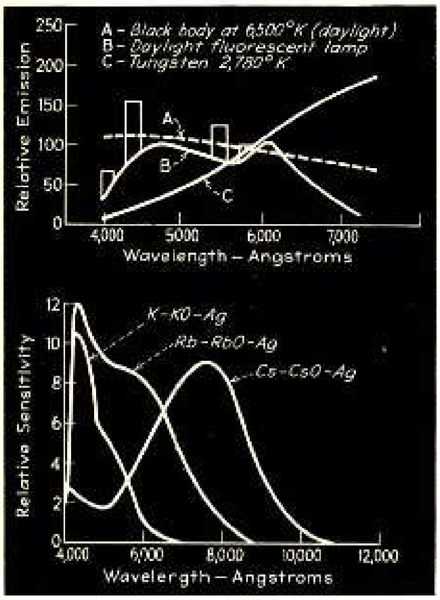
High-g_m Tubes Reviewed

M. A. Acheson and W. P. Mueller of Hygrade Sylvania presented a review of the high-mutual-conductance tube situation. The authors pointed out four figures of merit:

FALL MEETING



Grid-driver wavemeter used in u-h-f development (Minter)



Spectral distribution of light sources compared with responses of different types of phototubes

the ratios of g_m to tube capacitances, to plate current, to manufacturing uniformity, and to price. Three general types of high-g_m tubes were discussed: the space-charge tube, the electron multiplier, and the conventional or "brute-force" type. While g_m values as high as 100,000 micromhos may be obtained from space-charge types, their operation is exceedingly unstable with respect to changing applied voltages and aging. Accordingly they cannot be used in practical equipment. The electron multiplier type, such as the type EE50 recently introduced in England but not commercially available in this country, is more stable but is expensive to manufacture, due largely to the necessity of protecting the secondary emissive surface from contamination by the primary (thermionic) cathode. Baffle plates necessary to secure this protection increase the tube capacitances. Values of g_m up to 15,000 or 20,000 micromhos are available in these types. The conventional type tube has a construction similar to the usual pentode tube, but has extremely small spacing between cathode and grid, and corresponding fine grid winding pitch and fine grid wires. Values of g_m up to about 10,000 micromhos have been produced in such tubes. The principle difficulties are nonuniformity in manufacture, microphonism, and tendency to grid emission. In such tubes the g_m/i_p ratio increases as the 4/3rd power of the grid-cathode spacing, and the capacitance between grid and cathode increases in very nearly the same ratio. The authors' estimate is that the difficulties of manufacture increase as the third or fourth power of this spacing.

Noise Measurements in the Television Bands

A noise meter for use in the television bands, built according to specifications laid down last spring by the R.M.A., was described by Jerry Minter of Microvolts, Inc. The instrument, as shown in the accompanying diagram, consists of a 956 r-f stage, a 955 oscillator, a 954 converter, three 6SK7 i-f stages and a 6SQ7 detector-audio. Calibration is afforded by the use of a 958 tube connected as a diode across the antenna input. The shot-effect noise, which is calibrated in terms of the plate current in this diode, is inserted across the input circuit as a standard reference voltage. The meter covers a frequency range from 15 to 150 Mc, somewhat wider than the specifications demand, covers a frequency band of 150 kc and the calibrated measuring range extends from 5 to 200,000 microvolts per meter, the latter indication

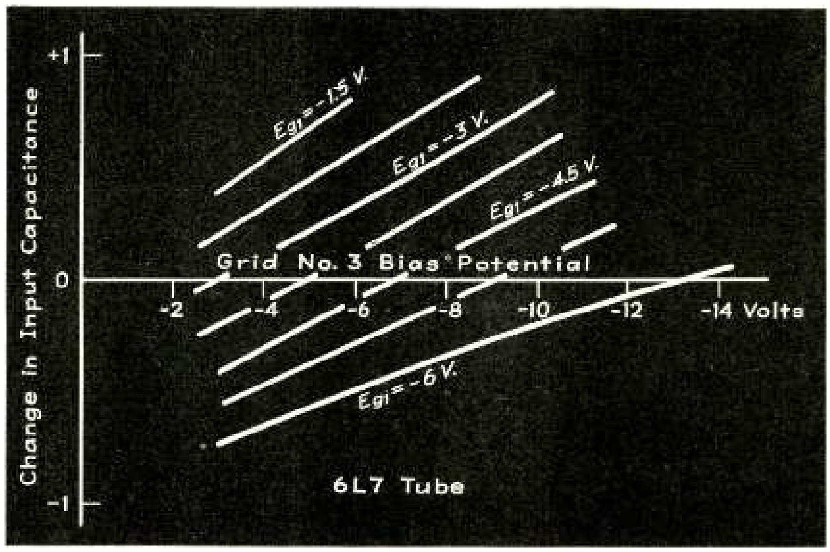
Paul DeMars points to the New England coverage map in comparing conventional broadcast stations with frequency-modulation station W1XOJ

being practically independent of the frequency of operation. In the development of the instrument, to eliminate dead spots, a u-h-f version of the grid-meter driver circuit, shown in the diagram, was employed as a dynamic wavemeter. The pick-up coil was placed on the end of a probe which contains the entire circuit. A tuning range of from 23 to 280 Mc is obtained with this arrangement. The use of the instrument in tracing down the sources and magnitude of ignition and diathermy interference was described.

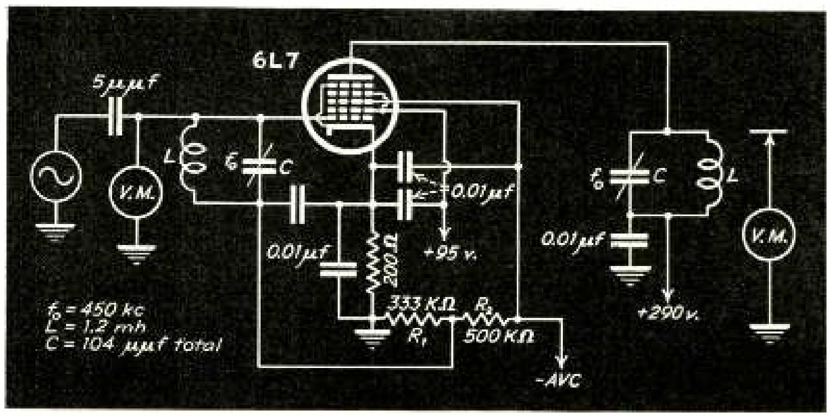
Converter Tubes Compared

Circuit considerations of superheterodyne converter tubes were discussed in a paper written by C. R. Hammond and E. Kohler, Jr., of Ken-Rad. Three tubes, the 6A8, 6SA7 and 6K8, were under discussion and several curves for the operation of each tube were presented. The comparison was made on a basis of stability with changing operating conditions. Curves were presented which showed the frequency drift of oscillators using the various types of tubes under conditions of use in a household receiver from a cold start until normal operating temperatures were reached, frequency shift versus varying electrode voltages with an input frequency (r-f) of 18 Mc and an output frequency (i-f) of 456 kc, and frequency shift with varying line voltage. A comparison in the Hartley oscillator of the three tubes was also made. The curves shown indicated that the 6SA7 is definitely superior to the other tubes with the 6K8 running second on the basis of frequency stability.

A highly theoretical paper on the ever-important topic of obtaining amplifiers with flat response was delivered by V. D. Landon of RCA Victor who discussed "Cascade Amplifiers with Maximal Flatness". The conditions of coupling circuits offering the most uniform impedance over a given band were derived for one and two reactive elements and for coupled circuits. Dr. H. E. Kallman contributed his ideas on the subject during the discussion.



Input capacitance variation of the 6L7 converter tube as a function of the potential of grid No. 3, used as a basis of Farrington's correction circuit



Typical circuit for compensating the effects of input capacitance variation by tapping the No. 3 grid off the a-v-c circuit

Vacuum Tube Input Capacitance Compensation

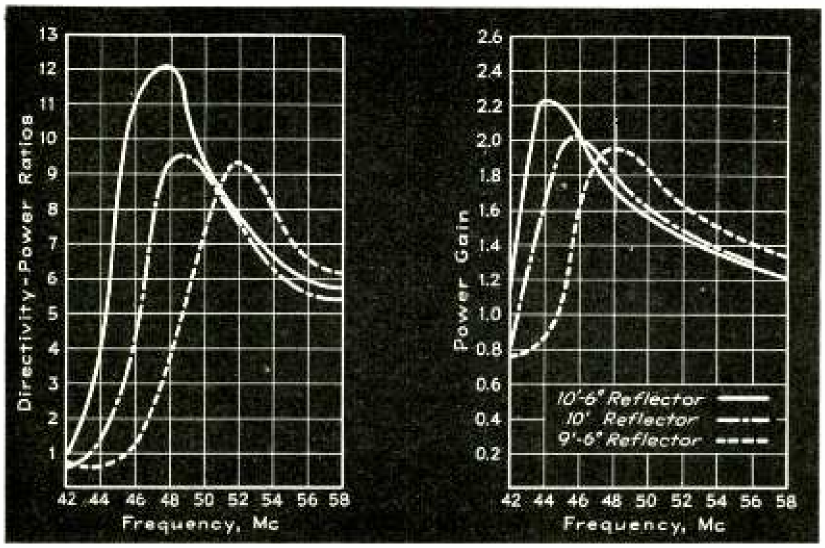
A paper delivered by John F. Farrington of Hazeltine Service Corp. was entitled "Compensation of Vacuum Tube Input Capacitance Variation by Bias Potential Control". In tubes used in high gain, high frequency amplifiers a variation in the input capacitance arises when the gain is controlled by the bias on the grid, due to the rearrangement of electrons near the grid. This variation may exceed 1.5 μμf in a typical tube such as the 6K7 or 6L7. If the potentials on grids (1) and (3) are properly varied, however, the gain may be controlled with the input capacitance remaining constant. This may be done by applying a-v-c potentials simultaneously and in the proper proportion to grids (1) and (3). The ratio is not constant and therefore to obtain the proper varying ratio, a voltage divider (R_1 and R_2) is placed in the cathode circuit as shown in the accompanying circuit diagram. In this circuit a ratio of two-fifths between the a-v-c volttages applied to the input and injector grids holds the input capacitance within close limits over the useful range of a-v-c potentials.

Standard Signal Generators reviewed by Karplus

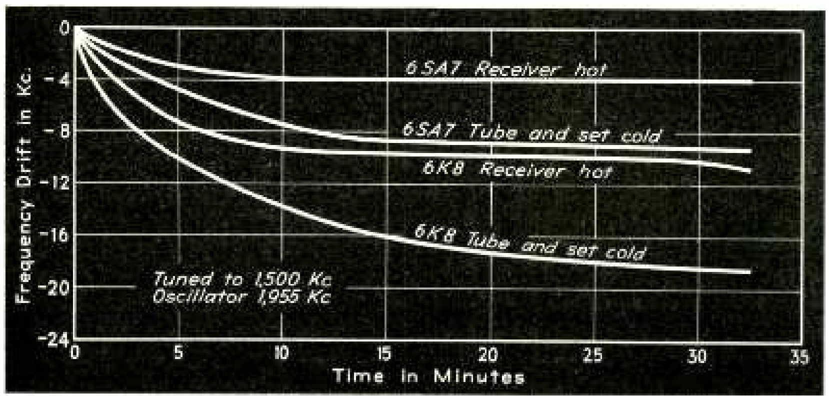
A "Survey of Standard Signal Generators" was presented by E. Karplus of General Radio Co. It was pointed out that there is a very wide range of types available to cover different frequency ranges and with varying degrees of accuracy. In spite of the fact that most radio receivers have a range from 500 kc to 20 Mc a signal generator is expected to have a range from at least 100 kc to 30 Mc with ranges up to 200 and 300 Mc in the offing.

The limitations caused by the maximum practical variation of capacitance in tuning condensers was discussed and the suggestion was made to change tuning condensers as well as coils for different frequency ranges. The most desirable form of frequency variation is that of the straight line curve, although other forms such as given by the straight line logarithmic curve are useful for certain purposes. The question of whether or not an amplifier should be used was discussed at considerable length with the conclusion reached that it is desirable in high radio-frequency standard signal generators to eliminate the amplifier.

In present day signal generators, the percentage modulation is generally continuously variable from low values up to 100 per cent with plate-voltage modulation as the most practical method. The output voltage range is from one microvolt to one volt with relatively few units having larger outputs because of the difficulties involved. The resistance attenuator, the simplest form, is used in the majority of instruments.



Directivity and power gain characteristics of dipole television receiving antennas employing reflectors, described by Stanford Goldman



Evidence pointing to the superiority of the 6SA7 converter tube in applications where frequency drift must be minimized, described by Hammond and Kohler

In instruments with a frequency range above about ten megacycles per second, the capacitive type of attenuator is used. Inductive attenuators have found only limited application, although at the higher frequencies, resistive attenuators become inductive.

Frequency Modulation in Television

The current interest in frequency modulation led C. W. Carnahan of Hygrade Sylvania to consider its possible use in television transmissions. While the wideband system of frequency modulation could not be employed without increasing the width of the required channel many times, it is possible to employ a relatively narrow frequency swing, of say one megacycle. This would not afford the full advantage of noise reduction, but it would have advantages in transmission since the peak power of the transmitter would then coincide with the carrier power instead of being four times as great, as in amplitude modulation. Mr. Carnahan analyzed mathematically the implications of operating in this manner, both in double sideband and single sideband forms, using a bandwidth no wider than that allowed by present channel assignments. His conclusions were that the system was feasible, and that it offered advantages. In particular he showed that the time of rise of a f-m receiver responding to a unit pulse of modulation was about the same as that of an amplitude modulated signal using the same bandwidth, but that a swing away from the carrier produced an overshoot, whereas one toward the carrier did not. At the conclusion of his paper, an engineer of the General Electric Company reported that experiments similar to those proposed by Mr. Carnahan had recently been made at Schenectady, and that the results showed a marked improvement not only in noise reduction, but in reducing the effects of ghost images arising from multi-path reception.

Lenses for Television Cameras

H. B. DeVore and Harley Iams of RCA Radiotron presented a practical analysis of the types of lenses required for television cameras. The factors governing the choice include the desired field of view and depth of focus, the brightness of the subject to be televised, least circle of confusion, and required signal to noise ratio. The characteristics of the lens are its f/number (numerical aperture), its focal length and its transmission coefficient. On the assumption of a signal to noise ratio of 10-to-1, considered to be the minimum for satisfactory reproduction, formulas were derived for the required f/number in terms of the width of the mosaic plate, and the brightness of the scene to be televised. The results are shown in the accompanying diagram. On the assumption of a mosaic 4.75 inches wide, a sensitivity of 0.4 μa per lumen, a 200,000 ohm input resistance, 500 ohm effective noise grid resistance, 26 $\mu\mu$f shunt capacitance, an angle of view of 30 degrees, and a brightness of 50 candles per square foot, the required lens was found to have an aperture of f/7 an 8.9 inch focal length, and transmission 60 per cent.

Square-Wave Testing at Audio Frequencies

L. B. Arguimbau, research associate at M.I.T. on leave of absence from General Radio, reviewed the useful means of testing a-f amplifiers using square waves. He pointed out that the response of an amplifier to a unit pulse of voltage gives all the information on the amplifier (amplitude as well as phase), and that the square wave, being a succession of unit pulses may be used to obtain the same information, providing the period of the wave is long compared with the transient response. Mr. Arguimbau derived the appearance of waveforms passed through various series reactance-resistance circuits and demonstrated the actual waveforms on a cathode-ray oscilloscope. The importance of waveform response in audio amplifiers has been emphasized by the extension of the audio range to the upper audible limit, where the ear's response to phase changes is more pronounced than in the middle range. Mr. Arguimbau suggested that in the future amplifiers may be characterized by low-frequency time constant, high-frequency time constant and per cent of overshoot, rather than in db variation within specified frequency limits.

An exercise in probability applied to consumer satisfaction with radio tubes was revealed by Henry Parker of Rogers Radio Tubes. The paper, which is reprinted in the R.M.A. Engineer, reached the conclusions that the average tube life should be proportional to the number of tubes in the set, that the uniformity of tube mortality and the average tube life are both of great importance in consumer equipment, the first for initial equipment, the second for replacement.

Progress of Radio Noise Meters

C. M. Burrill of the Victor Division of RCA Mfg. Co. traced the history of the development of instruments for the measurement of radio noise. The first noise meters were merely receivers with meters connected across the output. It was a considerable time before noise meters were designed to measure radio noise directly instead of converting it to audio frequencies first. A joint committee of R.M.A. and S.A.E. was instrumental in the design of such a noise meter. An international committee known as the C.I.S.P.R. contributed to further development and in 1938 a noise meter conforming to the specifications recommended by this body was built by C. J. Franks. A valuable development is the logarithmic frequency scale used on noise meters during the past few years.

A Look Into the Future

Sometimes in jest and sometimes seriously, Kenneth Jarvis in his paper "What Do We Do Next?" pointed the way to what may be the radio industry of tomorrow. Commenting on the continued trend of reducing the size of radio receivers, Mr. Jarvis not only demonstrated in working order an extremely small receiver, about one-third the size of today's smallest receiver, but he also demonstrated how the cabinet for such a receiver might be made. After the set is all assembled, it is placed in a mold and a mixture of two liquids is poured into the mold. After a short time, the liquid is hard so that the mold may be removed and the set is ready for use. This glimpse into the future indicates that not only is the radio industry far from stagnation, but is in the healthy condition of demanding new changes and improvements of itself.

Coverage by Frequency Modulation in the New England Area

Paul A. DeMars, chief engineer of the Yankee Network, reported on the coverage of station W1XOJ, the frequency-modulated transmitter of 2 kw power (50 kw in the near future) at Paxton, Mass. This is roughly 45 miles airline from Boston (see *Electronics*, November 1939, page 20), and the antenna is approximately 1800 feet above sea level. After pointing out that he meant by "coverage" substantially perfect reception free from noise, in contrast to the usually accepted definition in conventional broadcasting, he reported reception in downtown Boston, in the suburbs of Boston, and in a number of towns in Massachusetts, Rhode Island, Connecticut, Vermont, New Hampshire and Maine indicating that coverage, in the meaning of Dr. DeMars definition, is available over a radius of 75 miles, even with the present power of 2 kw. With the full 50 kw installed, the coverage will extend to a radius of 100 miles or more.

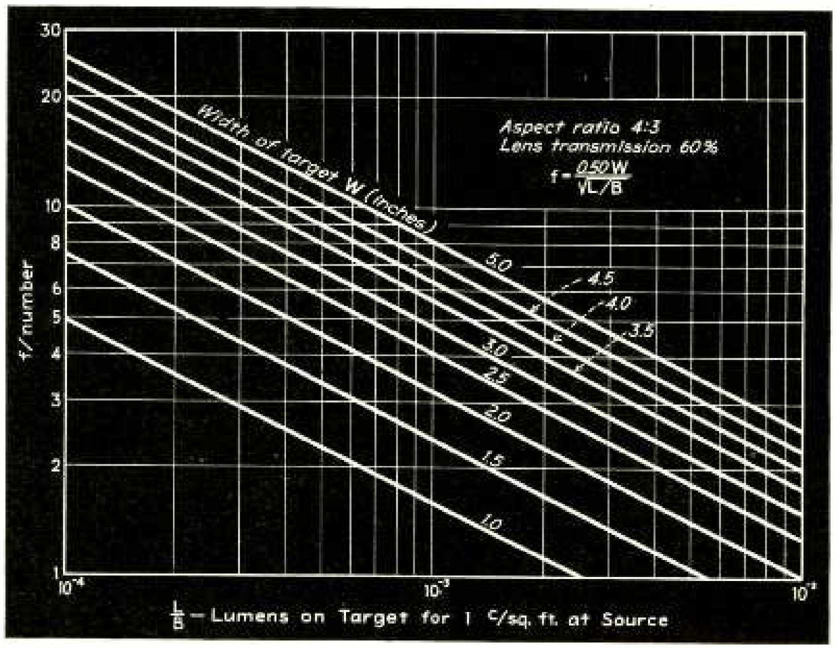


Chart for selecting lenses for television cameras (DeVore and Iams) in terms of plate size and light-brightness ratio, assuming lens transmission of 60 per cent

Good reception is, of course, possible outside these limits when a favorable site and directional receiving antenna can be used. Dr. DeMars showed a map of New England on which were marked the primary, secondary and rural coverage areas now used in selling time on the conventional broadcast stations of the Yankee Network. This map showed that the area of coverage of a 50-kw frequency-modulated station would be five times that of the 50-kw broadcast station in Hartford. This is in sharp contrast to earlier opinions on the coverage possible on ultra-high frequencies, as Major Armstrong pointed out in the discussion which followed the paper.

Iron Cores for Loop Antennas

An unusual application of powdered iron core material was described by W. J. Polydoroff. Large cores of this material were inserted in loop antennas, similar to those used for directional reception in aircraft. The *Q* of the antennas was thereby increased roughly 20 to 30 per cent, but the number of turns for a given inductance was reduced in about the same ratio. Theoretically, therefore, the effective height of the antenna should not be increased, but practically it is found that the antenna picks up an increased voltage, the increase being in rough proportion to the increase in permeability. Mr. Polydoroff suggested therefore that the usual formula for effective height be multiplied by the effective permeability of the material comprising the core. He pointed out also that antennas would on such cores display much less sensitivity to the near presence of metallic shields, and hence aircraft loop antennas may be placed much closer to the metal fuselage (with decrease in wind resistance) without adverse effect on the signal pick-up.

