electronics

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

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(See page 1)

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MARCH
1936

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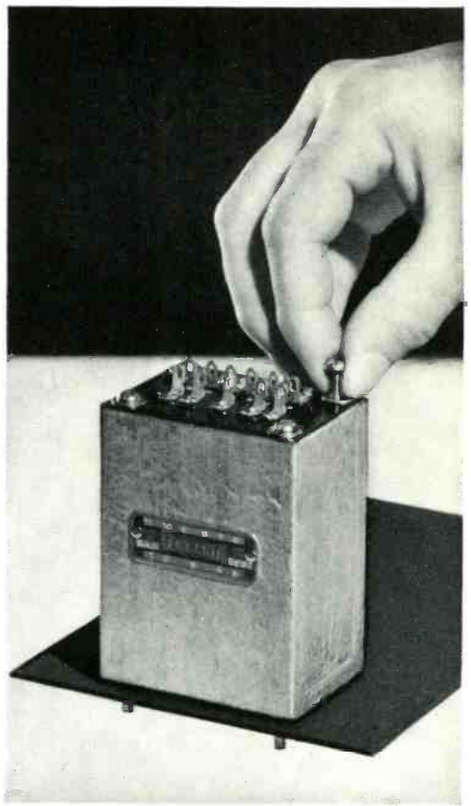

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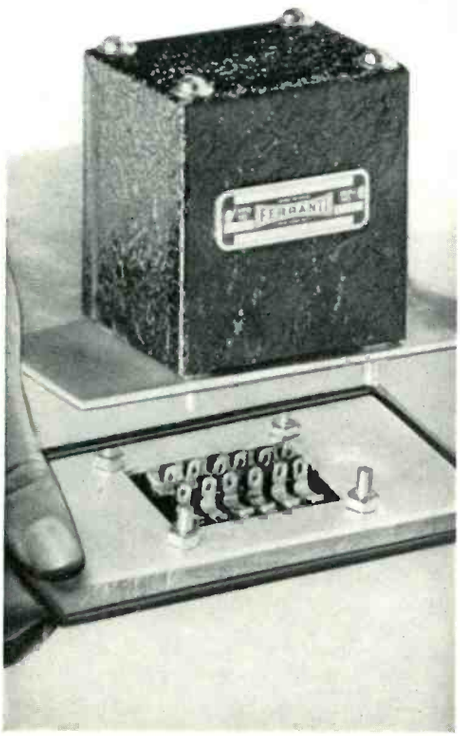

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ELECTRONICS

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

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Contents • March 1936

COVER—*Spark gap photography is not new but is becoming of greater importance in research. This refraction photograph shows the detail and clarity possible*

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DEPARTMENTS

VOLUME 9 . . . NUMBER 3

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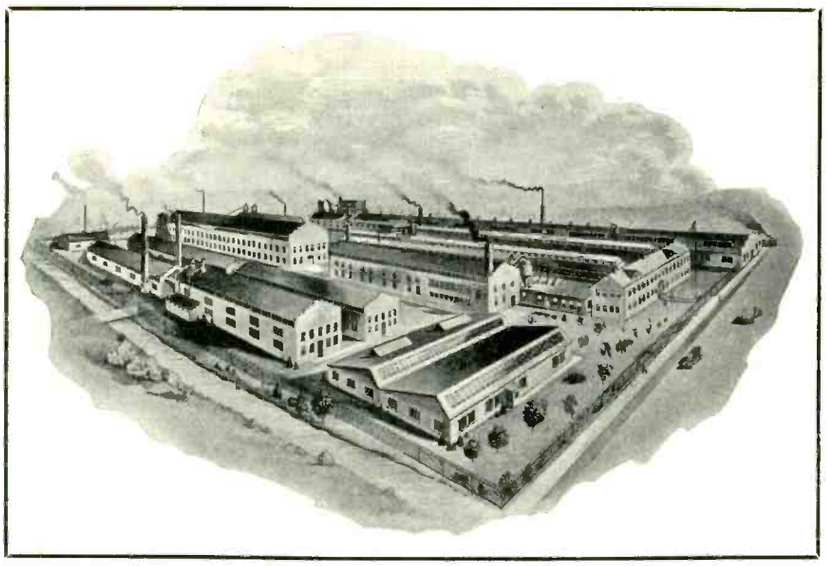