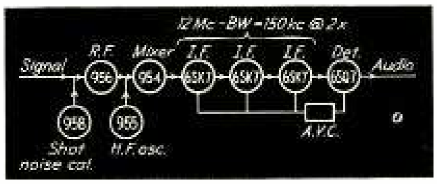
Frequency Modulation Station Demonstrated

A practical demonstration of the workings of frequency modulation equipment was afforded by the Stromberg-Carlson Company. This Company received delivery of their one-kilowatt frequency-modulated transmitter from the Radio Engineering Laboratories, several days before the convention, and the installation was completed in time to give a very satisfactory demonstration. The transmitter is located in the Rochester Gas and Electric Building, next door to the Sagamore Hotel where the convention was held. Consequently it was not possible to give a demonstration of the signal-to-noise advantages of frequency modulation, since the transmission path from transmitter to receivers was in the hundreds of feet. Instead, attention was focused on the high quality of the reproduction. Three Stromberg-Carlson receivers were set up in one of the hotel rooms. Two were combination amplitude-modulation frequency-modulation sets, the other a converter unit used in conjunction with a standard labyrinth model broadcast receiver.

As a preliminary to the demonstration, Frank Gunther, chief engineer of the Radio Engineering Laboratories gave a brief description of the transmitter. It employs the Armstrong type of modulator, in which a small phase angle shift is used as the basis of the modulation, followed by a frequency multiplication of approximately 3000 times. The 1000-kw output is fed to a vertically-polarized coaxial type antenna on the roof of the Rochester Gas and Electric Building.

In the studio, precautions were taken to avoid noises and to prevent the announcer from speaking too close to the microphone, a common cause of distortion in high fidelity systems. A barrier was placed around the microphone for this purpose.

The demonstration consisted of playing several high-fidelity (vertically-cut) phonograph records and picking up difficult-to-reproduce sound effects. Among these were sawing through wood, driving a nail into wood (the ping of the nail and hammer head was clearly audible) pouring water from a bottle into a glass, tearing paper, lighting a match, and whispering (the latter several feet from the microphone).



Tube line-up of television-band noise meter described by Minter

The concensus was that the sound reproduction was virtually perfect. One new development used in the largest of the demonstration receivers was the so-called "coaxial" speaker system, in which the low-frequency and tweeter speakers are mounted on a common axis. This is not only neat from the mechanical viewpoint, but is said to result in a more even distribution of the high frequency sound.

Since the transmitter had been in service only two or three days prior to the demonstration, no opportunity had been available to test the coverage of the equipment in the Rochester area, although one or two instances of reception up to 35 miles had been reported. Another installation of frequency-modulation equipment in Rochester will shortly be made by station WHEC.

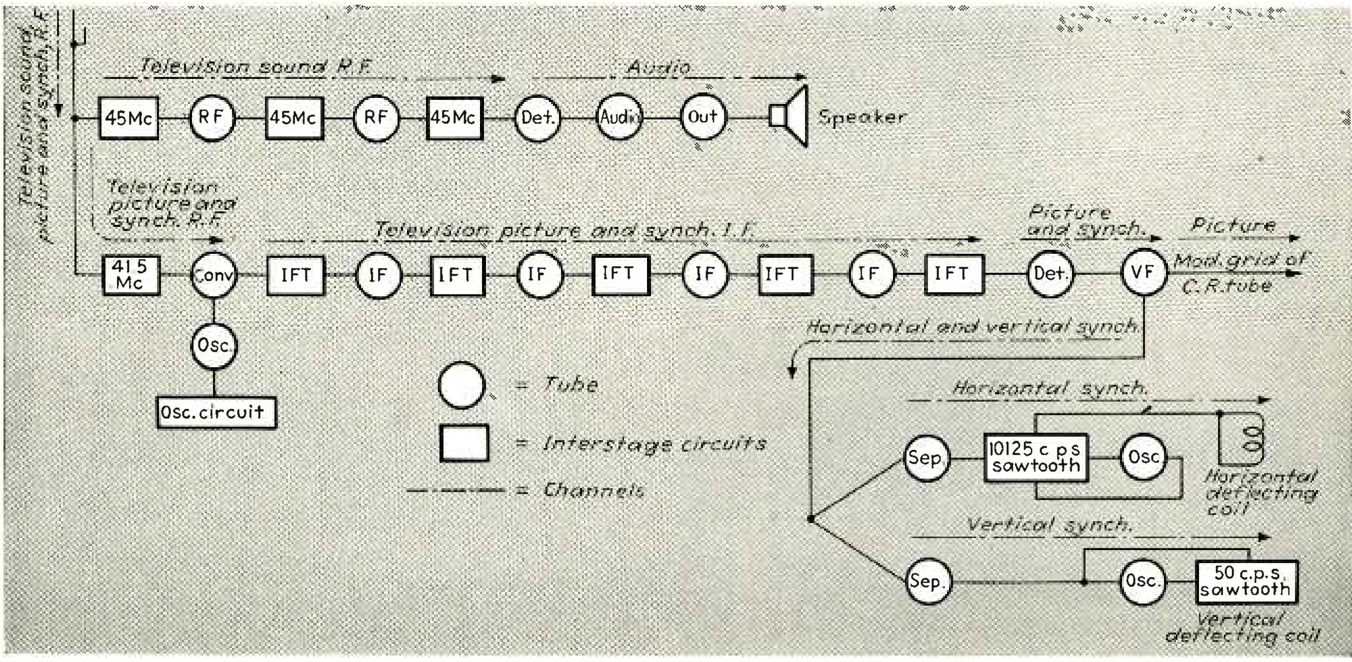
Dipole Arrays for Television Receivers

Stanford Goldman of General Electric Co. delivered a paper entitled "Television Receiving Antennas" in which he made a theoretical analysis of dipole arrays operating at television carrier frequencies and then discussed the design of practical antennas for television. It was pointed out that although the theory of dipole antennas might seem simple and that they could be designed on the basis of theoretical calculations alone, the operation of arrays is quite complicated and in the design of such an antenna, experimental work must supplement paper work. The fundamental equations were discussed and curves were presented to show various characteristics of the arrays. The sensitivity and directivity (in a forward and backward sense) can be increased by the use of a reflector which may be another dipole insulated from the receiving dipole and located generally one-quarter wave-length behind it. The experimental work consists of setting up the array with a transmission line about 100 feet long to simulate actual operating conditions and a measuring device at the end of the line. A test oscillator with the proper frequency range is set up several wave-lengths in front of the array. Several practical antenna systems were illustrated and their characteristics discussed.

Tones in Television Pictures

A provocative paper dealing with the effect of tonal reproduction of television images on the apparent reality of reproduction was presented by H. E. Kallman, formerly of E.M.I. in England. Dr. Kallman pointed out that the eye has a sort of "a-v-c" system which makes it equally sensitive to equal ratios of brightness regardless of the absolute brightness, over a wide range, and that this logarithmic characteristic should be taken into account in television transmission and reception. In particular he recommended a transmission curve in which the depth of modulation would be proportional to the logarithm of the studio brightness, which would give a constant signal-to-noise ratio at all signal levels and permit a better distribution of contrast between highlights and shadows. He took issue with the name of controls of television receivers, showing that the contrast control really controls the apparent brightness of the image, rather than its contrast.

British Vision Receivers—I



By W. J. BROWN

THE fact that commercial television started in England about two and one-half years earlier than in the United States makes it interesting and profitable to study the progress which has been made over there, as a possible guide to future trends in this country. Television started in England just as it has done in America, with relatively complicated and expensive receivers, which have since undergone progressive simplification.

The tendency has been to retain the original high priced receivers but to introduce each year new receivers in lower and lower price brackets, which have now reached a price of only 25 per cent of the original level. At the other extreme, one or two projection type receivers have been introduced at even higher prices than the original level, but their sales have been small, and the popular demand has been for receivers in progressively lower price brackets. While every effort has been made to reduce the number of amplifying tubes and the cost of the receiver chassis, it will be seen from the accompanying table that the size of cathode ray tube has been kept as great as possible, and it is a notable fact that the size of picture per dollar is considerably greater in British than American practice.

In comparing the conditions of service for which a receiver must be designed in England and America, the outstanding difference is that British receivers are designed for a single program only as it was not contemplated that there would be more than one transmitter in each population center, whereas the American designer has to cater for 5 stations in a given area. The British designer, therefore, can and does usually adopt simple and cheap r-f amplification ahead of the converter stage in a superheterodyne, and in many cases uses t-r-f amplification throughout. In other respects, the American transmission perhaps leads to a more straightforward receiver design.

From the point of view of receiver design, the American waveform would appear to have the advantages: that correct interlacing may be obtained with simpler synchronizing circuits, and that single sideband transmission permits narrower receiver bandwidths for a given picture quality. The principal disadvantage is that higher synchronizing frequencies are required, due to greater number of lines and frames per second.

From the point of view of quality of reception, the American system appears to have the following advantages:—

1. Less troublesome interference from automobile ignition etc, due to negative instead of positive modulation causing small black spots instead of "blooming" white spots on screen.

2. Probably less interference due to horizontal instead of vertical polarization of the transmitted waves.

3. The constant peak level of the synchronizing pulses enables them to be used as a basis for effective a-v-c control.

4. Better picture definition, due to greater number of lines and frames per second and wider useful bandwidth.

5. Less critical adjustment of synchronizing controls is required.

The sum total of the advantages outlined above does show up after personal observation of the practical results obtained, to the extent that good pictures (i.e. correctly interlaced) are more usually seen in American receivers than British, and there is just a perceptible improvement in the average definition of the picture.

Early Superheterodyne

Price—85 guineas; 15-inch cathode ray tubes; 20 tubes. The circuit is shown in block schematic form in Fig. 1.

A pair of series-connected antenna coils was coupled to a pair of trimmer-tuned secondaries, one secondary being connected to a separate sound chassis, while the second was coupled to a tertiary or "band-pass" circuit, trimmer tuned, forming the input circuit for the picture channel. The tertiary circuit was connected to the grid of a pentode converter minated in an untuned center-tapped secondary winding feeding a full wave diode rectifier, which in turn fed a single stage pentode video amplifier. Eight tubes were thus employed in the picture channel.

An overall vision gain control was provided as a variable bias resistor in the cathode of the first three i-f stages. A further contrast control, affecting the picture only, was provided as a variable resistor in the plate circuit of the video stage.

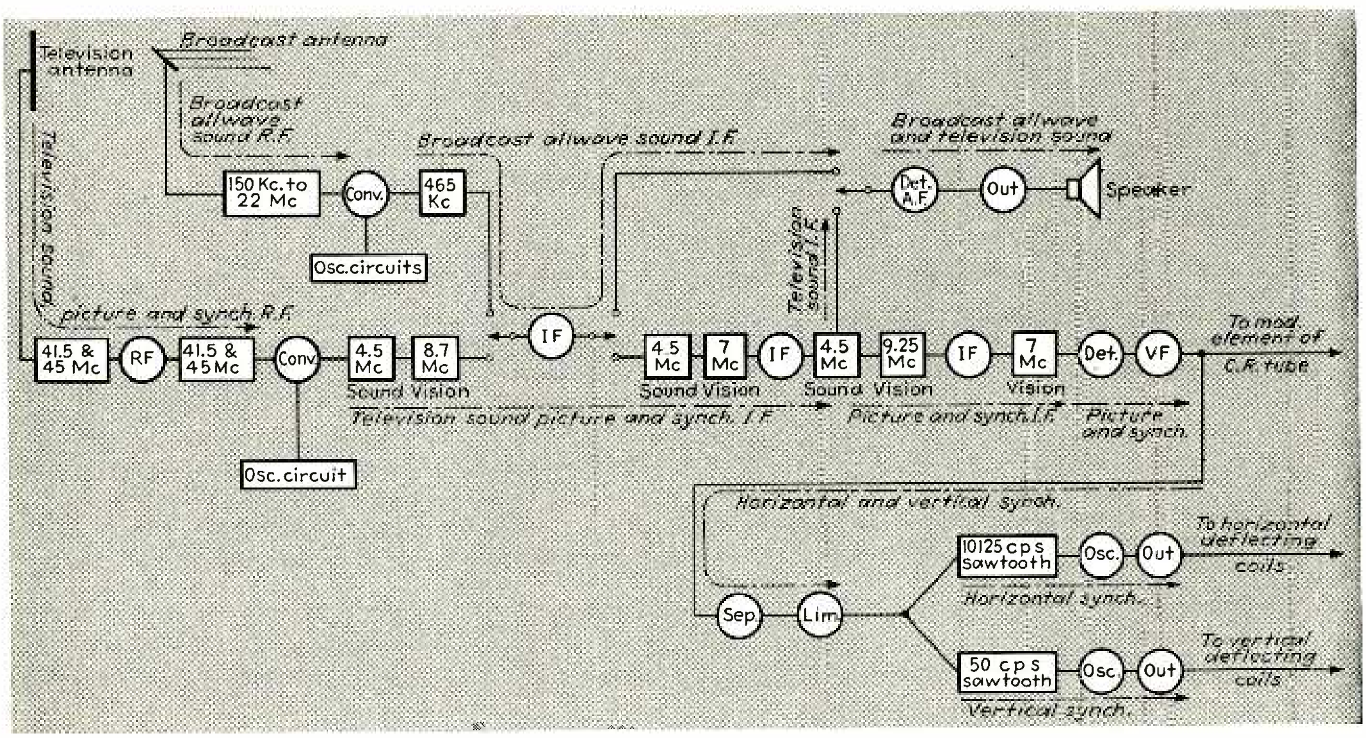
Horizontal sync separation was accomplished by an independently biassed pentode (with a r-f choke in its grid circuit), the plate circuit of which fed a tertiary winding on a blocking oscillator transformer. The other two windings were connected in the grid and plate circuits deflecting coils and comprised a "U" shaped laminated core with the extremities of the "U" shaped to embrace the neck of the picture tube. Four windings were provided on the yoke of the "U", one being connected in the plate circuit of the sync separator. Two other windings were in the grid and plate circuits respectively of the triode blocking oscillator, and the fourth winding was connected in series with a B supply bleeder to neutralize the d-c core magnetization.

Manual semi-accessible adjustments were provided for horizontal and vertical sync separation, horizontal and vertical frequency, picture height and picture width.

The sound receiver was mounted on a separate chassis, and in this

Fig. 1—Left, block diagram of an early superheterodyne produced in England. It used 20 tubes, sold for about 400 dollars, had a 15-inch picture tube

Fig. 2—Below, modern (1939) British superheterodyne receiver. 18 tubes including allwave receiver, price about 220 dollars, including a 10-inch picture tube



tube, into the cathode of which the oscillator frequency was injected from a triode oscillator having its grid tuned by a manually controlled variable condenser—the only tuning control provided.

Following the converter were 5 i-f amplification stages, comprising pentodes coupled alternately by two-circuit bandpass and single-circuit transformers with plate coils resistance-damped. The i-f amplifier ter- of a triode blocking oscillator. The output to the air core saddle deflecting coils on the picture tube was taken directly across the grid coil of the oscillator transformer, without further amplification. Vertical sync separation was obtained in an independently biassed triode having its grid fed through a 50,000 ohm resistor and shunted by a 500 $\mu\mu f$ capacitor. The scanning transformer in this case was integral with the case comprised a t-r-f receiver having two pentode r-f stages, a diode detector, triode audio and pentode output stage—five tubes in all. A single control only was provided, for volume, the circuit being tuned by trimmers.

Two separate powerpack chasses were provided, one for high voltage with a single half-wave rectifier delivering about 6500 volts, the other with two low-voltage rectifier tubes.

TABLE I

	FEATURE	1936–7	1937–8	1938–9	1939–40
HOME PROJECTION TYPES	Price	....	....	150–220 gns.	150 gns. upwards.
	Picture size	....	....	Projected picture 22″ x 18″	Projected picture 18″ x 14½″ to 24″ x 19″
	Cabinet	....	....	Console	Console
	Viewing	....	....	Screen	Screen
	Sound equipment	....	....	Allwave Radio	
HIGH	Price	120 gns.*	80–120 gns.	80–120 gns.	44–56 gns.
	No. of tubes	23–31	22	21	16–21
	CR tube dia	12″–15″	12″–15″	12″–15″	12″–15″
	Cabinet	Console	Console	Console	Console
	Viewing	Mirror	Mirror	Mirror	Direct
	Sound equipment	Allwave radio	Allwave radio	Allwave radio	Allwave radio
MEDIUM	Price	95 gns.	65 gns.	45–53 gns.	38–42 gns.
	No. of tubes	20–22	22	18	16–18
	CR tube dia	12″–15″	12″–15″	10″–15″	9″–10″
	Cabinet	Console	Console	Console or table	Console
	Viewing	Mirror	Mirror	Direct	Direct
	Sound equipment	Tel. sound only	Tel. sound only	Allwave radio	Allwave radio
LOW	Price	Nothing below	38 gns.	30 gns.	28–32 gns.
	No. of tubes	95 gns.	....	16–17	....
	CR tube dia	....	9″	9″ / 6″	9″–10″
	Cabinet	....	Console	Table or console / Table	Console or table
	Viewing	....	Direct	Direct / Direct	Direct
	Sound equipment	....	Tel. sound only	Tel. sound / All-wave radio	Tel. sound only
TEL. ATTACHMENTS	Price	....	....	21–23 gns.	22–25 gns.
	CR tube dia	....	....	5″ 6″–9″	7″–9″
	Cabinet	....	....	Table	Table
	Viewing	....	....	Direct	Direct
	Facilities	....	....	Sound output to phono jack only	Sound to phono jack

* gns. = guineas. One guinea = 21 shillings = £ 1.25 = approx. 5 dollars at pre-war parity.

Additional controls, not mentioned previously, were provided for focussing (magnetic) and brightness.

Altogether the receiver comprised five separate chasses, twenty tubes and had five accessible and six semi-accessible (but very necessary) controls. The chasses were grouped as two horizontal "decks" around the vertically mounted cathode-ray tube, and the picture was viewed in a mirror rising to 45°.

In performance this receiver was variable. Notwithstanding the use of separate tubes and even separate chasses for different functions, the controls were exceedingly critical and not by any means independent. By expert adjustment a good picture was obtained, but interlacing could only be achieved after the most painstaking efforts. Nevertheless it is interesting to note that the 15-inch cathode-ray tube was so good in color, brightness and of course size, that in the overall result many of the receiver faults could be overlooked.

Modern Superheterodyne Practice

In contrast with the three-year old receiver described above, a 1939 model superheterodyne will now be detailed: Price—45 gns; 10-inch cathode ray tube; 18 tubes, including all wave radio receiver.

Only two chasses are employed for this receiver, one for the whole of the amplifying and synchronizing circuits, and one for all of the power supplies. The cathode ray tube, which is of short design, is mounted at a slight angle to the horizontal, so as to present a directly-viewed screen in the slightly sloping front panel of the cabinet. Below the picture screen on the front panel are situated the controls and below these in turn, the loudspeaker. This arrangement shows in itself considerable economy as compared with the earlier type of receiver.

Dealing now with the circuit, of which a block schematic is shown in Fig. 2, two antenna terminals are provided, one for the shielded transmission line from the television dipole antenna, and one for a conventional antenna.

The transmission line is tapped into a self-tuned grid coil feeding an r-f stage in the television channel, the plate circuit of which includes a double-wound self-tuned r-f transformer, accepting both the vision and television sound signals.

This is connected to the signal grid of a triode-hexode converter tube, the Hartley oscillator circuit of which is trimmer-tuned.

The plate of the converter hexode system feeds a pair of i-f tuned circuits in series, one of which is trimmer tuned to the television sound i-f which is 4.5 Mc, the other being self-tuned to a frequency of 8.7 Mc, which is within the band of 6.5 to 9.8 Mc utilized for the vision i-f signal.

These series connected tuned circuits feed vision and sound i-f carriers to the grid of the first of three i-f amplifier tubes, which tubes have similar interstage couplings, each comprising a pair of tuned circuits in series, tuned respectively to the vision and sound intermediate frequencies. The tuning of the vision i-f circuits is staggered so as to obtain a broad bandwidth, and the resonant frequencies are as follows:

	Vision i-f tuning	*Sound i-f tuning*
Output from Converter Tube	8.7 Mc	4.5 Mc
Output from First i-f Tube	7.0 Mc	4.5 Mc
Output from Second i-f Tube	9.25 Mc	4.5 Mc

All vision circuits are self-tuned, using variable-inductance coils tuned by self-capacitance of coil, wiring and tubes.

The vision and television sound signals are thus amplified at radio frequencies, converted, and again amplified at intermediate frequencies, in a single dual frequency amplifier system. After the second i-f stage the vision and sound signals branch out into separate channels.

The vision i-f signal is further amplified in a third i-f stage, the plate circuit of which is self-tuned to 7 Mc, and across which is connected the vision diode detector and its resistive load circuit. The video signal developed across the diode load is further amplified in a pentode video stage before application to the cathode of the picture tube, which is used for modulation purposes, the grid being grounded through a bleeder-fed biassing potentiometer acting as a brightness control. Contrast is controlled by varying the grid bias on the r-f converter, and first i-f tubes.

Sync separation is accomplished by a diode which is connected across a portion of the plate circuit load of the video stage in series with a "priming" voltage sufficient to cause the diode to conduct and short-circuit its video input through a 16 μf condenser during the whole of the picture signal. During the synchronizing pulse, however, the "priming" voltage is neutralized by the video signal and the synchronizing pulses are passed on, as positive pulses, to the grid of a tetrode limiter operating at low screen voltage to limit and control the pulses, which are passed on from two taps on the limiter plate load resistor to the vertical and horizontal scanning circuits. The vertical and horizontal scanning circuits each comprise a high vacuum tetrode connected as a grid blocking oscillator with reaction feedback from the screen to a secondary winding of an iron-cored grid transformer, in parallel with which the synchronizing pulses are injected through a condenser. A grid series condenser and parallel leak are provided to establish blocking characteristics. The sawtooth pulses produced in the plate circuit are in each case amplified by a beam tetrode and the output is taken, direct in the case of the vertical, and through an iron-cored transformer in the case of the horizontal, to the saddle-type deflecting coils of the cathode-ray tube. The 10-inch picture tube is of the triode type, magnetically focussed and deflected, and operates at an anode voltage of 3500 volts.

For allwave sound reception, a separate triode-hexode converter tube is used, deriving its signal input from a group of three switched tuned circuits, one for each waveband, through suitable coupling coils and top-coupling condensers from the broadcast antenna system. The converter, which has conventional grid-tuned oscillator circuits, feeds a double wound i-f transformer in its plate circuit, tuned to 465 kc. The secondary of this transformer is switched into the grid circuit of the first i-f amplifier tube in the television channel described above. The plate of this tube is also switched from the television i-f circuits into a double-wound i-f transformer tuned to 465 kc and this in turn is switched into the diode which is also used for television sound as described above. From then on, the allwave sound channel is identical with the television sound channel.

In this way, by the introduction of extra switching, the number of extra tubes required for the allwave sound channel has been reduced to one, the converter tube. The wave bands provided on this receiver are:

Television, fixed tuning	6.67 meters, vision.
	7.23 meters, sound.
Broadcast	13.5— 50 meters, short waves.
	195 — 580 meters, medium waves.
	950 —2000 meters, long waves.

In performance, this receiver is much more consistent than the early superheterodyne previously described. Synchronizing controls are reasonably easy to handle, and interlacing can be obtained without serious difficulty, though this feature is by no means foolproof. During peaks of sound modulation, there is occasional evidence of superposition of the sound on the picture signal. In this connection, a resonant circuit is tapped into the cathode of the third i-f amplifier, which handles vision only, in order to suppress any spurious signal by degeneration.

	American	*British*
Number of lines	441 interlaced	405 interlaced
Number of frames per sec.	30	25
Sense of modulation	Negative	Positive
Polarization of radiated wave	Horizontal	Vertical
Nature of sync pulses		
Sense	Positive	Negative
Datum line	Above black level	Below black level
Line of horizontal pulses	Single narrow pulse	Single narrow pulse
Frame of vertical pulses	Group of broad pulses	Group of broad pulses
Relative amplitudes of frame & line pulses	Equal	Equal
Preparatory or equalizing pulses before frame pulse	Six narrow pulses at half-line intervals	None
Modulation system	Single sideband and carrier.	Double sideband and carrier.

A STABILIZED BRIDGE CIRCUIT

By HENRY P. KALMUS

ELECTRIC circuits comprising amplifier tubes, particularly bridge circuits of measuring instruments, are affected by voltage variations of the power supply. The reason is that the d-c plate resistance of amplifier tubes is not constant but depends on the plate and screen voltages, grid bias and the heater current. Therefore, it has been necessary to operate circuits of this kind on a constant voltage. This calls for either a battery or for a voltage regulator. The latter involves considerable expense if the voltage has to be kept within very narrow limits. The circuit described below represents a highly efficient and inexpensive method for stabilizing amplifier bridges without the necessity of stabilizing the power supply proper. In this circuit, neither sudden nor slow line voltage changes have any effect upon the bridge.

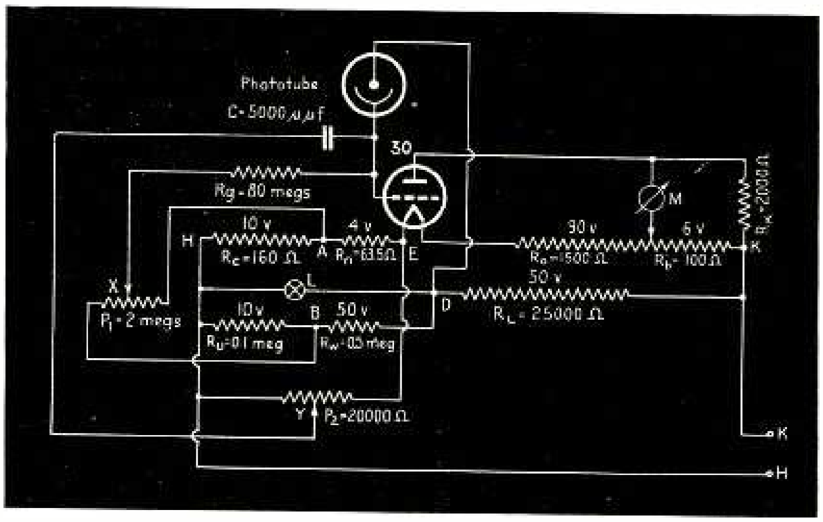


Fig. 1—Circuit diagram of the stabilized bridge. The grid bias of the triode, determined by the potentiometer P_1, is between the potentials of points *A* and *B*

The stabilization of bridge circuits comprising amplifier tubes has a wide field of application wherever the measurement of very small voltages and currents is involved. The new stabilization method was developed originally for a photometer for very small light values. There is a demand for a photometer of this kind in the field of photography. In many instances, it is necessary to measure the density in different parts of a negative film while it is in the enlarger by evaluating the light value in the respective parts of the image on the base board of the enlarger. Such measurements are not possible by means of self-generating photoelectric elements without amplification. At least, the light sensitive element would have to have such a large area that the purpose of measuring the light on a small spot would be defeated. The photometer incorporating the new stabilization method, although being equipped with an inexpensive microammeter, shows full scale deflection at a light flux as low as 5×10^{-5} lumen. This is equivalent to an illumination of 1/100 foot-candle on an area of 0.75 square inch (a circular spot one inch in diameter) or to an illumination of one foot candle on a spot 3/32 inch in diameter. On the 100 division scale of the microammeter, one division corresponds to 1/10,000 foot-candle on an area one inch in diameter. With this sensitivity on a small surface, this photometer solves the problem of practical enlargement control on a photoelectric basis.

The circuit diagram is shown in Fig. 1. The load resistor of the phototube is 80 megohms and the microammeter is deflected to full scale with a current of 100 microamperes. Such an instrument, without stabilization, would be thrown out of balance by very small changes in the line voltage. In the circuit diagram, *H* and *K* are the negative and positive terminals respectively of a 110 volt d-c line or power supply. The main portion of the current flows through the following resistors connected in series across the terminals *H* and *K*:—R_c (160 ohms), R_n (63.5 ohms), the filament of the type 30 tube (33 ohms), R_a (1500 ohms) and R_b (100 ohms). The current passing through these resistors is about 60 ma. The microammeter measures the difference between the plate current of the tube and the bucking current through R_b and R_k. The cathode of the phototube is connected to the grid of the type 30 tube and the anode of the phototube is connected to point *D*. The voltage across *H* and *D* is kept constant at approximately 60 volts by the action of the small glow lamp *L*.

When there is no light on the phototube and as long as the tap of the potentiometer P_1 is at the extreme right (which condition corresponds to an uncompensated circuit) the tube is biased by the voltage drop in the resistor R_n, i.e., 4 volts. The plate voltage is 90 volts and the tube draws a current of 3 milliamperes. If the line voltage

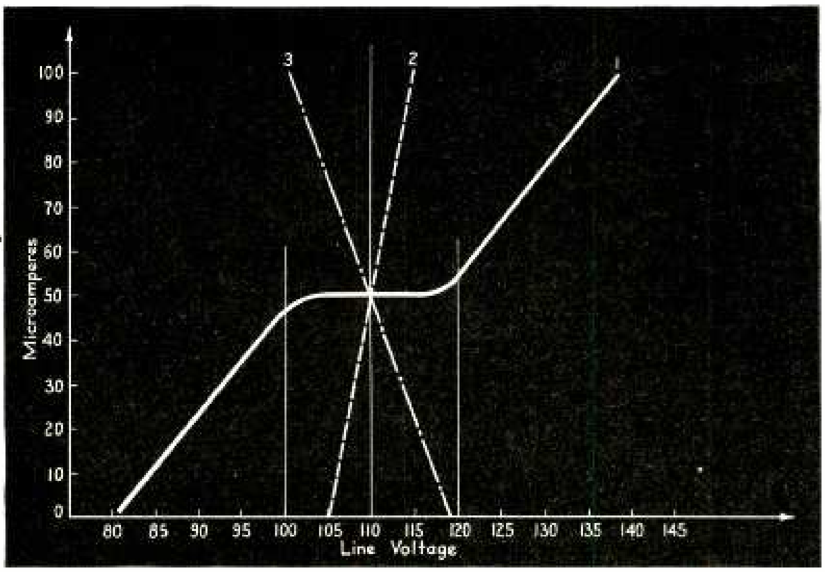


Fig. 2—Curve 1 shows a condition of stability, curve 2, of no compensation and curve 3, of over-compensation

drops by one per cent then the plate, grid and heater voltages also drop by one per cent. The d-c plate resistance of the tube of about 30,000 ohms is thereby increased and the bridge is thrown out of balance. This causes a considerable drop of the deflection of the meter needle. Conversely, an increase of the deflection of the meter needle is caused by an increase of one per cent of the line voltage. This results in an unstable zero setting of the instrument. Similarly, when light falling on the phototube is being measured, the readings on the microammeter are unstable. Inasmuch as line voltage changes will occur all the time in practically every power line, it becomes evident that the pointer never comes to a rest.

In order to stabilize the circuit and thereby the meter needle, it is necessary to keep the d-c plate resistance of the tube at a constant value. This is accomplished by the combination of two means: first, by what may be termed static stabilization and second, by what may be considered as dynamic stabilization.

In order to compensate for variations in static operation of the tube, the following fundamental automatic adjustment is required: The percentage change of grid bias is to be larger than the percentage change of plate voltage. This is obtained by means of R_c in series with the bias resistor R_n and the fixed potential of point B with respect to the reference point H. It is clearly seen from the diagram that if the grid is connected directly to point B (the tap of potentiometer P set to extreme left) the variation of the bias will be the variation in voltage drop across both R_c and R_n while the change in plate voltage will be that corresponding to the change in voltage drop across R_n only.

A second series circuit is connected across the terminals H and K. It consists of the glow lamp L and the resistor R_e (25,000 ohms). This circuit draws a current of 2 milliamperes. The voltage across the lamp is 60 volts, independently of line voltage changes. The lamp dissipates 1.2 watts and therefore may be of the smallest type. As the anode of the phototube is connected to point D, the voltage across the phototube is practically independent of line voltage changes.

The glow lamp is shunted by the voltage divider consisting of the resistors R_u (0.1 megohms) and R_w (0.5 megohms). The voltage across the points H and B is kept constant at 10 volts. This is the same voltage which prevails across H and A as long as the line voltage is 110 volts.

Now, if the line voltage drops by one per cent, the voltage across H and A also drops by one per cent. The voltage across H and B, however, remains constant as set forth above. The voltage across the cathode E and point A drops from 4 volts to $4 - 0.04 = 3.96$ volts. The voltage across the cathode E and point B, previously also 4 volts, drops to $14 - .14 - 10 = 3.86$ volts, by much more than one per cent. Actually, this latter drop is 3.5 per cent. If the tube were biased by the voltage across B and E instead of by the voltage across A and E, then, as the result of one per cent line voltage drop, the d-c plate resistance would be decreased considerably.

Thus, the effect on the d-c plate resistance has become reversed. As long as point A was used as bias source, a voltage drop caused increased d-c plate resistance which resulted in a downward shifting of the needle; now, point B being the bias source causes decreased d-c plate resistance and an upward shifting of the needle.

Now, a high resistance potentiometer P_1 is connected across the points A and B and the tap of this potentiometer is used as bias source. In shifting the tap from one end towards the other, any desired bias change within wide limits can be obtained. It is easy, therefore, to set the tap to a position so that the d-c plate resistance becomes constant and independent of line voltage changes. As a result, the meter needle shifts neither downward nor upward if the voltage supplied to the bridge changes.

In Fig. 2, the meter deflection in microamperes is plotted against line voltage for a certain illumination which produces at 110 volts line voltage a meter current of 50 microamperes. Curve 1 shows that the range of effectiveness of the stabilization is almost plus and minus 10 volts from an average line voltage of 110 volts for which the potentiometer P_1 has been set. Curve 2 shows the condition if no compensation were used (tap of potentiometer P_1 set to extreme right). Curve 3 shows an equally undesirable condition of over-compensation (tap of potentiometer P_1 set to extreme left).

This static compensation is checked and adjusted in the following way:

1. Set potentiometer tap to the extreme right. Decrease the line voltage and observe whether meter shows a downward deflection.

2. Set the potentiometer tap to the extreme left. Decreased line voltage should result in an upward deflection of meter needle.

3. Shift the tap step by step until the meter is not deflected by line voltage changes.

(*Continued on Page* 72)

TUBES AT WORK

This month, tubes are applied to monitoring police equipment, checking the speed of typists, and measuring the effects of shunt-feeding of tower antennas

An R-f Amplifier for Frequency Monitor

BY C. M. SMITH, JR.

No. Carolina State Highway Patrol

THE NORTH CAROLINA State Highway Patrol operates five police radio stations on 1706 kc, with the headquarters unit located near Raleigh. When the system was planned, it was decided that only one frequency monitor would be used, and that it would be located at the headquarters station. It devolved upon the writer to design and construct a radio-frequency amplifier for use with the monitor in measuring the frequencies of the four outlying stations, and it is this amplifier which is described herein.

At the Raleigh station the frequency monitor used is the 475-A General Radio unit, used in connection with the 681-A deviation meter. This combination is one used by many broadcast stations, and depends upon measuring an r-f signal from an unmodulated stage of the transmitter whose frequency is to be checked. This signal, normally obtained by loose coupling to an oscillator or buffer stage, is mixed with a standard signal generated by the 475-A oscillator to produce a 1000 cycle beat note, which is checked for deviation by the 681-A meter.

None of the four outlying stations is closer than 75 miles to Raleigh, so to use the equipment described, a very considerable amplification of the signal is required to drive the deviation meter circuits to standard output. If this amplification is provided, it becomes a simple matter to measure the frequency deviation of each of the Patrol's stations directly and visually. The signal must be unmodulated while the reading is taken, but this is easy to arrange in police service. Atmospheric noise will, at times, be so loud that a stable signal cannot be obtained for long enough to make a reading, but normally static causes little trouble.

In order to make operation of the monitoring equipment as convenient and simple as possible, it was thought desirable to use as effective an automatic volume control as possible on the amplifier, to make frequent readjustments of gain unnecessary. For this reason, and because of their low grid-plate capacity, 6L7 tubes were chosen for the amplifier. Impedance coupling of output was chosen, because a tuned output circuit would couple into the oscillator a reactance which would tend to detune the standard oscillator from its normal frequency. Some manual control of output was required, and it was decided to obtain this by variable self-bias of the output tube. A 6K7 tube was chosen for this output position.

Any avc requires several volts variation at the detector stage to realize maximum control. To help iron out this variation in the amplifier described a detector is used ahead of the 6K7 output tube, and its control voltage is applied to all grids, including the 6K7. In practice there is less than 2 per cent variation in output between our stations except the one at Asheville, from which the daylight signal voltage is too small for use.

Figure 1 is a schematic diagram of the complete amplifier. A 6H6 diode rectifies signal voltage for use in the a-v-c circuit, while the remaining diode gives a 3-volt delay to the operation of this circuit. Resistance-capacity filters are used in all tube element leads except cathodes, which are grounded to the chassis. Tuned circuits from RCA police receivers were used for reasons of convenience. These units are completely shielded and use bandspread, and they mount handily. All r-f wiring was shielded carefully and run as directly as possible. A power transformer incorporating electrostatic shielding of its primary winding was used to avoid the possibility of coupling from the oscillator to the amplifier through the power lead. All components are sturdy enough for operating continuously if desired.

The amplifier was built as a unit on an 8¾-inch high panel and chassis designed for standard 19-inch relay rack mounting. On the panel are a pilot lamp, power switch, and gain control. In addition, a spdt switch is provided for coupling the local transmitter's oscillator to the monitor when checking the local station, for which the amplifier is not used.

Values for the parts used in the amplifier are listed below:

C_2, C_3, C_6, C_7, C_{10}, C_{11}, C_{14}, C_{16}, C_{17}, C_{18}, C_{20},—.05 μf.
C_4, C_5, C_8, C_9, C_{12}, C_{13}, C_{21}, C_{25}—0.1 μf.
C_{15}, C_{19}—100 μμf.
C_{22}, C_{23}—8 μf.
C_{24}—one μf.
R_1, R_2, R_5, R_6, R_9, R_{10}—100,000 ohms, ½ watt
R_3, R_7, R_{11}—10,000 ohms, 1 watt
R_4, R_8, R_{12}—12,000 ohms, ½ watt
R_{13}, R_{16}—1 megohm, ½ watt
R_{14}—1 megohm, ½ watt
R_{19}—5,000 ohms, 1 watt
R_{20}—10,000 ohm volume control
R_{21}—100,000 ohms, 1 watt
R_{23}—50 ohms, 1 watt
R_{24}—12,000 ohm, 50 watt voltage divider
L_1, L_2—filter chokes
T_1—power transformer
Sw_1—power switch
RFC—2½ mh r-f choke

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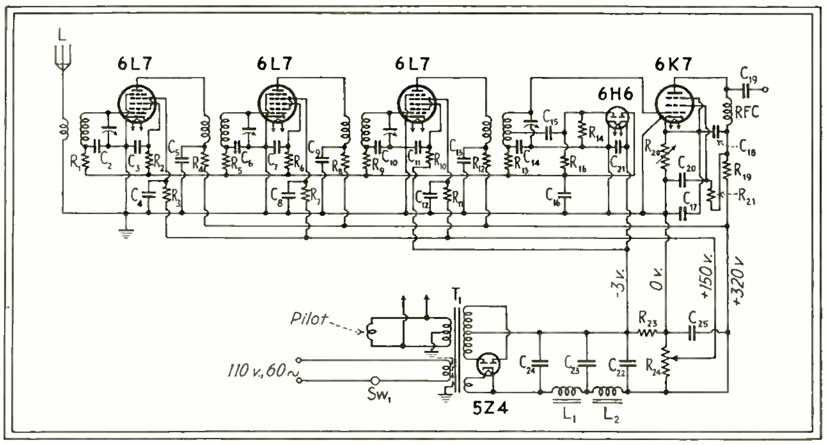

Fig. 1—Schematic of four-stage r-f input system for monitoring police equipment

Electronic Typewriting Speedometer

BY BERNARD EPHRAIM

A NEW LOW SPEED INDICATING instrument of the impulse type may be of use wherever stenography is taught, such as at public or secretarial schools, or wherever typewriters are used, sold and demonstrated. For contestants at speed exhibitions, the instrument indicator can be easily changed to a Weston projection meter so that the "words per minute" speed is projected onto a screen for observation by the spectators. In large offices and at employment desks, the speedometer can perform as a machine for testing an applicant's typing proficiency and speed capabilities. The device also

(*Continued on page* 38)

R-F POWER AMPLIFIER CHART

By E. H. SCHULZ
University of Texas

THE following simplified approximate method of designing Class B and C amplifiers gives results sufficiently accurate for most engineering work. If provision is made to vary the principal parts of the circuit (such as grid bias, driving voltage, and load coupling) by a small amount, optimum operating conditions may be obtained. The accuracy which may be expected is indicated by Table II. Although the method is outlined for Class C design, it may be used for Class B design by making the angle of conduction equal to or slightly larger than 180°.

The method is based on the following assumptions:

1. The I_p-E_p curves are parallel and equidistant apart for equal grid bias increments in the positive grid region.
2. $I_p = k(e_g + e_p/\mu)$.
3. The amplification factor, μ, is a constant.

In addition the grid current and the peak plate current must be approximated. The symbols are as follows:

I_m = peak plate current.
I_1 = peak value of fundamental component of plate current.
I_2 = peak value of second harmonic component of plate current.
I_{dc} = d-c plate current.
E_b = plate supply voltage.
E_c = grid bias voltage.
E_i = peak input from driver stage.
E_o = peak output voltage.
E_{pmin} = minimum value of plate voltage.
E_{gmax} = maximum positive value of grid voltage.
P_i = d-c plate input power.
P_o = r-f power output.
θ = angle of conduction in degrees of fundamental frequency.

Since the allowable peak plate current is not given by the tube manufacturer, it must be approximated by multiplying the emission as given in Table I by the filament heating power in watts. Allowance should be made for grid current (usually 10 to 20 per cent) and for tetrodes and pentodes allowance should be made for screen current.