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ELECTRONICS

MARCH
1936

KEITH HENNEY
Editor

Crosstalk

► **ANTENNAS** . . . April, it seems, is the month for antenna papers. At any rate we are fortunate in having in the shop, scheduled for April, several articles on antennas and instead of the more usual custom of spreading them a bit so that they would appear consecutively we have decided to shoot the works all in one issue. Dr. Brown of RCA Victor has a most interesting paper on the "Turnstile" antenna (see page 19, January, 1936); Mr. Laport, who has written several antenna articles for *Electronics* has worked out two-directional arrays in an interesting manner and Mr. Ebel of station WMT contributes patterns of directional antennas, worked out at considerable labor, we guess.

In addition there will be a story on the communication systems of Wall Street, and, as they say in the movies, selected short subjects.

► **PHOTOS BY TELEPHONE** . . . Ten years ago it was our pleasure to offer laboratory facilities to a young man from M.I.T. who wanted to try sending photos by wire and by radio. Austin Cooley set up his apparatus, then using a corona discharge, got himself a job as radio operator on the MacMillan expedition to the Arctic (in order to have a transmitting station at some distance from the receiver) and set sail.

A month or so later motors in the Long Island laboratory synchronized with Cooley's signals from Greenland and pictures (sort of) came through. It was a thrilling hour.

Friday, February 21, this year, the *New York Times* announced that its subsidiary Wide World Photos had perfected a system of low-cost wire transmission of pictures and that within a few weeks it would be in nation-wide operation. A brief description of the apparatus will be found in this issue. A more complete story will be found in *Editor and Publisher*, February 22 and in the *Times*, Sunday, February 23.

The Wide World system is that of Austin Cooley.

► **ELECTRONIC ORGAN-GRINDING** . . . The first electronic musical instrument to take hold in a big way is the Hammond Electric Organ, which generates tones by miniature alternators, amplifies them electronically and transduces them with a dynamic speaker. The new organ sounds and looks like a real organ (except for its portability and lack of pipes), sells for from 500 to 1,000 dollars less than an "equivalent" pipe organ. Result is that nearly two hundred of them are being sold every month to churches, broadcast stations, dance bands, private individuals. Which, at over 1,000 dollars per throw, is good selling. But the professional organists, who are highly influential in the business of selling organs for church and concert use, have lost no time in giving the new instrument a thorough panning. In their professional magazine, *The American Organist*, a recent questionnaire revealed that not one of the leading organists of the country considered the electronic organ in any way a satisfactory substitute for the pipe organ. The reasons given show only a small amount of reactionary prejudice, and display a good understanding of the physics of the production of musical tone. Apparently there are subtleties in organ tones, highly valued by the organist, dimly appreciated by the electronic engineer. But there is not one objection (lack of ensemble, improper proportioning of harmonic tuning and range, too sharp an attack and release) raised by the organists which cannot be solved by the electronic specialist. We believe that an instrument using tubes can be built which will satisfy the objectors and which will still be cheaper, more flexible, capable of better music in the best sense. But only when the engineer and organist sit down to do the job together can it be done.

► **PRICES** . . . Mr. William G. Ellis sales manager of a company making electrical equipment, writes: "The writer who is a subscriber to your magazine, has read with considerable interest and enthusiasm the section of your Crosstalk in the December issue pertaining to purchasing policies of some radio set manufacturers. I am actively interested in a field of a different nature but which is indicating exactly the same trend you have discussed." Radio parts suppliers may take some comfort in knowing that they are not the only sufferers from vicious price haggling policies.