Case I. Class C Amplifier with Given Plate Input Power

1. Select tube and plate supply voltage, E_b (high values give greater efficiency but require greater driving power).
2. Determine the d-c plate current, $I_{dc} = P_i/E_b$.
3. Select several angles of conduction between 100° and 130° (small angles give greater plate efficiency but require greater driving power). Determine the peak plate current, I_m, and the fundamental component, I_1, from I_{dc} and the chart (reverse side of this sheet) for each angle.
4. Check I_m against allowable value.
5. Consult I_p-E_p curves and select values of E_{gmax} and E_{pmin} to give required I_m. E_{pmin} should be as small as possible for maximum efficiency, and E_{gmax} should be less than 80 per cent of E_{pmin} for low driving power. In the case of tetrodes and pentodes E_{gmax} should not exceed 80 per cent of the screen voltage nor should E_{pmin} be less than the screen voltage.

Since the manufacturer's I_p-E_p curves do not extend far enough into the positive grid region, some I_p-E_p curves for positive grid voltages must be sketched in by assuming that the curves for constant grid voltage increments are equidistant apart and parallel to the straight line portion of the zero grid voltage curve.

6. Calculate the grid bias from $E_c = E_b/\mu + (E_{gmax} + E_{pmin}/\mu)\alpha$, where $\alpha = \dfrac{\cos(\theta/2)}{(1\text{-}\cos(\theta/2))}$ may be taken directly from the chart.
7. Calculate peak value of the driving voltage $E_i = E_c + E_{gmax}$.

Table I

Maximum Emission Current for Various Filament Materials to be Used in Choosing I_m

Type of filament	Maximum Emission Ma/Watt of heating power
Tungsten[1]	2 to 4
Thoriated Tungsten[2]	10 to 35
Oxide Coated[3]	10 to 40

[1] Based on safety factor of 1. Multiply by 0.6 to 0.7 for linear amplifier or for modulated stage to insure linearity.
[2] Based on safety factor of 3 to 10.
[3] Based on safety factor of 5 to 15.

Table II

Comparison of Design and Experimental Values for Class C Amplifier Using Type 10 Tube

	Design	Experimental
I_{dc}	60	62.5
P_o	19.6	18.8
P_i	30	31.2
E_{gmax}	110	118
E_{pmin}	130	123
I_g	10–12	12

E_b = 500 Volts f = 800 kc
θ = 135°, E_c = 138, I_m = 282, I_1 = 106

8. Calculate power output, $P_o = I_1E_o/2$ where $E_o = E_b\text{-}E_{pmin}$. Also calculate plate dissipation $= P_i - P_o$.
9. Assuming that the grid current is 10 to 20 per cent of the plate current, determine the approximate driving power from E_c multiplied by the d-c grid current.
10. Check I_{dc}, E_c, driving power, and plate dissipation against maximum allowable for tube.
11. Choose the angle of conduction that gives the most desirable operation from the standpoint of output, efficiency, and driving power. If desired, this may be repeated for several values of E_{pmin} and E_{gmax}.
12. Design tank circuit:

Equivalent Impedance of tank, $Z_o = E_o/I_1$,
$L = Z_o/2\pi fQ$ henries
$C = 1/(2\pi f)^2L$ μf

Q may be set arbitrarily between 10 and 15 or may be established by the allowable second harmonic as follows:

$$Q = \frac{66}{\text{Per cent 2nd Harmonic}} \times \frac{I_2}{I_1}$$

where I_2 = second harmonic component of plate current for given θ. A large Q will give a low harmonic component but will increase the heating loss in the tank circuit.

Case II. Class C Amplifier with Given Power Output

1. Select tube and E_b as in step 1, case I.
2. Choose allowable I_m from Table I.
3. Select E_{pmin} and E_{gmax} as in step 5, case I.
4. Calculate $E_o = E_b - E_{pmin}$ and $I_1 = 2P_o/E_o$.
5. From the ratio I_1/I_m (see Figure 2), determine θ and I_{dc}.
6. Calculate plate input $P_i = E_bI_{dc}$ and plate dissipation $= P_i - P_o$.
7. Calculate E_c, E_i, and driving power as in steps 6, 7, and 10 of case I.
8. Repeat for several values of I_m or try different combinations of E_{pmin} and E_{gmax} for a given I_m to give better results from the standpoint of efficiency, tube life, driving power, etc.
9. Design tank circuit as in Case I.

After the tank circuit has been tuned to resonance and the grid bias and plate voltage have been adjusted to the correct values, the grid excitation voltage should be adjusted so that the correct E_{gmax} is obtained, as measured by means of a peak voltmeter. The coupling of the load to the tank circuit should then be increased until the desired plate current is obtained. The tank circuit should be returned each time that the coupling is changed. Small variations from the calculated values may improve the overall operating conditions. In amplifiers using tetrodes and pentodes the tank should be tuned for maximum output rather than for minimum plate current, because the plate current is not very critical with respect to tuning.

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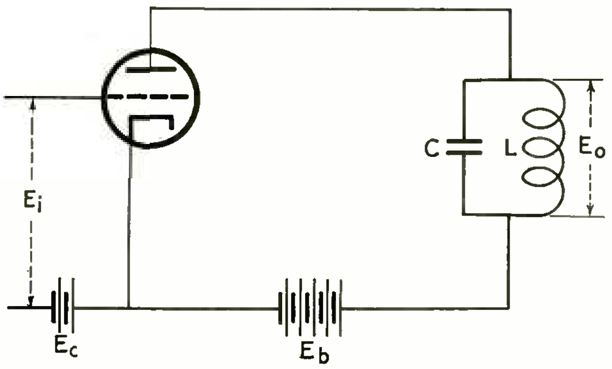
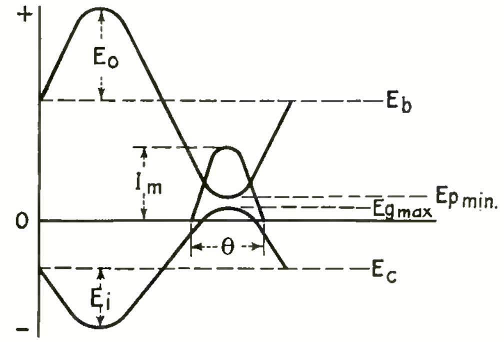
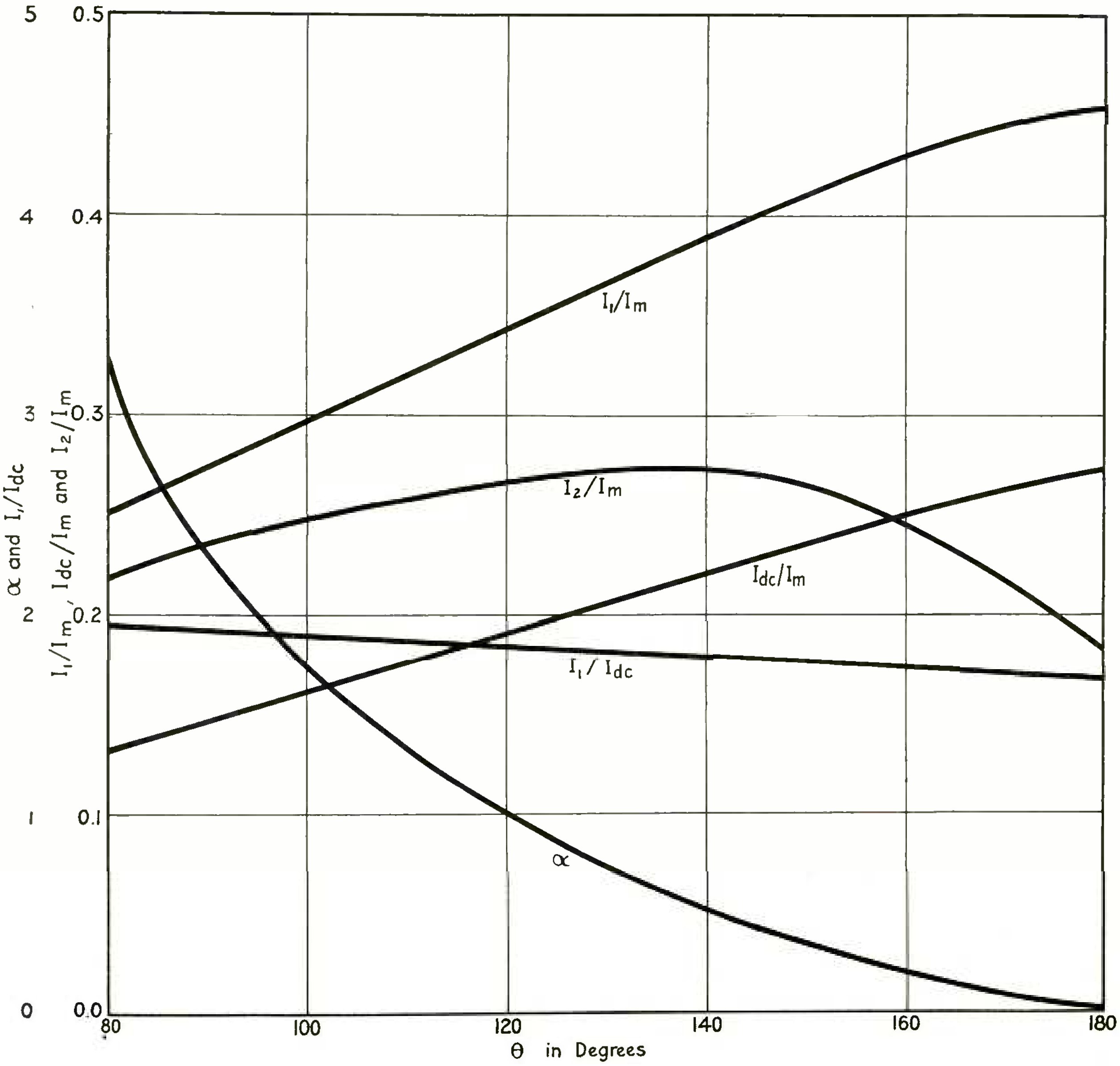
R-F POWER AMPLIFIER CHART

By E. H. SCHULZ, UNIVERSITY OF TEXAS





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2335 WEST VAN BUREN STREET, CHICAGO, ILLINOIS
MANUFACTURING CORPORATION

finds its use as a fatigue indicator by which one can record the most efficient typing speed over any period of hours. And in another instance, the instrument can be wired to function as a tell-tale to detect slow typing. This is important where large groups of stenographers handle voluminous papers as the burden then must be carried by the more industrious workers.

The electronic speedometer is relatively a simple device and gives positive visual indication of the stroke speed per minute. The meter shows the number of times per minute the keys are struck. For a very selective count or speed determination, any letters, punctuation marks or characters can be eliminated. The speed per minute is metered the moment the typist begins and increases as in an ordinary automobile speedometer, and dropping likewise when the typist slows down. In addition to the speedometer circuit, a five-impulse electric counter can be

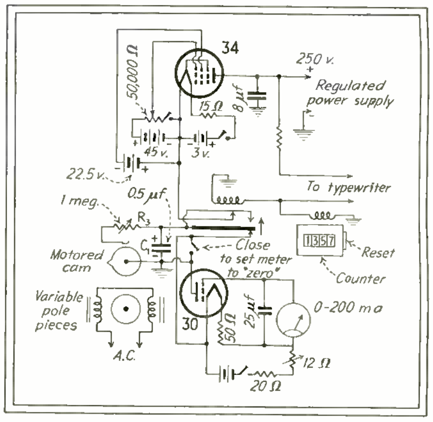


Fig. 1—Circuit of typewriter speed indicator

combined to give an accurate word count of all the words typed.

For classrooms, only one instrument is required, each typewriter being wired into a small rotary switch to enable the instructor to check the progress of any pupil at any time. The instrument has an educative value in that it provides the student with an incentive to do better and to improve ones typing ability.

Circuit Specifications

A wiring diagram of the speedometer circuit is shown in Fig. 1. The schematic shows a current limiting pentode to govern the charging of a fixed condenser, and an electrostatic voltmeter[2] to read the potential across the condenser. Excepting the contacting relay and motored discharge resistor, the circuit is quite conventional. Each time the relay is operated, condenser C_1 receives a small charge through the circuit formed by the front contacts of the relay. As the speed of the relay armature increases, the charge on the condenser rises. The potential across the condenser is meas-

[2] Koechel, W. P., *Electronics*, Sept. 1933.

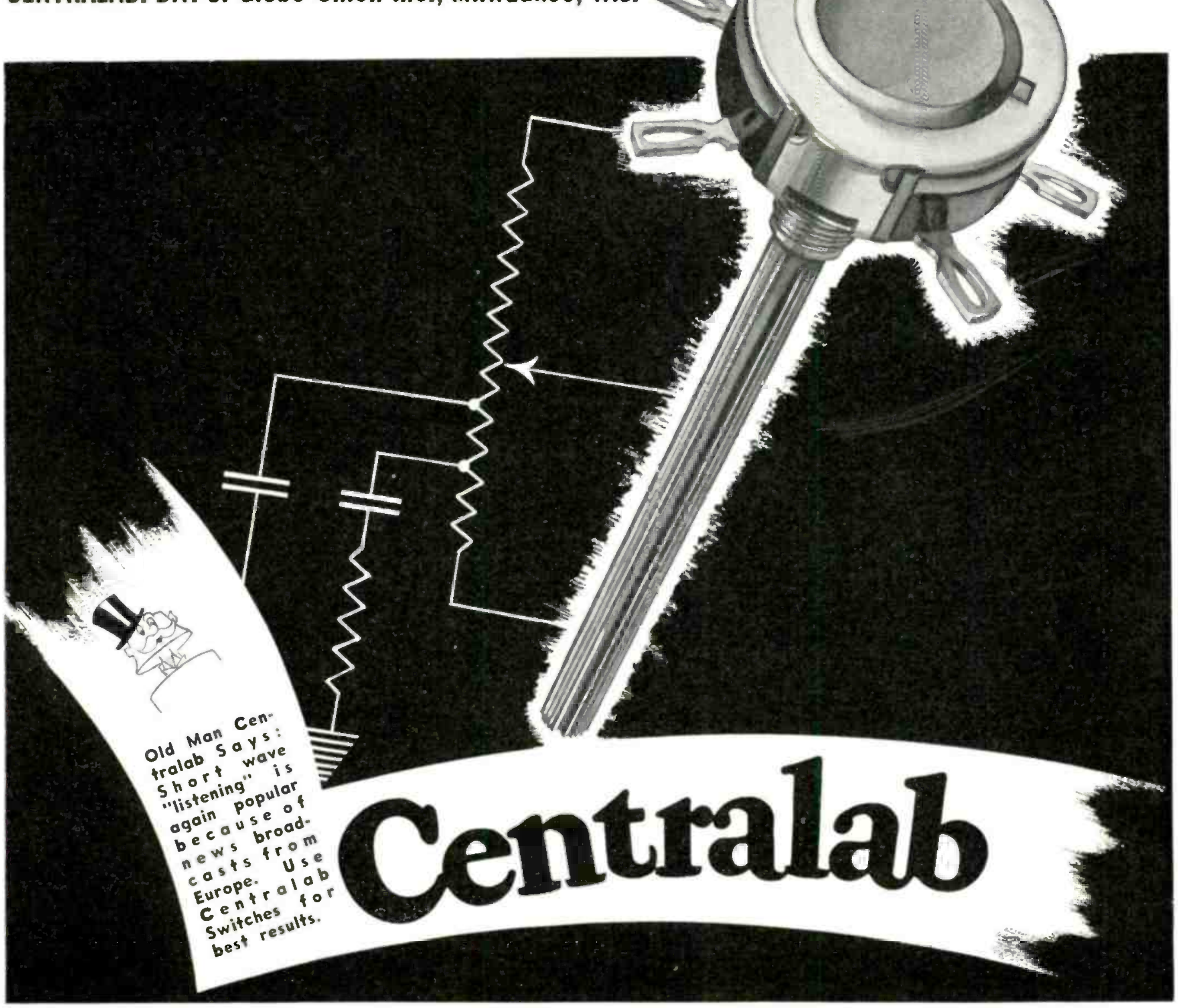
CENTRALAB AGAIN KEEPS PACE WITH AN INCREASING DEMAND

"The best demand in years" is the verdict of manufacturers who produce better grade radio receivers. This brings an increased demand for better "tone compensation" ie: Centralab's tapped volume controls.

Centralab Standard and Midget Radiohms have a longer path of resistance than other controls of similar size because the resistor strip is coiled on the inner circumference of the case. This long, straight resistor strip is particularly advantageous when taps are required, because good attenuation curve forms can readily be maintained along with low contact resistance at the tap.

Either standard or midget radiohms are available with 1, 2, or 3 taps, located at any desired position between 20% and 80% rotation.

CENTRALAB: Div. of Globe-Union Inc., Milwaukee, Wis.



ured each time the back contact spring on the relay returns to its normal operating position. The condenser receives two charging impulses each time the relay armature is actuated. The totalized voltage is read by the meter circuit, the readings decreasing as the voltage increases on the condenser. The meter is pre-set to a fictitious zero (maximum scale reading) before the instrument is placed in operation.

The motored discharge resistor partially discharges the condenser each time the cam on the motor shaft closes its associated contact springs. The cost of the small variable speed motor[3] is under three dollars, complete with cam switch mechanism. The motor is reliable and less costly than thyratron tube operated devices; in addition, the mechanically controlled discharge has a linear characteristic. The speed of the motor is adjusted by varying the shading pole pieces on the motor stator. This governs the cam operating cycle so that the discharge is very much slower than the charging periods. The arrangement assures vibrationless meter readings.

No special precautions are required in selecting the electrical components embodied in the circuit other than the storage condenser must have a very high leakage resistance, and the power supply be well regulated[4]. The d-c pentode tube may be replaced with an a-c type and the bias voltages then bled from the power supply. The a-c line and battery switch to the meter circuit are mechanically linked or operated in tandem.

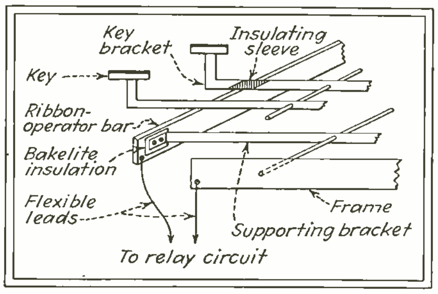


Fig. 2 — Ribbon-bar contactor assembly

Contact Assembly

A simple contact-making mechanism is used to close the relay circuit on all typewriters equipped with a ribbon-operator bar which is depressed each time any of the keys are operated. This bar must not function when the space-bar is touched. Figure 2 shows how the ribbon-operator bar mechanism is found on either Remington or Underwood noiseless portable typewriters, and the means for modifying the bar to act as a contacting device. Where this bar is not included in the mechanical complement an auxiliary one may be attached or a substitute contacting scheme devised. Observe that the rib-

[3] James Research Laboratories, Chicago, Illinois, Motor No. 100 with cam No. 101.
[4] Curran, G. W., *Electronics*, Jan. 1939, p. 25, "Regulated Power Supply."


It's a gem for transcriptions!
—plays both lateral and vertical recordings with *new sparkle!*
Here's a pick-up that can handle *all* recordings — whether vertical or lateral. The Western Electric 9A Reproducer brings out their full quality—has a diamond stylus insuring long life—costs much less than the *two* pick-ups you'd otherwise need.
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Western Electric
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Graybar Electric Company, Graybar Building, N. Y.
In Canada and Newfoundland: Northern Electric Co., Ltd.
In other countries: International Standard Electric Corp.

bon-operator bar is insulated at all points from its supporting brackets by bakelite insulating spacers or washers. One flexible lead wire is brought out from the insulated bar and another from the typewriter frame to the relay circuit. For each time any typewriter key strikes the ribbon-operator bar, the circuit between the bar and frame is closed and the relay circuit actuated.

Word Counter

To count typed letters in any predetermined word grouping, for example, a five character sequence, it is only necessary to parallel the relay coil circuit with an electric counter. The counter must be back-geared so that after receiving five initial impulses only one count will be registered. By further modification of the gearing any word group count is possible.

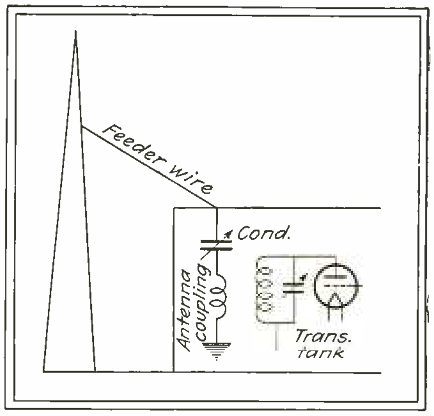
By insulating any of the keys from striking the ribbon-operator bar, only those letters as preselected will be counted. Such characters as punctuation marks, symbols and numerals can be eliminated from the count whenever desired by wrapping bakelite or insulated sleeves around the key bracket. This effectively isolates the associated key from closing the circuit to both counter and speedometer.

In general, the counter does not record the movements of the space-bar or carriage. The instrument is not operated as a stroke counter, nor does it count words by means of the spaces which separate words. Instead, the standard test count of "one" for every five typed characters allowed is used. When the counter is combined with the speedometer, a complete typewriting analysis can be obtained from either students or professional typists.

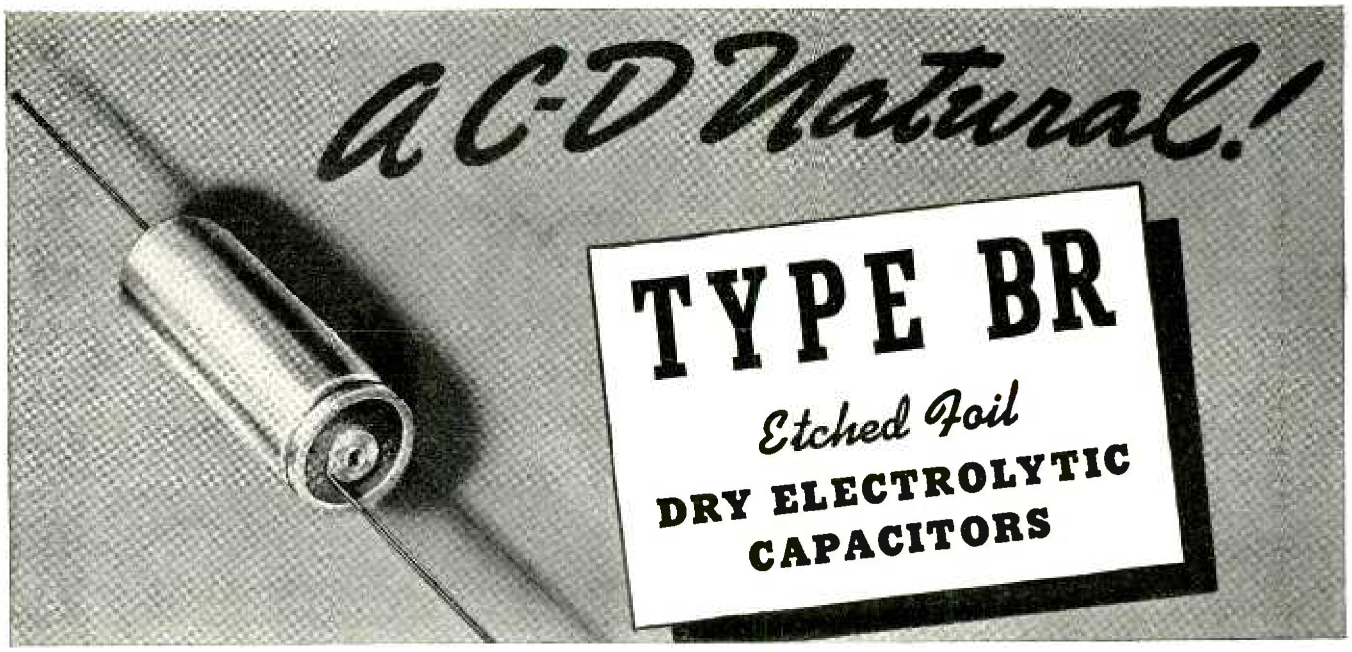
• • •

Testing the Shunt-Fed Antenna

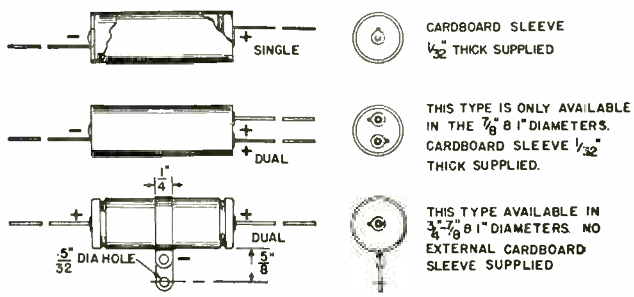
A SIMPLE METHOD of tuning a grounded antenna has been devised by A. A. Touchstone, Chief Engineer of WAML. The antenna in question is one of the older wide base type towers, using eight base insulators. The base of

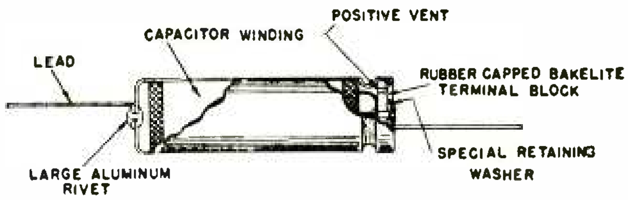


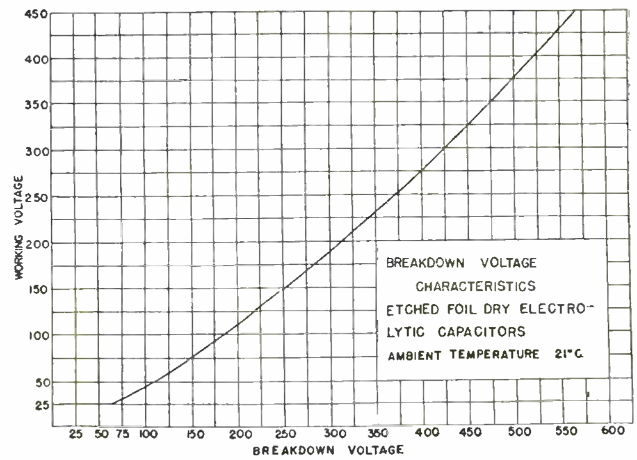
Basic shunt-feed connection



CONSTRUCTION DETAILS OF TYPE BR CAPACITORS







Years of intensive laboratory research is the secret of the advanced engineering design you will find in these new Cornell-Dubilier Type BR Etched Foil Dry Electrolytics.

Credit C-D research for:—

- **Exclusive electro-chemical etching process —eliminating corrosion.**
- **Hi-pressure centrifuge impregnation — resulting in better impregnation and lower power-factor.**
- **Special C-D super-purity cellulose separator—makes possible longer life expectancy.**
- **Double ageing — assures uniform and stable electrical characteristics.**
- **Special safety vent—eliminates the danger of destructive high internal pressures.**
- **Hermetically sealed aluminum container—ideally suited for operation under conditions of high relative humidity.**

The Type BR electrolytics are available in both single and dual capacity combinations. In the smaller diameters the dual capacity unit is supplied with two positive leads extending from the opposite ends of the tube. The container is negative. In larger diameters dual section units can be supplied with both positive terminals on the same end. In this construction a common negative lead is supplied. In the smaller diameters a mounting strap acts as the negative terminal. In all cases the container is negative. Complete technical and physical data supplied on request. Your inquiries are invited.

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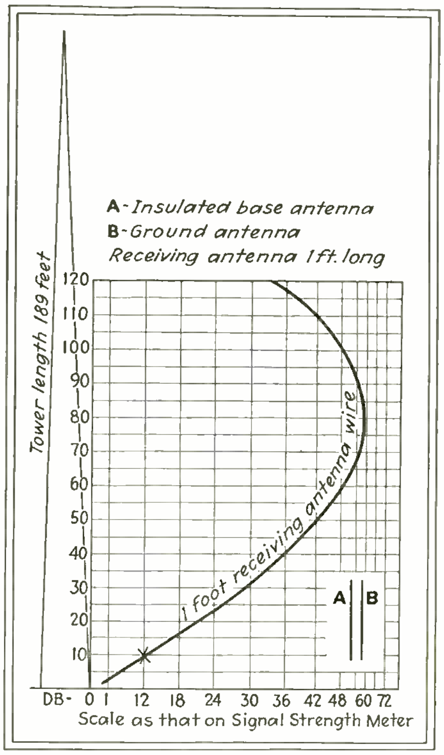
the antenna is only twenty-four feet from the transmitter.

As the geographical location of the antenna was known more or less exactly, it was an easy matter to locate a building two miles from the antenna that had telephone service. An amateur radio receiver with a signal strength meter was installed in the building and tuned to the transmitter frequency, using just sufficient length of receiving antenna to make the signal strength meter read full scale.

Starting at the base, the antenna was marked off at five foot intervals for two thirds the length of the antenna. As the operator climbed up the tower marking it, he carried with him the feeder wire (No. 8 stranded) and an iron clamp. This iron clamp was used to connect the feeder wire to the antenna. The iron clamp also allowed the operator to make connection changes very quickly. When the operator reached the two thirds mark on the antenna, he signaled the transmitter operator to tune the transmitter and antenna.

After the antenna was tuned to the transmitter, the transmitter operator telephoned the operator at the receiver and asked him for readings of the signal strength meter on the receiver. These readings were marked down on a chart that had been previously prepared for this purpose, shown in diagram. After this reading was completed, the feeder wire was moved down to the next lower mark on the antenna and readings again taken after tuning the antenna to the transmitter.

Readings were taken from all points that had been marked on the antenna and these readings entered on the



Measurement of field strength of shunt-fed tower

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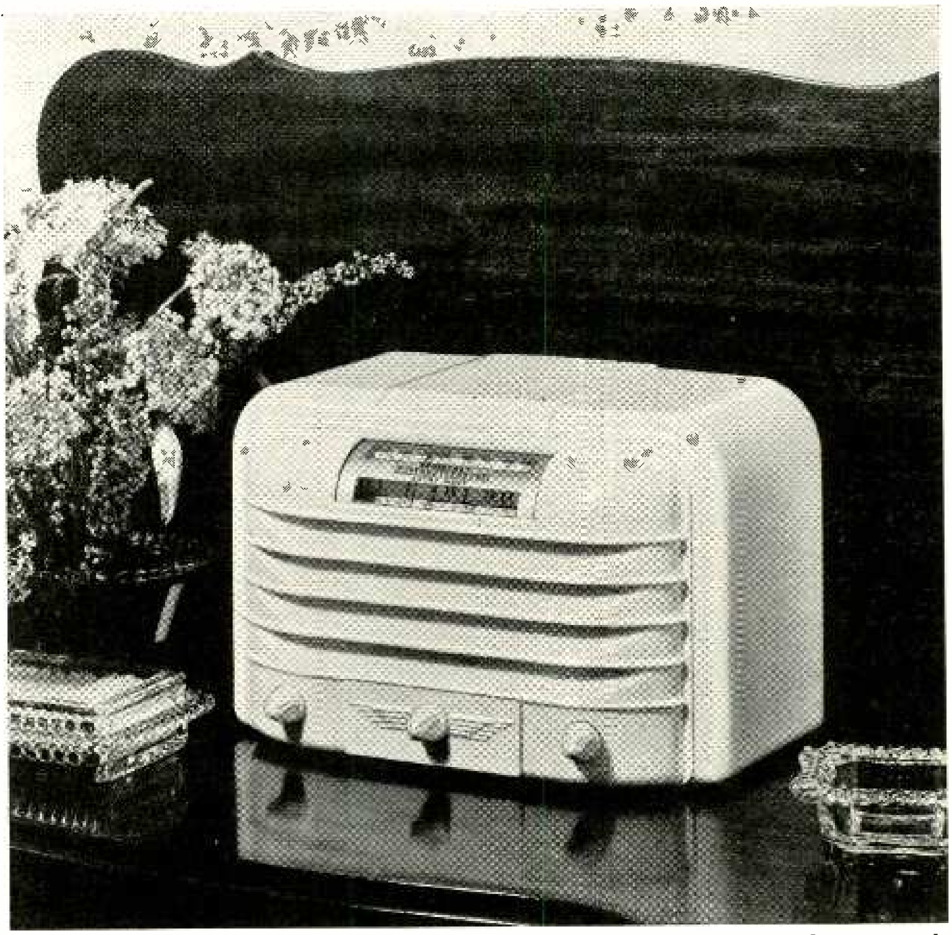
with Versatile Bakelite Plastics



Attractive, modern design and permanently delicate ivory color are achieved in this Automatic Radio Mfg. Co. table model with a cabinet of Bakelite Urea molding materials. Molder: Gorham Co.

WHEN YOUR cabinets are designed with Bakelite Plastics they have an added attractiveness that contributes to increased salability. The inherent lustre and rich surface texture of these materials impart compelling eye-appeal to any radio cabinet. By providing permanent fine appearance they insure lasting consumer-satisfaction.

An equally advantageous styling feature of cabinets made of versatile Bakelite Plastics is the great variety of effects obtainable . . . colors and shades that range from delicate ivory and white to deep-toned browns and rich jet black . . . that include an array of pastel shades as well as bright hues which rivals the rainbow in its brilliance.

Still more important to the manufacturer is the facility with which Bakelite Plastics may be molded in intricate shapes as well as simple forms. This factor provides quantity-production savings that are an advantage in competitive selling.

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PLASTICS HEADQUARTERS

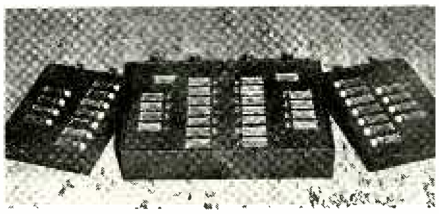
chart. After making all readings, a new feeder wire was cut and connected to the point on the antenna that gave the greatest reading and a permanent connection was made. Measurements showed that the grounded antenna had a little more than five db gain over the antenna when it was connected as an insulated base antenna.

• • •

Football Pickup and Spotting Equipment

By KING H. ROBINSON
Chief Engineer, KTRH

FOR THE PAST FOUR YEARS the technical staff of station KTRH has conducted the technical arrangements on the majority of Southwest Conference football games, and during this period many problems have arisen which the average remote broadcast would never create. Among these problems has been the necessity of perfecting various pieces of equipment whose value to the broadcasting station is to a large degree dependent upon football pickups. Two of these special objects of equipment are the parabola and the "grid-graph" spotting machine.



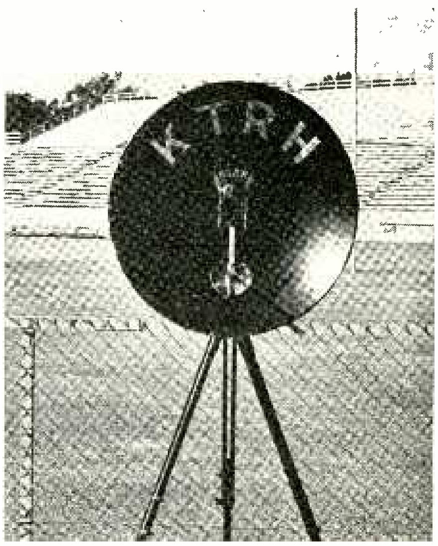
"Grid-graph" spotter equipment

The parabola lends itself admirably to broadcast pick-ups direct from the football field as it may be rotated and directed toward any sound source, picking up crowd cheers and moving bands with the approximate comparative clarity of a studio broadcast. The standard parabola consists of a semiconical bowl of pressed paper, covered with a protective material of treated linen. The diameter of the standard parabola is normally thirty-six inches, and the bowl is mounted upon a portable tripod with the apex mechanism constructed to control rotation and angular movement. The microphone is mounted facing the focal center of the parabola and means provided for adjustment to the focal point which is the location where all signals reflected from the concave portions of the bowl converge and are further reflected from the center into the microphone.

Due to the large size of the thirty-six inch parabola it is extremely bulky and does not facilitate easy portability, especially on distant trips. For this reason, where trips of several hundred miles are to be made, and compactness of equipment a prerequisite, a smaller parabola has been constructed. This parabola is twenty-four inches in diameter and has proved to be as efficient as the larger instruments. It is also easily packed together with regular broadcast equipment and may be carried as luggage by the engineer on long trips.

The football grid-graph has had many forms and variations. Some announcers still prefer the old pencil-pointing method, in which the spotter stands beside the broadcaster and points to players' names with a pencil as they institute various plays. The grid-graph is a natural outgrowth of the pointing method; it combines efficient and accurate spotting with freedom of movement and unobstructed view. The earlier form of grid-graph was a cumbersome affair; sizes varying from two to four feet in length were used by some radio stations and, of course, did not make very well for compactness or portability.

The grid-graph instrument now being used by KTRH for football spotting is a compact construction of three pieces. It may be transported in a small case eleven by fourteen inches and consists of an announcer's lamp indicator panel together with individual spotting push-button boards for two spotters. During the football broadcast two spotters, men who are intimately acquainted with team players, flank each side of the announcer, one for each spotting panel. Before the spotter is a control board of push-buttons lined up in seven-four formation which, although unorthodox in football practice, is very applicable to spotting. On one side of the announcer's indicator board is a similar line-up of lights. At each push-button side a strip bearing the name of a particular player is located, and this strip corresponds to the player's name alongside a lamp indicator on the announcer's panel. As a play is placed



Parabolic equipment for outside pick-ups

into motion by a team the experienced announcer immediately realizes its nature, then by merely glancing at the lamp indicators before him the identification of the responsible players is made known.

Electronics — 1939 — Progress Report

ADVERTISING—More advertisers spent more dollars for advertising space in ELECTRONICS in 1939 than in any other of the ten years of this publication's history. One hundred and seventy advertisers purchased a total of 446 pages during the year. Forty-two *new* advertisers started using ELECTRONICS as a new and powerful sales medium.

CIRCULATION—ELECTRONICS has established another all time high, with more than 13,800 net paid subscribers at $5.00 per year. More than 17% of this circulation goes to a constantly increasing foreign group in 63 countries.

EDITORIAL — ELECTRONIC'S editorial leadership reached another peak—with a total of 525 pages, averaging 44 pages per issue. Two new editors were added to the staff further to increase ELECTRONIC'S service to its readers.

The outlook for 1940 is good. Increases in production and sales are indicated in every branch of the industry. Contracts already in promise that the 10th Anniversary year of this "electronic engineer's textbook" will exceed all others. The constant increase in numbers of advertisers using month by month schedules proves that this business is not a seasonal one—that products are bought every month in the year.

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Place ELECTRONICS on your sales staff in 1940

TUBES

News of recently issued tube types including a month-by-month registry of new tube types and also older types compiled by the R.M.A. Data Bureau

A Change in Maximum Ratings of Receiver Tubes

APPLICATION NOTE No. 105 issued on November 15 by RCA Manufacturing Co., Harrison, N. J. presents information on receiving-tube ratings according to the new system adopted by the Radio Manufacturers Association.

The system of ratings which has been in use up to the present was originated in the early days of radio when B-supply voltages were obtained from batteries. In those days, the output of a 90-volt supply fell below 90 volts during receiver operation, but it never rose appreciably above 90 volts. Maximum plate-voltage ratings for tubes, therefore, were set up as absolute maximums. A maximum plate-voltage rating of 90 volts meant that the d-c plate voltage should not exceed the rating at any time.

This practice of setting ratings as absolute maximums has continued up to the present even though other sources of supply have been in common use. Today, tube voltages are usually obtained from sources, such as power lines, where the voltage varies, not only below, but also above its nominal value. In many receivers, this upward variation causes tube voltages to exceed the maximum ratings. The reason is that these receivers have been designed so that plate and screen voltages are at the maximum rated values when line voltage is at its average value. In other words, many receiver designers have interpreted tube maximum ratings as design maximum values, although the ratings were intended to be absolute maximums. While this misinterpretation has caused no trouble with many tube types because of the factor of safety in the ratings of these types, it has caused trouble with some rectifier and power amplifier types. To avoid this misinterpretation, it has become desirable to modify the system of tube ratings.

It is also desirable that tube ratings be established so as to make allowance for the difference in variation of supply voltage which exists between automobile receivers and receivers operated from power lines. Surveys have shown that most of the power lines in this country deliver a voltage within ±10 per cent of 117 volts. The voltage of automobile storage batteries, however, may vary 40 per cent or more.

According to the R.M.A. system it shall be standard to interpret the ratings on receiving types of tubes according to the following conditions:—

Cathode:—The heater or filament voltage is given as a normal value unless otherwise stated. This means that transformers or resistances in the heater or filament circuit should be designed to operate the heater or filament at rated value for full-load operating conditions under average supply-voltage conditions. A reasonable amount of leeway is incorporated in the cathode design so that moderate fluctuations of heater or filament voltage downward will not cause marked falling off in response; also, moderate voltage fluctuations upward will not reduce the life of the cathode to an unsatisfactory degree.

Plate and Screen:—In the case of plate voltage and screen voltage, however, recommended maximum values are given. The interpretation of this maximum value depends on the power source, as follows:

A-c or d-c power line:—The maximum ratings of plate and screen voltages and dissipations given on the tube type data sheets are Design Maximums. For equipment designed for use in the United States on nominal power-line services of 105–125 volts, satisfactory performance and serviceability may be anticipated provided the equipment is designed so as not to exceed these Design Maximums at a line voltage of 117 volts.

Automobile storage batteries:—When a tube is used in automobile receivers and other equipment operated from automobile storage batteries, consideration should be given to the larger percentage range over which the battery voltage varies as compared with the power-line voltage. The average voltage value of automobile batteries has been established as 6.6 volts. Automobile-battery-operated equipment should be designed so that when the battery voltage is 6.6 volts, the plate voltage, the plate dissipation, the screen voltage, the screen dissipation, and the rectifier load current will not exceed 90 per cent of the respective recommended design maximum values given in the data for each tube type.

"B" Batteries:—Equipment operated from "B" batteries should be designed so that under no condition of battery voltage will the plate voltage, the plate dissipation, the screen voltage, and the screen dissipation ever exceed the recommended respective maximum values shown in the data for each type by more than 10 per cent.

CONVERTERS AND MIXERS

TYPE	NAME	MAXIMUM									MINIMUM
		PLATE VOLTAGE	SCREEN SUPPLY	SCREEN VOLTAGE	ANODE-GRID SUPPLY	ANODE-GRID VOLTAGE	DISSIPATION			TOTAL CATHODE CURRENT	EXTERNAL SIGNAL-GRID BIAS
							PLATE	SCREEN	ANODE-GRID		
		volts	volts	volts	volts	volts	watts	watts	watts	milliamperes	volts
6A8 6A8-G	PENTAGRID CONVERTER	300	300	100	300	200	1.0	0.3	0.75	14	0
6D8-G	PENTAGRID CONVERTER	300	300	100	300	200	1.0	0.3	0.75	13	0
6K8 6K8-G	TRIODE-HEXODE CONVERTER	300*	300	150	-	125#	0.75**	0.7	0.75##	16	0
6L7 6L7-G	AS MIXER	300	-	150	-	-	1.0	1.5	-	-	-

* Hexode plate voltage. # Triode plate voltage. ** Hexode plate dissipation. ## Triode plate dissipation.