► **DEFLECTION TUBES** . . . In the opinion of far-sighted engineers the tuning indicator tube, 6E5 (a small cathode ray tube), marks but the beginning of a new series of tubes employing beams of electrons and their deflections rather than the space charge effect. Professor Hazeltine, at a recent meeting of the Emporium section of the IRE, opened up a whole new box of tacks with his discussion of deflection control tubes (see page 14, this issue). No one can forsee the end of this kind of thinking or of the research it will stimulate. Furthermore the talk of Mr. Hazeltine at the first meeting of the 1936 IRE New York season indicates that he has other tricks up his thinking sleeve. It is inspiring that one who has been away from radio for so long can return to it, refreshed perhaps by his detachment, and throw into the ring several most inviting speculations.

On deflection type detectors see *Wireless World*, November 8, 1935, and page 46, this issue.

► **REALLOCATION PLANS** . . . Once, not so long ago, a very live subject, reallocation of broadcast channels seems to have disappeared from the lime light in Washington. The chances are that nothing much will be done until after November, and what will be done then depends upon the way the election winds blow.

Photos by Telephone

Photographs as reproduced on Rotogravure, a 60-line newspaper, and in *Editor and Publisher* and transmitted over the *New York Times* Wide World system which uses ordinary telephone conversation circuits and portable transmitters.

The March of Electronics

Photographs by telephone. RCA Photophone develops use of ultra-violet light for recording. Noise silencer of ARRL technical staff squelches man-made static. Automatic frequency control circuits make tuning simple and certain

NEWS is always being made in the electronics industries. On February 21 the *New York Times* announced that Wide World Photos, its subsidiary, had completed research and development of a simple method of transmitting photos by telephone, an announcement that has been expected for some time. Instead of using special wires, rented by the year, and heavy terminal apparatus Times Wide World uses portable transmitting equipment which can be taken to the field, set up near an ordinary telephone.

The sound signals (1800 cycles) corresponding to light variations in a photograph are sent to the receiver on a straight long-distance call basis. The portable transmitter weighs 60 pounds, will operate two hours from a 15-lb. storage battery sending 8 pictures in this time. The system seems to be conventional in so far as the pick-up of light and the final transfer of sound modulations to photographic paper is concerned.

The virtue of the system is its simplicity, and its cheapness so far as wire charges are concerned. At night toll rates a 6½x8½ inch photo can be sent across the country for about $25. Signals are put into, and taken from the telephone line by induction from the telephone box, no actual connection being made to the lines. No special line characteristics are necessary. All that is desired is that the operators keep off the line during the transmission. Going through carrier circuits where the 1800 cycle signals are beat to appear as some other frequency, a slanting picture results—but the *Times* engineers have designed compensations that get around this trouble. A preliminary signal sent over the circuit discloses whether or not these compensations at the receiver must be made.

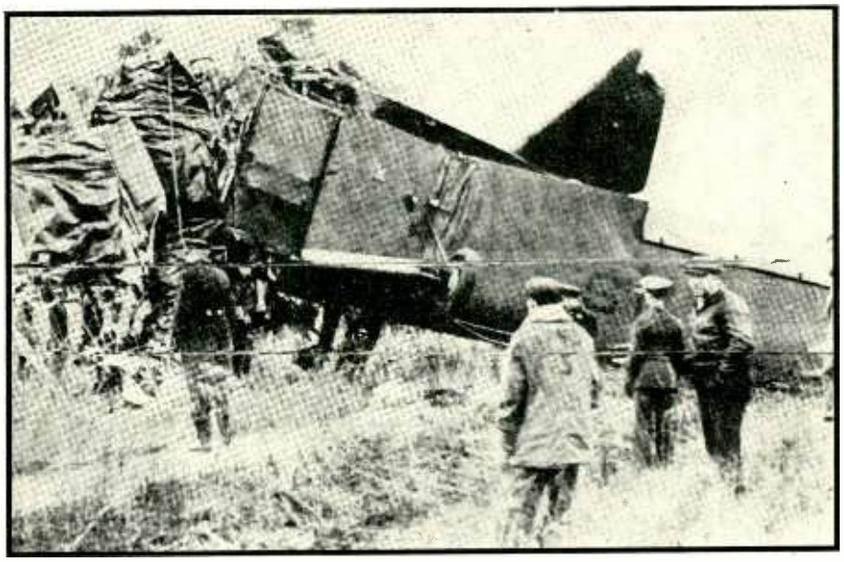
The pictures as transmitted have not the detail possible with the Associated Press system (see *Electronics*, January, 1935) but for newspaper work they are entirely satisfactory. The frontispiece shows a reproduction of a sheet of photographic paper just as it came from the Wide World machine, showing the results secured by transmitting photos from three different sources, Rotogravure, a page of *Editor and Publisher*, and a 60-line newspaper.