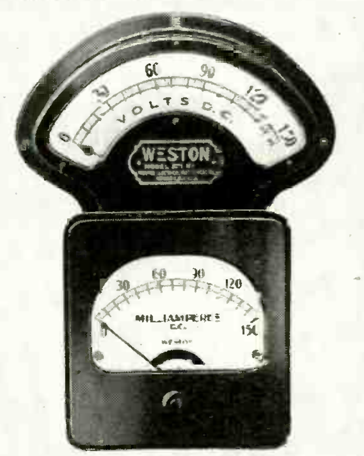
RECTIFIERS

TYPE	NAME	MAXIMUM			CONDENSER INPUT TO FILTER			CHOKE INPUT TO FILTER		
					MAXIMUM		MINIMUM	MAXIMUM		MINIMUM
		PEAK INVERSE VOLTAGE	STEADY-STATE PEAK PLATE CURRENT PER PLATE #	D-C HEATER-CATHODE POTENTIAL	A-C PLATE VOLTAGE*	D-C OUTPUT CURRENT	TOTAL EFFECTIVE PLATE-SUPPLY IMPEDANCE*	A-C PLATE VOLTAGE*	D-C OUTPUT CURRENT	VALUE OF INPUT CHOKE
		volts	milliamperes	volts	volts (RMS)	milliamp.	ohms	volts (RMS)	milliamperes	henries
5T4	FULL-WAVE	1550	675	-	450	225	150	550	225	3
5U4-G	FULL-WAVE	1550	675	-	450	225	75	550	225	3
5V4-G	FULL-WAVE	1400	525	-	375	175	65	500	175	4
5W4 5W4-G	FULL-WAVE	1400	300	-	350	100	25	500	100	6
5X4-G	FULL-WAVE	1550	675	-	450	225	75	550	225	3
5Y3-G	FULL-WAVE	1400	375	-	350	125	10	500	125	5
5Y4-G	FULL-WAVE	1400	375	-	350	125	10	500	125	5
5Z4	FULL-WAVE	1400	375	-	350	125	30	500	125	5
6X5 6X5-G	FULL-WAVE	1250	210	450	325	70	150	450	70	8
6ZY5-G	FULL-WAVE	1250	240	450	325	40	225	450	40	13.5
25Z4	HALF-WAVE	700	750	350	235	125	100	-	-	-
25Z6 25Z6-G	VOLTAGE-DOUBLER	700	450	350	117	75	□	-	-	-
	HALF-WAVE	700	450	350	235	75	100	-	-	-

\# When a filter input condenser larger than 40 μf is used, it may be necessary to use more plate-supply impedance than the MINIMUM value shown.
* Per plate.
□ Zero ohms for full-wave voltage-doubler circuit; 30 ohms for half-wave voltage-doubler circuit (in which one d-c terminal is connected to one side of a-c line).

Built-in SECURITY

Unfailing in their dependability, WESTON instruments play an essential role in the efficient functioning of all types of electrified equipment. Especially so, for machinery or equipment where an instrument is "built-in"... where the user of the machine *relies* on that instrument pointer as his key to operating efficiency. Here, design engineers wisely build-in instruments they can trust... which they know through experience will *insure* a dependable check on operating conditions, for the life of the machine. Thus to the equipment builder, WESTONS bring the security of unfailing performance out in the field... and to the equipment user, the truthful indications essential to the safe, efficient operation of the machine. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.



Build-in WESTONS

No matter what your "built-in" instrument problem, the WESTON field representative near you can give you sound advice both as to instruments themselves and their relation to problems of design, operation and control. Just 'phone the WESTON office in your vicinity, or write to Newark for complete data on all instruments.

WESTON *Instruments*

VOLTAGE AMPLIFIERS

TYPE	NAME	MAXIMUM					MINIMUM
		PLATE VOLTAGE volts	SCREEN SUPPLY volts	SCREEN VOLTAGE volts	DISSIPATION PLATE watts	DISSIPATION SCREEN watts	EXTERNAL GRID BIAS volts
6B6-G	DUPLEX-DIODE HIGH-MU TRIODE	250	-	-	-	-	-
6B8 6B8-G	DUPLEX-DIODE PENTODE	300	300	125	2.25	0.3	0
6C5 6C5-G	DETECTOR AMPLIFIER TRIODE	300	-	-	2.5	-	0
6C8-G	TWIN TRIODE AMPLIFIER	250	-	-	*1.0	-	0
6F8-G	TWIN TRIODE AMPLIFIER	300	-	-	*2.5	-	0
6J5 6J5-G	DETECTOR AMPLIFIER TRIODE	300	-	-	2.5	-	0
6J7 6J7-G	AS PENTODE	300	300	125	0.75	0.1	0
	AS TRIODE	250	-	-	1.75	-	0
6K7 6K7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	300	300	125	2.75	0.35	0
6L7 6L7-G	AS CLASS A_1 AMPLIFIER	300	-	100	1.5	1.0	-
6S7 6S7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	300	300	100	2.25	0.25	0
6SQ7	DUPLEX-DIODE HIGH-MU TRIODE	250	-	-	-	-	-
6U7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	300	300	100	2.25	0.25	0
6W7-G	TRIPLE-GRID DETECTOR AMPLIFIER	300	300	100	0.5	0.1	0
12SQ7	DUPLEX-DIODE HIGH-MU TRIODE	250	-	-	-	-	-

* For each plate.

Other electrodes:—When a tube is of the multigrid type, the voltage applied to the additional positive electrodes will be governed by the considerations stated under Plate and Screen.

Typical operation:—For many receiving tubes, the data show typical operating conditions in particular services. These typical operating values are given to show concisely some guiding information for the use of each type. They are not to be considered as ratings, because the tube can be used under any suitable conditions within its rating limitations.

POWER AMPLIFIERS

TYPE	NAME	MAXIMUM			
		PLATE VOLTAGE Volts	SCREEN VOLTAGE Volts	PLATE DISSIPATION Watts	SCREEN DISSIPATION Watts
6F6 6F6-G	AS PENTODE	375	285	11.0	3.75
	AS TRIODE	350	-	10.0	-
6G6-G	PENTODE	180	180	2.75	0.75
6K6-G	PENTODE	315	285	8.5	2.8
6L6 6L6-G	AS BEAM TUBE	360	270	19.0	2.5
	AS TRIODE	250	-	10.0	-
6V6 6V6-G	BEAM POWER AMPLIFIER	315	250	12.0	2.0
6Y6-G	BEAM POWER AMPLIFIER	200	135	12.5	1.75
25A6 25A6-G	PENTODE	160	135	5.3	1.9
25B6-G	PENTODE	200	135	12.5	2.0
25L6-G	BEAM POWER AMPLIFIER	117	117	4.0	1.25

TUNING INDICATORS

TYPE	NAME	MAXIMUM		MINIMUM
		PLATE SUPPLY Volts	TARGET VOLTAGE Volts	TARGET VOLTAGE Volts
6E5	ELECTRON-RAY TUBE	250	250	100
6N5	ELECTRON-RAY TUBE	180	180	100
6U5/6G5	ELECTRON-RAY TUBE	250	250	100

In the new system of ratings, the meaning of a maximum rating is changed from "absolute maximum" to "design maximum." A complete interpretation of ratings according to the new R.M.A. system is included in this article. From the tube types on which R.M.A. has recommended new ratings, selected types of particular interest to the set designer are included in the accompanying chart.

It can be seen from this chart that the values of the new design maximum ratings for many rectifier and power-amplifier types have been made lower than the former absolute maximum values. In certain other types, the new values of design maximum ratings are the same as the former absolute maximum values. For these types, the change in interpretation of ratings is, in effect, an increase in ratings. In some of the voltage-amplifier types, the design maximum plate-voltage rating has been made 300 volts instead of the former 250-volt absolute maximum.

Tube Registry

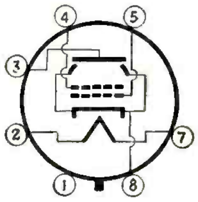
Tube Types Registered by R.M.A. Data Bureau During October 1939

Type 50C6 (G)

Prototype 6Y6G or 25C6G

BEAM power amplifier; heater type; (ST-14) glass envelope; seated height 4 1/16 inches (max); medium octal 7 pin base.

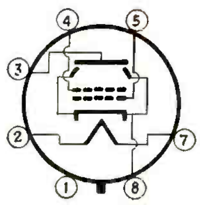
e_h = 50 v
i_h = 0.15 amps
e_p = 200 v (max)
e_s = 135 v (max)
e_g = −14 v
i_p = 61 ma
i_s = 2.2 ma
R_p = 18,300 ohms
G_m = 7100 μmhos
R_l = 2600 ohms
PO = 6.0 watts (10%)
Basing 7-AC



Type 12A6 (M)

BEAM power amplifier; heater type; (T-8) metal envelope; seated height 2 11/16 inches (max); 7 pin octal base.

e_h = 12.6 v
i_h = 0.15 amps
e_p = e_s = 250 v
e_g = −12.5 v
i_p = 30 ma
i_s = 3.5 ma
μ = 218
R_p = 50,000 ohms
G_m = 3000 μmhos
R_l = 7500 ohms
PO = 2.5 watts (10%)
Basing 7-AC

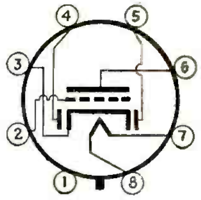


Type 12SR7 (M)

Prototype 6R7

DOUBLE diode, triode; heater type; (T-8) metal envelope; seated height 2 1/16 inches (max); 8 pin octal base.

e_h = 12.6 v
i_h = 0.15 amps
e_p = 250 v
e_g = −9 v
i_p = 9.5 ma
μ = 16
R_p = 8500 ohms
G_m = 1900 μmhos
C_{input} = 3.4 μμf
C_{output} = 2.8 μμf
C_{gp} = 2.0 μμf
Basing 8-Q



Type 12K8 (M)

Prototype 12K8

TRIODE-hexode, remote cutoff; heater type; (T-8) metal envelope; seated height $2\frac{9}{16}$ inches (max); 8 pin octal base.

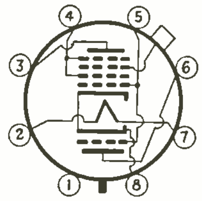
e_h = 12.6 v
i_h = 0.15 amps

HEXODE SECTION

e_p = 250 v (max)
$e_{g\,2,4}$ = 100 v (max)
e_{g3} = −3 v (min)
i_p = 2.5 ma
i_s = 6 ma
G_c = 350 µmhos
R_p = 0.6 megohms
$C_{rf\ in}$ = 6.6 µµf
$C_{if\ out}$ = 3.5 µµf

TRIODE SECTION

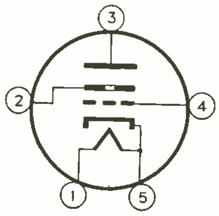
e_p = 100 v
e_g = 0 v
G_m = 3000 µmhos
$C_{osc\ in}$ = 6.0 µµf
$C_{osc\ out}$ = 3.2 µµf
Basing 8-K



Type 7AP4

PICTURE tube; heater type; phosphor No. 4 (white); magnetic deflection; electric focusing; J-56 bulb; overall length $13\frac{7}{8}$ inches (max); maximum diameter $7\frac{1}{4}$ inches; screen radius $3\frac{1}{4}$ inches (min); medium 5-pin base.

e_h = 2.5 v
i_h = 2.1 amps
$e_{anode\ \#2}$ = 3500 v (max)
$e_{anode\ \#1}$ = 1000 v (max)



SCREEN input for static pattern = 2.5 milli watts/cm²
e_g for cutoff = 67.5 volts with max permissible resistance in grid circuit.

$C_{rf-input}$ = 12 µµf (max)
Basing 5-AJ

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SORTING FREIGHT CARS BY PUSH BUTTONS

Electrical equipment, operated by push buttons is used to control the movements of 5,000 coal cars daily at Toton, Derbyshire, England. The microphone at the control board enables the operator to talk directly with the men in the railroad yards.

Tube Types Registered by R.M.A. Data Bureau During June 1939

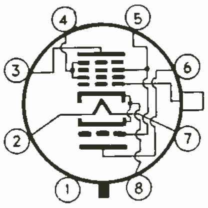
Type 6E8 (G)

FOREIGN service, triode-hexode; heater type; (ST-12) glass envelope; 8 pin small octal base.

E_h = 6.3 v
I_h = 0.3 amps

TRIODE
e_p = 150 v
e_g = 0 v
G_m = 2800 μmhos

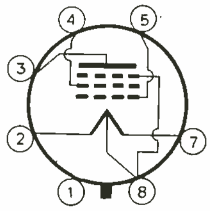
HEXODE
e_p = 250 v
e_g = −2 v
G_c = 630 μmhos
R_p = 1.25 megohms
Basing 8-0



Type 3C5 (GT)

POWER amplifier pentode; mid-tapped filament type; (T-9) glass envelope; seated height 2⅜ inches; 7 pin small octal base and shield ring.

E_f = 2.8 v
I_f = .05 amps
e_p = 90 v
e_g = −9 v
i_p = 6 ma
R_l = 10,000 ohms
PO = .260 watts
Basing 7-AQ

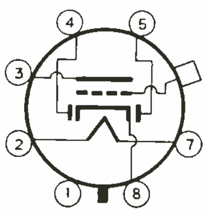


Type 6R7 (GT)

Prototype 6R7 (M)

DOUBLE diode, triode; heater type; (T-9) glass envelope; seated height, 2⅜ inches; 7 pin octal base.

E_h = 6.3 v
I_h = .3 amps
e_p = 250 v
e_g = −9 v
i_p = 9.5 ma
G_m = 1900 μmhos
R_p = 8500 ohms
μ = 16
Basing 7-V

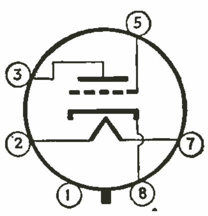


Type 6C5 (GT)

Prototype 6C5 (M)

TRIODE; heater type; (T-9) glass envelope; seated height 2⅜ inches; internal shield, 6 pin small octal base.

E_h = 6.3 v
I_h = .3 amps
e_p = 250 v
e_g = −8 v
i_p = 8 ma
G_m = 2000 μmhos
R_p = 10,000 ohms
μ = 20
Basing 6-Q

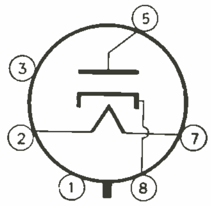


Type 25Z4 (GT)

Prototype 25Z4 (M)

HALF-WAVE rectifier; heater type; (T-9) glass envelope; seated height 2¾ inches; 6 pin small octal base and metal shell.

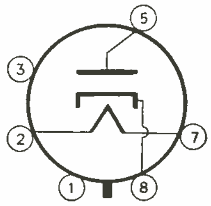
E_h = 25 v
I_h = .3 amps
e_{ac} = 125 v (max)
i_{dc} = 125 ma (max)
e_{drop} @ 125 ma = 12 v
Basing 5-AA



Type 25Y4 (GT)

HALF-WAVE rectifier; heater type; (T-9) glass envelope; seated height 2¾ inches; 6 pin small octal base and metal shell.

E_h = 25 v
I_h = .15 amps
e_{ac} = 125 v (max)
i_{ac} = 75 ma (max)
e_{drop} @ 125 ma = 18 v
Basing 5-AA

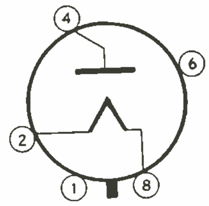


Type 2W3 (GT)

Prototype 2W3 (M)

HALF-WAVE rectifier; filament type; (T-9) glass envelope; seated height 2¾ inches; 5 pin octal base.

E_f = 2.5 v
I_f = 1.5 amps
e_{ac} = 350 v (max)
i_{dc} = 55 ma (max)
Basing 4-X



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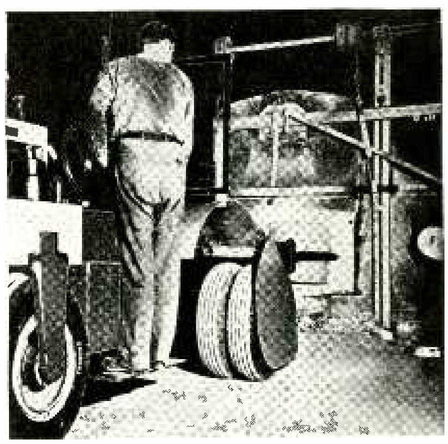
PHOTOTUBE AIDS IN MANUFACTURE OF GLASS

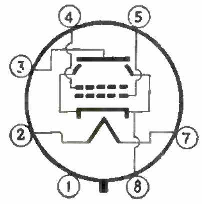


A recently developed "seeing eye" machine is removing a crucible of optical glass, weighing two tons, from a furnace with tongs at the end of a nine-foot arm. From this glass spectacles will be ground and polished

Type 6W6 (GT)

BEAM power amplifier; heater type; (T-9) glass envelope; seated height $2\frac{3}{4}$ inches; 8 pin octal base.

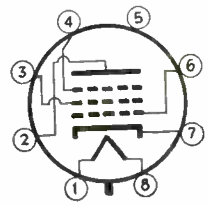
E_h = 6.3 v
I_h = 1.25 amps
e_p = 135 v (max)
e_g = 9.5 v
i_p = 58 ma
G_m = 9000 μmhos
R_l = 2000 ohms
PO = 3.3 watts (11%)
Basing 7-AC



Type 12B7 (GL)

R-F pentode, remote cutoff; heater type; (T-9) glass base-envelope; seated height $2\frac{1}{4}$ inches; 8 pin loktal base.

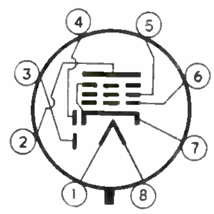
E_h = 12.6 v
I_h = .15 amps
e_p = 250 v
i_p = 9.2 ma
e_g = 3 v
G_m = 2000 μmhos
R_p = .8 megohms
Basing 8-V



Type 7E7 (GL)

DOUBLE diode, r-f pentode, remote cut-off; heater type; (T-9) glass base-envelope; seated height $2\frac{1}{4}$ inches; 8 pin loktal base.

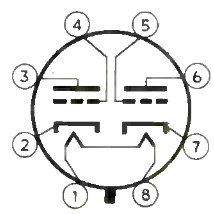
E_h = 7.0 v
I_h = .32 amps
e_p = 250 v (max)
e_g = −3 v
i_p = 7.5 ma
R_p = .7 megohms
G_m = 1300 μmhos
Basing 8-AE



Type 7F7 (GL)

DOUBLE voltage amplifier triode; heater type; (T-9) glass base-envelope; seated height $2\frac{1}{4}$ inches; 8 pin loktal base.

E_h = 7.0 v
I_h = .32 amps
Each triode section
e_p = 250 v (max)
e_g = −2 v
i_p = 2.3 ma
μ = 70
R_p = 44,000 ohms
G_m = 1600 μmhos
Basing 8-AC

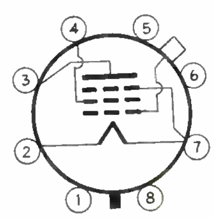


Type 1P5 (GT)

Prototype 1P5 (G)

R-F pentode, remote cutoff; filament type; (T-9) glass envelope; seated height $2\frac{3}{4}$ inches; 7 pin small octal base and shield ring.

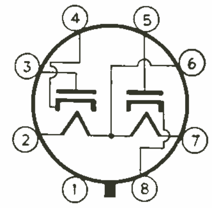
E_f = 1.4 v
I_f = .05 amps
e_p = 90 v
e_g = 0 v
i_p = 2.3 ma
G_m = 800 μmhos
R_p = .8 megohms
Basing 5-Y



Type 50Z7 (G)

BALLAST, rectifier-doubler; (ST-12) glass envelope; seated height = $3\frac{9}{16}$ inches; 8 pin small octal base.

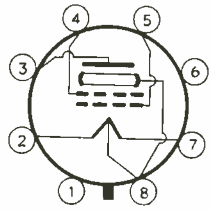
E_h = 50 v
I_h = .15 amps
e_{tap} = 2.00 v
e_{ac} = 117 v (max)
i_{dc} = 65 ma (max)
Basing 8-AN



Type 3Q5 (GT)

BEAM power amplifier; mid-tapped filament type; (T-9) glass envelope; seated height $2\frac{3}{4}$ inches; 7 pin octal base.

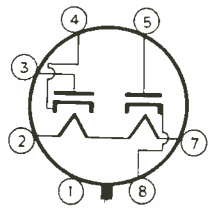
E_f = 2.8 v
I_f = .05 amps
e_p = 90 v
e_g = —4.5 v
G_m = 2100 μmhos
R_l = 8000 ohms
PO = .27 watts(7.5%)
Basing 7-AP



Type 50Y6 (GT)

RECTIFIER-doubler; heater type; (T-9) glass envelope; seated height $2\frac{3}{4}$ inches; 7 pin octal base.

E_h = 50 v
I_h = .15 amps
e_{ac} = 125 v (max)
i_{dc} = 85 ma (max)
Basing 7-Q



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TELEVISION IN POLICE WORK

Police and detective heads, together with municipals from Philadelphia and adjoining counties gathered at the Franklin Institute recently to witness a demonstration of television in its application to police work. Mrs. Brusco is shown here appealing to police and the people of Philadelphia to locate her missing son, whose photograph is shown on the stand at the left

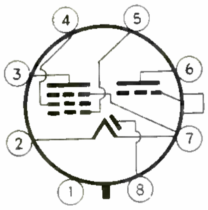
Type 1D8 (GT)

DIODE, triode, p-a pentode; filament type; (T-9) glass envelope; 8 pin intermediate octal base.

E_f = 1.4 v
I_f = .1 amps

TRIODE
e_p = 90 v
e_g = 0 v
i_p = 1.1 ma
G_m = 575 μmhos
R_p = 43,500 ohms
μ = 25

PENTODE
e_p = 90 v
e_g = −9 v
i_p = 5.0 ma
G_m = 925 μmhos
R_l = 12,000 ohms
PO = 0.2 watts (10%)
Basing 8-AJ

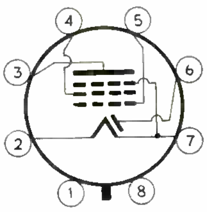


Type 1N6 (GT)

Prototype 1N6 (G)

DIODE, power amplifier pentode; filament type; (T-9) glass envelope; seated height 2¾ inches; 8 pin octal base.

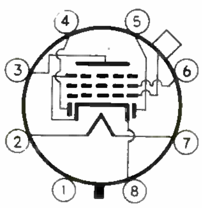
E_h = 1.4 v
I_h = .05 amps
e_p = 90 v
e_g = − 4.5 v
i_p = 3.1 ma
G_m = 800 μmhos
R_l = 25,000 ohms
PO = 10 watts (10%)
Basing 7-AM



Type 6H8 (G)

FOREIGN service, double diode, high mu pentode; heater type; (ST-12) glass envelope; seated height 3 31/32 inches; 8 pin octal base.

E_h = 6.3 v
I_h = .3 amps
e_p = 250 v
e_g = −2 v
i_p = 8.5 ma
G_m = 2400 μmhos
R_p = .65 megohms
Basing 8-E



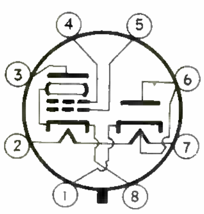
Type 70A7 (GT)

BALLAST-rectifier, beam power amplifier; heater type; (T-9) glass envelope; seated height 2¾ inches, 8 pin octal base.

E_h = 70 v
I_h = .15 amps
e_{tap} = 7.5 v

RECTIFIER
e_{ac} = 125 v (max)
i_{dc} = 60 ma (max)
e_{drop} @ 120 ma = 14 v

BEAM POWER AMPLIFIER
e_p = 110 v (max)
e_g = −7.5 v
G_m = 5800 μmhos
R_l = 2500 ohms
PO = 1.5 watts (6.5%)
Basing 8-AB



THE ELECTRON ART

PRE-SELECTIVE circuits for television receivers and stabilized ultra-high-frequency oscillators are the subjects of review this month

Television Signal-Frequency Circuit Considerations

THE RELATIVE MERITS of pre-selective circuits for television receivers are compared as to gain and selectivity in an article entitled "Television Signal Frequency Circuit Considerations," by Garrard Mountjoy in the *RCA Review* for October 1939. The band width which the circuits are required to pass is assumed to be 4.5 Mc. In considering the pass bands the prime consideration is the picture-frequency requirement, as it is not necessary that the signal-frequency circuits have flat response characteristics to include the sound channel. Some attenuation of the sound frequency is permissible provided it does not produce too low a ratio of sound signal for the service intended. A horizontal doublet antenna one-half wave length long connected to the receiver by means of a transmission line is assumed in this discussion. The following types of circuits are discussed: (1) one tuned antenna circuit, (2) two coupled tuned to the antenna circuit, (3) an r-f stage of one tuned circuit preceded by either (1) or (2), (4) an r-f stage of two tuned circuits preceded by either (1) or (2).

The single-tuned antenna circuit in which a damping resistor was used to provide a reflector terminating resistance for a transmission line of characteristic impedance equal to the internal impedance of the antenna has a gain at the center frequency of

$$g_o = \frac{\sqrt[4]{\frac{1}{P^2} - 1 - \frac{\Delta\omega}{\omega_o}}}{\sqrt{2\Delta\omega\, Cr_a}}$$

and when $P = 0.9$ and $\frac{\Delta\omega}{\omega_o} = 0.1$,

$$g_o = \frac{0.42}{\sqrt{\Delta\omega Cr_a}}$$

Other types of single tuned systems such as that with the unterminated transmission line and that with a primary terminating resistor are inferior to the above mentioned circuits except at small and unusable values of P.

Two tuned circuits critically coupled in the manner shown in Figs. 2 and 3 have a gain equal to

$$g_o = \frac{0.5}{\sqrt{\Delta\omega Cr_a}}$$

The system shown in Fig. 4, while not providing proper termination for a transmission line has the interesting gain characteristic that

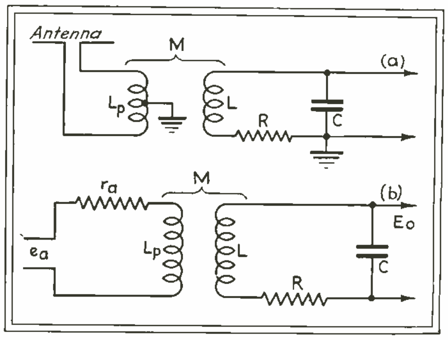


Fig. 1—Preselector of one tuned circuit and its equivalent circuit

$$g_o = \frac{1}{\sqrt{\Delta\omega Cr_a}}$$

The r-f stage circuits treated are of two types, those having single and double tuned output circuits. They are treated in a manner similar to that used with the preceding antenna systems.

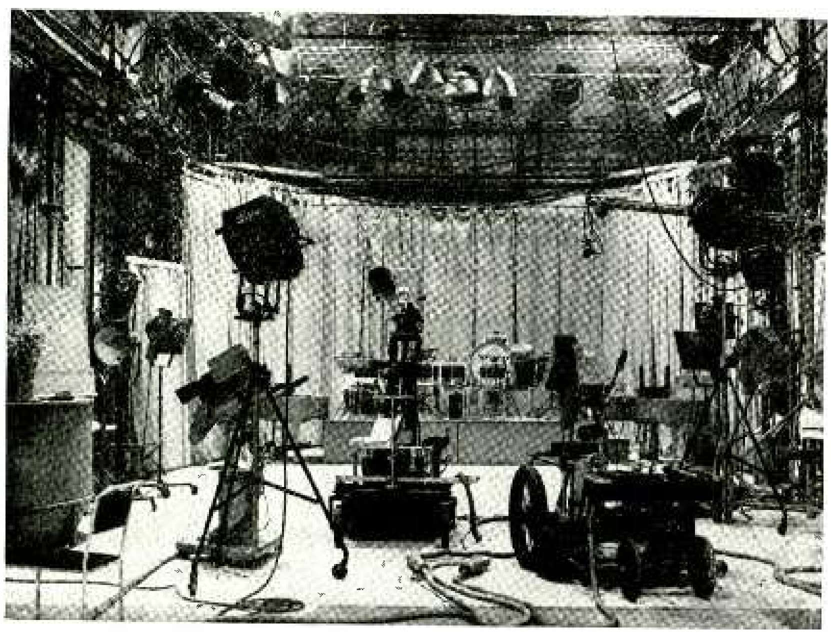
Figure 4a shows an r-f stage in which C_1 is the capacitance associated with the output in the r-f amplifying tube and C_2 the capacitance associated with any succeeding tube. C_1 and C_2 combine to act as one capacitance C_T.

The expression for the response ratio for any frequency remote from ω_o in this circuit is similar to that of one tuned antenna circuit showing image ratios very close to it.

With two tuned circuits such as shown in Fig. 4b considerable improvement in gain may be obtained for comparable flat transmission. With this circuit an image ratio equal to 100 to 1 is obtained which is considerably better than that obtained from the double-tuned antenna circuit and much greater than the image ratio of one tuned circuit.

Considerable attention is given to the problem of individual channel or station selection. It is stated that probably selections made by either pushbuttons or a rotating switch offer the greatest possibility of restricting lead lengths and compacting assembly, in the event that channel selection is obtained by tapped conductors rather than by separate components for each channel. It is pointed out that it is important that nearly optimum coupling be maintained if maximum energy transfer in the channel is to be ob-

TELEVISION STUDIOS OF THE B. B. C.



Bearing a close resemblance to some of the studio sets at Hollywood is the television studio of the B. B. C. in London. The picture shows studio "A" at Alexandria Palace in readiness for Jack Jackson's Band performance. Two Emitron cameras mounted on movable dollies may be seen near the middle of the stage set. As much as 60 killowatts of power may be used for illumination. On the right can be seen the microphone boom, with microphone suspended and ready to be swung to pick up any desired piece of the band

tained. This implies that the percentage coupling must be materially reduced at the high frequency end of the television frequency range.

Internal receiver noise is also discussed. Determination of television receiver noise involves many considerations, the magnitude and effect of which has not yet been completely evaluated. Particularly is this true of the optical effects of noise which are influenced by such factors as line structure and ratio of high- and low-frequency noise components, etc. An r-f stage will lose its effectiveness in reducing noise if its gain is small. For example, if the r-f stage gain were only 1.22, the total r-f antenna noise would be equal to that obtained without an r-f stage. The desirability of

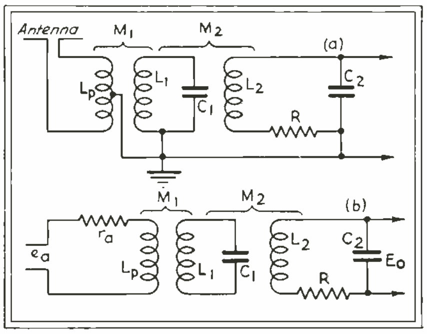


Fig. 2—Preselector of two tuned circuits (a) and its equivilant circuit (b)

using an r-f stage is determined in part by the intensity of interference noises, such as automobile ignition, diathermy, etc., at the location of the receiver. In locations of considerable noise the merits of a low noise level in a television receiver will not be greatly appreciated. However, some locations are quite free from these

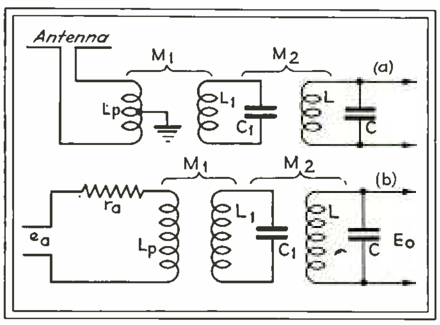


Fig. 3—This circuit is similar to that shown in Fig. 2 and has a high theoretical gain

forms interference, and in such places a receiver of low noise level is quite desirable.

Other and possibly more important considerations determine the desirability of an r-f stage. Preselector selectivity is important in reducing interference from strong signals adjacent to the desired channel and in reducing image and i-f interference. An r-f stage of one-tuned circuit pre-

THE INDUSTRY IN REVIEW

News

✦ John E. Otterson, President of Radio Wire Television Corp. of America, has disposed of his interest in the company and is no longer connected with the management. A. W. Pletman, Vice President, takes over managerial control of all the company's affairs effective immediately . . . John G. T. Gilmour former director of the motion picture department at General Electric Co., Schenectady, N. Y., has been appointed Program Manager of their new television broadcasting station W2XB which will go into operation soon. Charles R. Brown will succeed Mr. Gilmour in the motion picture department . . . Oak Mfg. Co., Chicago, manufacturers of wave band and selector switches, etc., for the radio industry, is taking over the Reliance Die & Stamping Co., Chicago, including the factory and office space as well as the equipment . . . A new broadcasting station WMAM was opened recently in Menominee, Mich. . . . The traffic and direction control signs along the Henry Hudson Parkway, New York City, are made of reflector material manufactured by Arcturus Radio Tube Co., Newark, N. J. A separate division was organized by Arcturus to develop this material, called Mir-o-Ray. Specially processed aluminum sheets were pressed by the Mir-o-ray Div., into panoramic mirror surface which catches and reflects light from any source or angle, both in night and day. The material is highly resistant to rust. It is available in sheets, strips, letters, etc. . . . Allied Recording Products Co., have moved to 21-09 43rd Ave., Long Island City, N. Y. . . . The Federal Communications Commission Chief Engineer has approved three new Amperex Electronic Products transmitting tubes for use in final stages of commercial broadcast transmitters. The tube types are 892-R, 343A and 342A.

Literature

Mallory-Yaxley Radio Service Encyclopedia

Third Edition, September 1939. P. R. Mallory & Co., Indianapolis, Ind. 264 pages, price $1.25.

THE MALLORY-YAXLEY Radio Service Encyclopedia contains a wealth of data for the servicing of a large number of receivers, old as well as new. A total of 195 pages are used to list the receivers with the proper replacement information. There are separate sections of the book devoted to discussions of the various controls of a receiver, the different applications of condensers to a receiver and the operation of the vibrator in supplying high voltage from a storage battery. A rather complete list of typical circuit diagrams for these various components is given.

In view of the very large number of new models introduced recently, several economies have been effected to keep the book at its low price. The stiff cover has been eliminated and the book is easily carried in the pocket or it may be fitted into a loose-leaf binder to be filed. The technical articles of the first and second editions have been omitted because to print them would mean a rather bulky and costly book of about 500 pages.

On the improvement side of the ledger are several changes in the method of listing the receivers. The total number of tubes is given as well as the tube complement so that the receiver may be more easily identified. Also, for those who want more complete circuit information, reference is made to Rider's Manual. To provide up-to-date information as new models appear, there will be published a monthly series of supplements at an additional cost of $1.00. This book and the supplementary booklets will prove worth while to the serviceman.—C.W.

Sound Recording Equipment. A 4-page folder describes "Sound Scriber" recording equipment for use in speech and music, professional recording studios, broadcast stations, and communications and conference use. A junior model is also described, as well as recording turntable equipment. A 1-page form describes a "Sound Scriber" oil damped dynamic pickup for playing all types of lateral cut phonograph records. The response is rated at from 30 to 10,000 cps. A brief description is also given on the same bulletin of an electromagnetic cutting head. Sound Specialties Co., Stamford, Conn.

Transmitting Equipment. Limited strictly to broadcasters interested in television is a bulletin "Television Transmitting Equipment" issued by Allen B. DuMont Laboratories, Passaic, N. J. It deals with essential studio, transmitting and receiving equipment, including direct pickup camera, film pick-up camera, studio lighting, special film projector, studio sound apparatus, master sweep panel with interlace control, shading and mixing controls, phasemajector test pattern generator, control test oscillograph, etc.

Wire-rope Clamp. A "Safe-line" wire-rope clamp which is safe and easy to use and which eliminates splicing is described in a bulletin issued by the Clamp Division of National Production Co., 4561 St. Jean Ave., Detroit, Mich.

Mallory Literature. Standard magnesium copper sulphide rectifiers are described in a 14-page booklet which contains technical data, complete listings of single phase and full wave bridge rectifiers, as well as circuit considerations. This booklet is Form No. R-165.

Contacts which are silver-faced base-metal backed are described in form M-240 which also includes a table giving possible combinations of facing and backing materials which may be obtained. The different types are illustrated with dimensional drawings.

Non-ferrous alloys are described in Form No. M-250 which contains the physical and electrical properties of those alloys. All of these bulletins are available from P. R. Mallory & Co., Inc., Indianapolis, Ind.

Radio Coordination. "Instruments for Radio Coordination" is a new bulletin issued by Tobe Deutschmann Corp., Canton, Mass. It describes equipment for use in radio interference work.

Phase Displacement in Electrical Circuits. Bulletin of Research, No. 11, captioned "Study of Phase Displacement in Electrical Circuits from Linearly Expanded Lissajous Figures" is available from Underwriters' Laboratories, 161 Sixth Ave., New York City.

Switches. Numerous switching combinations are available in Type 86 switch manufactured by Communication Products Co., 245 Custer Ave., Jersey City, N. J. Drawings showing the switching combinations are given in a leaflet.

Technical Manual. The fifth edition of the Sylvania Technical Manual is available from Hygrade Sylvania Corp., 500 Fifth Avenue, New York City, at a price of 35 cents. The book is compiled for servicemen, radio technicians, engineers and amateurs. It is coat-pocket size—4½x9¼ inches, and has 264 pages of complete data and tube diagrams, prepared from RMA standards, for 344 types of tubes, as well as data on television amplifiers, cathode-ray tubes, etc., etc.

Relays, Thermostats, Timing Devices. A 32-page catalog contains new items and prices and other information on relays, timing devices, and thermostats manufactured by Struthers Dunn, Inc., 1315 Cherry St., Philadelphia, Pa.

House Organ. "Relaying News" is a bulletin devoted to the discussions, types, and problems of relays. It looks like an interesting bulletin. It is available from General Electric Co., Schenectady, N. Y.

Geophysical Instruments. Last month the editors mentioned Catalog No. 116 as describing geophysical instruments, instead of mentioning Circular "D" as containing this information. The catalog is available from Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.

House Organ. Two articles contained in the November issue of the "Experimenter" are "Inductance Measurements on Loop Antennas" and "Modernization of types 605-A and 605-B Standard-Signal Generators" General Radio Co., 30 State St., Cambridge A, Mass.

General Electric Literature. Bulletin GEA-1546F is prepared as a guide for the proper selection of electrodes. Complete descriptions are given of the 20 types of electrodes, their applications, sizes, recommended currents, arc-voltages, and identification. This 40-page book is profusely illustrated and is entitled "Arc Welding Electrodes."

Plunger-Type Relays is the title of a 19-page booklet (No. GEA-1811B) which describes and gives diagrams of different types of relays such as overcurrent, undervoltage, auxiliary, instantaneous and time. Ratings and characteristics are also given.

Diactor generator-voltage regulators, Type GDA, for a-c machines are illustrated and described in bulletin 2022-C. All of these bulletins can be obtained from the News Bureau of General Electric Co., Schenectady, N. Y.

Tube. A new 5-kw air radiation-cooled tube of the 1½ inch anode diameter size, or in the 2 or 3 inch sizes, are described in literature available from Amperex Electronic Products, Inc., Brooklyn, N. Y.

Power Resistors. Cement-coated power resistors are illustrated and described in a 4-page bulletin available from Clarostat Mfg. Co., 285 N. 6th St., Brooklyn, N. Y.

Servicing Literature. Several recent pieces of literature for servicemen and servicing are available.

Solar Mfg. Corp., Bayonne, N. J., have issued Catalog 10-A which describes capacitors and capacitor analyzers.

Cornell-Dubilier Electric Corp., S. Plainfield, N. J., have available a 240-page book which constitutes a speedy guide to the selection of standard C-D capacitors for use as replacements in all types of receivers. The book is called "C-D Capacitor Manual for Radio Servicing." Two new test instruments "Service-Mike" and "Test-Mike" are described in Catalog No. 168-A also available from Cornell-Dubilier.

Aerovox Corp., New Bedford, Mass., have two bulletins available. The first is "L-C Checker" and it tells about Model 95 Checker, while the other one is called "Capacity and Resistance Bridge" and deals with that subject.

Weston Electrical Instrument Co., Newark, have available literature on Model 777 Tube and Battery Tester for use as a tube checker permitting battery tests under load.

New Products

Megohm Bridge

THIS NEW TYPE 544-B mebohm bridge meets the requirements for simple, accurate insulation-resistance measurement. It consists of a conventional Wheatstone bridge with a sensitive vacuum tube voltmeter used as the null indicator. The range is 0.1 megohm to 10,000 megohms, covered by a dial and a 5-position multiplier switch. A resistance of 1,000,000 megohms can be detected. The bridge operates directly from a 115 volt, 40–60 cycle line, (a 25–60 cycle model is also available), and is completely self-contained, including the galvanometer. It is compact and portable. The voltage applied to the insulation under test is 500 volts. A test voltage of 100 volts is also provided for testing insulation of very low dielectric strength. The test voltages are obtained from a transformer-rectifier system. Form 535-A gives a further description and is available from General Radio Co., Cambridge, Mass.

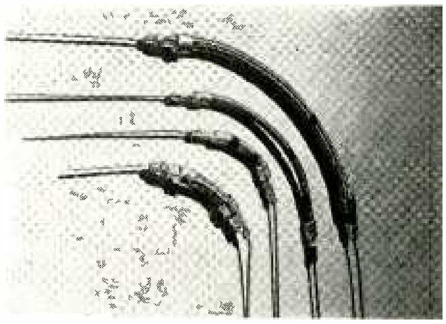
Pyrometer

SERIES 2850 SURFACE Temperature Pyrometers are designed for precise readings of all surface temperatures by Wheelco Instruments Co., 1929 S. Halsted Street, Chicago. They are available in fan-shaped and dial-shaped types; are equipped with detachable thermocouples, and a quick change from one couple to another will accomodate the instrument to any type of surface—flat or curved surfaces; stationary or moving. The flexible, adjustable couple joint can swing through 180°. The handle may be screwed in either at the bottom or the back of the instrument. Automatic cold junction compensation, hand-wound coil and sapphire jewels provide good accuracy.

Four models of thermocouples are available for surface temperature work. The Lava type is designed for any clean or coated flat surface; Bow type for curved surfaces of all shapes; General Purpose type for general temperature checking purposes, such as molten metals, oven type furnaces, etc., or checking other pyrometer installations; and Needle type for measurements of rubber surfaces and of plastic materials and wax.

Resistors

FIBRE-GLASS FLEXIBLE resistors known as "Glasohms" are available from Clarostat Mfg. Co., 285 North 6th St., Brooklyn, N. Y. These resistors are available in 1/16 inch diameter core, rated at 1 watt per body inch; and ⅛ inch diameter core, rated at 2 watts. Resistance values run as low as ¼ ohm, and as high as 750 ohms per body inch. Units may be made up to 500 feet long. These flexible power resistors are for voltage-dropping units, attenuators, voltage dividers and other functions calling for a fixed resistance capable of handling considerable wattage. Glasohms make use of fibre-glass filaments 0.0002 inch in diameter as the basis for the threads subsequently worked into cores and braided coverings. Due to the high melting point of the glass, these units may be operated at temperatures up to 1000° F without charring, burning or deterioration.



Clarostat "Glasohms"

VITREOUS ENAMELED porcelain resistors for heavy duty service are offered by Ohmite Mfg. Co., 4835 Flourney St., Chicago. One is 12x2 inches and is rated at 500 watts. Another one is 2½x20 inches and is rated at 1000 watts. These are two of more than 50 resistor sizes which range from 1 to 1000 watts.

Ohmite resistor

A NEW AND COMPACT design of "Ohiohm" ceramic-insulated wire-wound resistors is now being manufactured by The Ohio Carbon Co., 12508 Berea Road, Cleveland, in addition to their line of carbon resistors. The units are applicable to such uses as original and replacement equipment for radio sets, broadcasting station apparatus, general industrial plant uses such as motor-starters and relays and on photoelectric safety and counting devices. Standard units are from 5 to 20 watts in a range of resistance values; with an accuracy of 5 per cent plus or minus. The compactness of these resistors is obtained by the use of axial terminal wires instead of projecting side-lugs.

Balancing Equipment

A NEW GENERAL ELECTRIC portable dynamic balancing equipment combats vibration in rotating machines. The new device is a self-contained precision instrument capable of measuring the amount and phase angle of unbalance vibration present in the bearing pedestals of a rotating machine running in its own or substitute bearings at any speed between about 600 and 5000 rpm. The complete equipment, packed in a single case with no batteries or external power source required, consists of a sine-wave alternator, a vibration pickup, and an instrument with its associated circuit on which the vibration is read.

Automatic Tube Tester

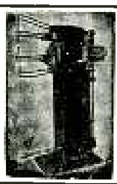
AN AUTOMATIC tube tester, Model 401, has just been announced by Dayco Radio Corp., 915 Valley St., Dayton, Ohio. A number of cards, one for each tube type, are provided and the proper one is inserted in the card slot and the lever is pulled. The tube is then automatically tested. The main indicator is a large meter calibrated for direct reading. Ten short test indicators automatically locate any shorts.

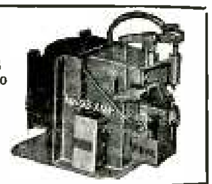
Checker

A CHECKER WHICH tests condensers and inductances under actual service conditions of frequency is announced by Aerovox Corp., New Bedford, Mass. It is self-contained except for the power supply. It contains an oscillator covering 60 kc to 26 Mc in six coil ranges, together with a frequency-matching indicator. The frequency dial is directly calibrated in frequency for each of the six ranges and is accurate to one per cent. The shadow angle of a Type 6E5 tube is used to indicate the amount of energy in the oscillator circuit. This angle widens when the oscillator is coupled to a tuned circuit of the same frequency as the oscillator. The dial is also calibrated in capacity from 0.0004 to 1 μf to an accuracy of plus or minus ten per cent. Capacitors smaller than 0.0004 μf may be measured in several different ways.

Set Tester

A NEW SET TESTER, a feature of which is a nine inch meter, has recently been introduced by Simpson Electric Co., 5216 Kinzie St., Chicago. This new tester, Model 320 Giant Set Tester, has a total of fifty ranges on the meter scale. There are nine voltage ranges, both ac and dc, from zero to 3000 volts with a resistance of 1000 ohms per volt. The current ranges are from zero to 15 amperes and zero to 750 ma over six scales. There are also five resistance ranges, four capacity ranges and seven decibel ranges. Also announced by this company is a Giant Tube Tester, Model 325. It also has a nine inch meter. The filament voltage range is from 1.5 to 120 volts so that an extremely wide range of tube types can be tested.





Electric Power Plant

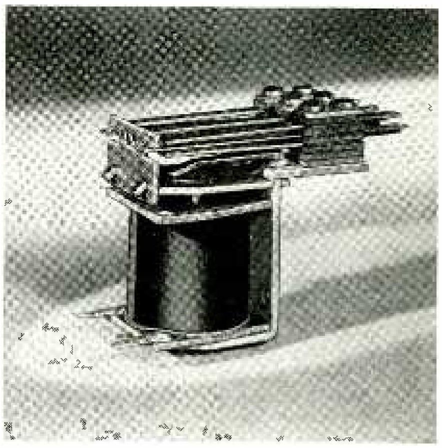
A NEW LINE of Utilite Electric Power Plants with higher capacities has just been announced by Eicor, Inc., 515 S. Laflin St., Chicago, Ill. The new units are rated at 450 watts ac and 500 watts dc. The a-c models operate at 1800 rpm and furnish 110 volt 60 cycle power and have ample reserve for temporary overload. Electric push button starting is built in and the six volt starter battery is charged automatically. Remote control is available on the a-c models. The overall size of all models is 17 inches high, 15 inches wide and 17 inches long. The net weight is 90 pounds.

Tracing Paper

ALBANENE, a new type of tracing paper combining the transparency of oil treated sheets with the permanence of natural rag papers, was recently announced by Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. It is made of 100 per cent long fiber clean white rags and it is treated with a new crystal clear synthetic solid called Albanite. Because Albanite is free from oil and wax and is chemically and physically inert, Albanene will not oxidize, turn yellow, become brittle or lose transparency with age. The new paper has a fine toothed, smooth drawing surface which takes strong pencil lines with a minimum wear on the point and also has good blue printing quality.

Relay

A NEW LOW COST relay, "Autelco Jr." is announced by Automatic Electric Co., Chicago. The relays are approximately cubical in shape and provide a compact and efficient magnetic field. The armature pivots on a sharp edge, and is held tightly against the heelpiece by means of a leaf spring, so that all



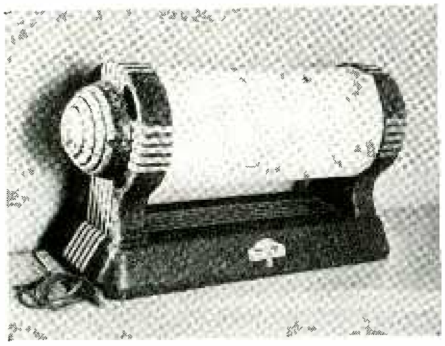
magnetic effort is put to work at the armature. A maximum number of springs can be operated with minimum current. Coils and springs are insulated to carry 110 volts or more, safely, and contact points are available with carrying capacities up to 4 amps. Spring arrangements to meet all usual requirements can be supplied.

PA System

A FLEXIBLE TRI-PURPOSE public address system which, in addition to operating with microphones and phonographs, can be used as a powerful auxiliary amplifier with Ampro's (Ampro Corp., 2839 N. Western Ave., Chicago) classroom model projectors for auditorium use, provides adequate volume for audiences up to 10,000 and over. It delivers an undistorted output of 55 watts with less than 5 per cent total harmonic distortion and a maximum usable output of 85 watts. A 500 ohm output is provided for use with long speaker cables to avoid line losses.

Blueprint Machine

A BLUEPRINT MACHINE which makes blueprints in one minute or less and is practical for the small office as well as a large department is being manufactured by Paramount Engineering Co., 5707 W. Lake St., Chicago. The desk space required is 9 inches by 26 inches and prints of any size up to 18



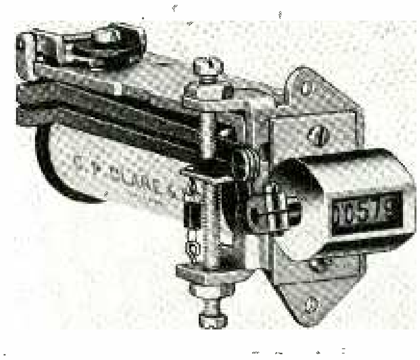
by 24 inches can be made by this machine. The original and sensitized paper are wrapped around a glass cylinder 8 inches in diameter and 19 inches long and are held in place by a heavy canvas pre-shrunk adjustable cover. Two photo-flood lamps inside the cylinder are controlled by a Mark Time timer to give the proper exposure.

Plasticized Resin Sheets

CARBIDE & CARBON Chemicals Corp., of 30 East 42nd St., New York City, has developed calendered sheets of "Vinylite" plasticized resins which have many of the advantages, and few of the disadvantages, of leather and rubber. The material, which is suitably plasticized copolymers of vinyl chloride and vinyl acetate, can be supplied colorless, or in transparent or opaque colors. It is flexible to the point of withstanding folding and repeated flexing. Elongations up to 250 per cent with a tensile strength of 3000 lbs. per sq. in. are readily obtained. The new materials are made in thicknesses ranging from film, approximately 0.003 inches in thickness up to almost any thickness desired. Stocks in thicknesses from 0.003 to 0.090 inches are available in essentially continuous lengths.

Counters

A NEW LINE of electric counters is announced by C. F. Clare and Co., Lawrence and Lamon Aves., Chicago. Type C is for direct current up to 110



volts and Type A is for alternating current up to 110 volts, 60 cycles. They are capable of counting up to 600 counts per minute. They measure 1½ inches wide by 2 inches high by 4⅝ inches long.

Intercommunication System

OPERADIO MFG. Co., St. Charles, Ill., have combined paging and inter-communication in one system, over one set of wires, in their Type B H unit. Calls go out over the system direct to the person called, and he can answer from any place within the area in which the outlying station is located. The Intercommu-Paging system (Type B H) operates on 115 volts, 50–60 cycles, a.c. only. Complete details are available from the manufacturers.

Oscillograph

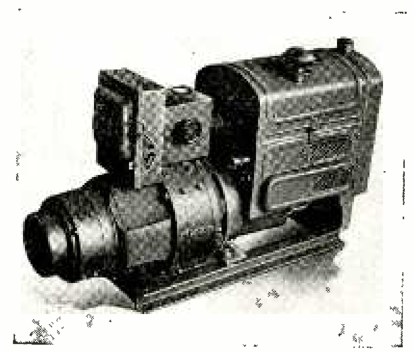
A LOW COST five-inch cathode ray oscillograph intended for use in school and industrial laboratories has been announced by RCA Manufacturing Co., Camden, N. J. The amplifiers of this oscillograph have wide frequency ranges and have a horizontal sweep frequency range from four to 22,000 cps. It is contained in a portable lightweight cabinet with all controls on the front panel. The net price is $130.

Lettering Set

A FAST, ACCURATE lettering set is announced by Eugene Dietzgen Co., 2425 Sheffield Ave., Chicago. With a single guide it is possible to produce eight different types of lettering by changing the setting of the tracer and the pen arm. There are six different weights of penpoints from extra light to extra bold, thus making 48 different weights and styles of type available. Letters are formed in one continuous movement without shifting the guide. Each guide has upper and lower case letters, numerals and characters. The guide is made of a special durable plastic material.

Power Plant

A FIVE KILOWATT power plant is announced by Pioneer Gen-E-Motor Corp., 466 West Superior St., Chicago as an addition to their present line of Pincor Gold Crown heavy duty power units. The engine is completely enclosed in a sheet metal housing to protect it against the elements. A four-pole generator with a speed of 1800 rpm is used. Rheostat, voltmeter and switchbox are standard equipment. Remote control and other accessories are available.



Loudspeaker

A SINGLE HORN which does the work of four trumpet type loudspeakers in distributing upper register sound in the horizontal plane has been announced by the Western Electric Co., New York City. Sound radiation is substantially uniform over 120° horizontally and 40° vertically. This distribution characteristic enables uniform coverage in very wide auditoriums and eliminates overlap conditions. Either of two Western loudspeaking receivers may be used with this new 31-A horn. When used with the 594-A receiver, a frequency range extending from 400 to 10,000 cps is reproduced thus lending itself as a h-f element of a two-way loudspeaker for h-f work. The 31-A horn may be used as an announcing speaker. For this purpose, by means of a special fixture, it may be equipped with a type 707-F receiver. It will then reproduce all frequencies between 400 and 6500 cps.

Western Electric has made available Model 50A radio compass which was designed to operate in conjunction with marine radio telephones including the small 227-B and which will serve as a precision navigating instrument. The unit covers frequencies between 230 and 350 kc which include all of the marine radio beacons maintained by the U. S. Lighthouse Service. Numerous aircraft beacon stations which are operated by the Civil Aeronautic Authority may also be received by the compass for frequent weather broadcasts. The instrument consists essentially of a specially shielded loop antenna, mounted on a tuned r-f amplifier, and a frequency converter. It derives all power from the radio telephone equipment with which it is used.

Relay

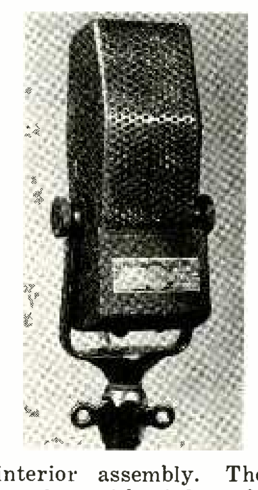
THE NEW M-39 Relay, announced by The Autocall Co., 27 Mack Ave., Shelby, Ohio, is a rotating type relay employing a tilting mercury switch and has been designed for high speed operation. The magnetic brake dampens the movement of the switch making it "dead beat" in action. The mercury switch, attached to a rotating disc on the armature shaft of the magnetic element, is unbreakable and eliminates the annoyance of broken tubes. It consists of an iron tube, insulated cap and refractory breaker. This breaker shields the metal parts from the arc and retains a pool of mercury in the cap end of the switch so that there is always a positive mercury-to-mercury contact. At 115 volts ac each switch has a breaking capacity of 15 amperes. Coils are available for operation from six to 250 volts ac or dc.

Electronic Switch

TYPE 185 ELECTRONIC switch makes possible the amplification of d-c signals through conventional a-c amplifiers. Important applications of the switch are the measurements of signals containing both d-c and a-c components and the study of the modulation characteristics of radio transmission at the transmitter or at remote locations. A complete description of the unit can be found in *Oscillographer*, September 1939 issue. This is published by Allen B. DuMont Laboratories, Passaic, New Jersey, and is a reprint of a paper prepared by Dr. Thomas T. Goldsmith, Jr., of the DuMont laboratory.

Velocity Microphone

MODEL 300-V VELOCITY type microphone was designed to overcome noisy and feedback conditions due to faulty acoustics. It includes static and magnetic shielding, stand or suspension mounting, live rubber shock insulation, sturdy construction and corrosion proof interior assembly. The 300-V comes complete with 20 feet of shielded rubber covered cable and is available in two models—200 ohms impedance and 500 ohms impedance. Complete technical data is available from Carrier Microphone Co., 15 East 26th St., New York.



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AUTHORS INDEX

Rawhide Radio Cabinet

BEAUTY, DISTINCTION and craftsmanship are combined in a radio cabinet covered with genuine rawhide. This rawhide is made from the hides of selected cattle, and specially processed to make it practical for covering radio cabinets. The rawhide is available natural or in colors. The cabinet is a product of Churchill Cabinet Co., Chicago, and the rawhide is supplied by Gutmann & Co., Inc., Chicago.

Photoelectric Colorimeter

THE LUMETRON COLORIMETER, incorporating a number of distinctive features is announced by Dr. Loewenberg, 10 East 40th St., New York City. It has been designed for the greatest possible flexibility and for obtaining results reproducible within narrow limits. The construction of the colorimeter allows the use of a variety of sample holders and light filters, including monochromatic filters, and as a result the instrument covers a wide field of application, ranging from simple measurements of light transmission of liquids to colorimetric and turbidimetric chemical analysis and to abridged spectrophotometric determinations. Special provisions have been made for the accurate measurement of extremely dark and extremely transparent liquids. The instrument uses two blocking-layer photocells in a balanced circuit. Literature is available which describes completely the four standard models.

Microphone Boom Stand

A MICROPHONE BOOM stand for broadcast and other microphone applications is available from Atlas Sound Corp., 1447-39th St., Brooklyn, N. Y. The new stand features "floating action" which permits movement of the boom arm in every direction without moving the adjustments. The fully adjustable boom and counter-balance can be preadjusted to compensate for either heavy velocity type microphones or lightweight crystal types. The stand can be used as a standard vertical telescoping floor stand by simply and quickly removing the boom section. This unit is known as Model BS-35 stand.

Lightweight Genemotor

A HIGH POWER lightweight genemotor for use on aircraft, marine and police radio, is available from Carter Motor Co., 1608 Milwaukee Ave., Chicago. A one-piece field ring and armature design eliminates many parts and provides a more rigid and lighter weight dynamotor. The unit is provided with double sealed grease packed ball bearings that require no oiling or attention; double enamel and silk wire is used on the armature; covers are removable in order that brushes and commutators may be easily inspected. It is available in two sizes, 150 and 250 watts, output up to 1000 volts, input from 5.5 volts up.

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or RESALE

UNDISPLAYED RATE:

10 cents a word, minimum charge $2.00.

Position Wanted: (full or part-time salaried employment only), ½ the above rates, payable in advance.

Proposals, 40 cents a line an insertion.

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Box Numbers in care of our New York, Chicago, or San Francisco offices count 10 words additional in undisplayed ads. Replies forwarded without extra charge.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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The advertising rate is $6.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

Copy for new advertisements must be received by December 28 for the January issue

INDEX TO ADVERTISERS

SEARCHLIGHT SECTION

(Classified Advertising)

Stabilization

(Continued from page 31)

This static compensation is sufficient as long as line voltage changes are slow or at least not too sudden. Very rapid line voltage changes, however, cause a temporary deflection of the needle. This temporary deflection is due to the filament requiring a certain time to attain its new temperature.

The filament of directly heated tubes is very thin and the time lag of temperature changes during which the needle is deflected very short. Proper damping of the meter further reduces this effect of sudden line voltage changes. Nevertheless, in most locations the line voltage variations due to loads being switched on and off the line are so sudden and frequent that the needle fluctuations are disturbing.

In order to overcome this effect, the static stabilization described above is supplemented by a further compensation of dynamic action. It has been shown above that the static stabilization corrects the effect of changes in grid and plate voltages and filament temperature. Two of these changes, the grid and plate voltages, occur simultaneously with the change in line voltage, but the third, filament temperature, is delayed. Now, the dynamic compensation produces a temporary shift of the bias timed for the period of this delay. As a result, the d-c plate resistance is kept constant even during this short lapse of time.

If the filament were heated by a constant voltage, the tap of potentiometer P_1 would have to be set nearer point A as only plate and grid voltage changes would have to be compensated. Now, at the first instant after a sudden line voltage change, the filament is still at its previous temperature. Therefore, the tap of potentiometer P_2 has to be set in such a way that, for the instant after the sudden line voltage change, the grid assumes a potential nearer to point A. While the filament approaches its new temperature, the condenser C is discharged through resistor R_g and the grid assumes its bias from the tap of potentiometer P_1 again. The value of the time constant of C and R_g determine the duration of the temporary bias change.

When used in place of ordinary mica condensers, the new molded Erie Silver Micas will prevent the possibility of frequency drift caused by temperature change in condensers.

Because their capacity change is only approximately 25 parts per million per °C. and power factor is less than .030%, these dependable condensers will provide an unusually high degree of tuning stability. Their molded construction makes them practically impervious to humidity changes. After 100 hours in 100% relative humidity at 104 °F., maximum capacity change is less than .05%.

In addition to the improved operation of oscillators brought about by the above characteristics, performance of your receivers can be still bettered by using tolerances of 1% or smaller at critical points. The unique construction of Erie Silver Micas makes possible their production in these close tolerances without excessive cost.

A letter to us will bring samples and complete engineering data to you. Write today.

ERIE RESISTOR CORPORATION, *Erie, Pa.*

TORONTO, CANADA • LONDON, ENGLAND • PARIS, FRANCE-J.E.CANETTI CO.

MANUFACTURERS OF RESISTORS • CONDENSERS • MOLDED PLASTICS

AMPEREX

AIR RADIATORS

FOR WATER COOLED TUBES

AMPEREX laboratories have designed a series of Radiators suitable for the forced air cooling of metal anode power tubes which are ordinarily water cooled.

These Radiators are scientifically designed for the greatest transfer of heat to the air stream. Their structures are simple, yet they are remarkably efficient. In fact, for some high frequency uses, they are far more desirable than water cooling systems.

The installation of air cooling systems and Air Cooled tubes in broadcast and communication transmitters results in simplicity of design, considerable economy in construction and in greatly lowered maintenance costs.

AMPEREX Radiators are available with the 891, 892, 232C, 220C, 228A and can be readily manufactured for many other types of tubes.

Because of the technical skill required for imbedding the anode into the radiator well these radiators are only sold as an integral part of the tube.

AMPEREX ELECTRONIC PRODUCTS, Inc.

79 WASHINGTON STREET **BROOKLYN, NEW YORK**