A rapid expansion of the *Times* system throughout the country, and possibly abroad, is to be expected.

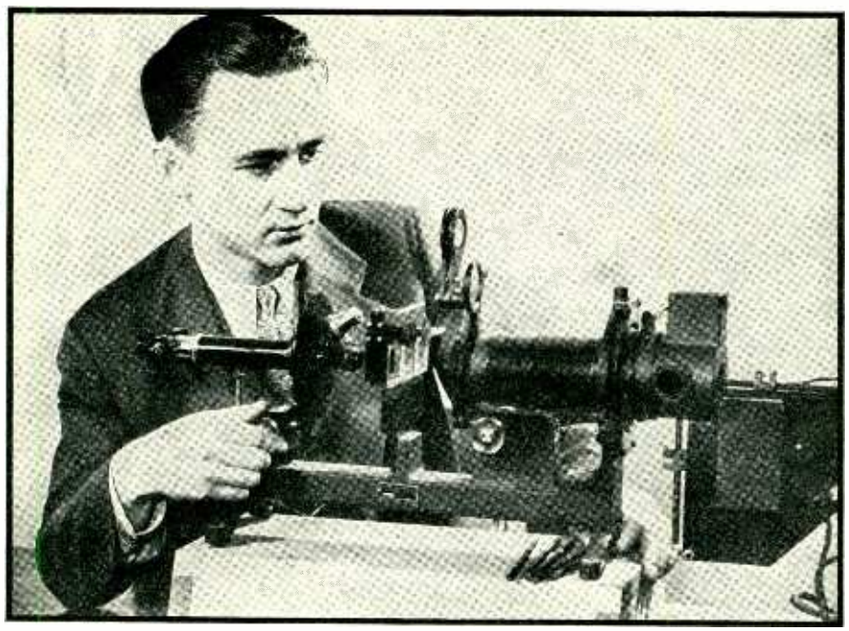
On February 27 the Associated Press, already in possession of an expensive and extensive system developed by the Bell Laboratories, announced that it, too, had perfected a portable transmitter soon to be placed in 25 key cities thus doubling the number of points in which sending equipment is located. By these new machines a 4 by 5 inch photo is automatically enlarged to 8 by 10. Furthermore it is stated that regular telephone lines may be employed; that 100 line screens are in use on the fixed terminal equipment and that 200 lines are used on the portable apparatus.

Photophone uses Ultra-violet

● ON FEBRUARY 19, Glenn L. Dimmick, RCA Photophone engineer, described before the Society of Motion Picture Engineers the results of considerable work at the Camden laboratories where the use of ultra-violet light for recording on film has been worked out. The value of this method, compared to the use of longer wavelength light, is the superior definition secured on the higher frequencies. Just as an ultra-violet microscope permits smaller objects to be resolved, so the shorter wavelengths permits a cleaner reproduction of those higher



Times Wide World photo as sent over telephone line. Lines are caused by operator breaking in



Glenn L. Dimmick examining a strip of film recorded by the RCA Photophone ultra-violet process

frequencies which lend so much realism to sound reproduction of any kind.

Engineers state that no extension of the frequency or volume range was secured by the restriction of the exposing light to a narrow band in the ultra violet; the great virtue is as stated above. The Editors listened to the demonstration of the system, however, and found it remarkably realistic. The difference between the film demonstrating this new development (good to 9000 cycles with a considerable volume range) and a radio (even those costing many dollars) is tremendous. Newspaper editors listening to the demonstration stated they felt the movies had little to fear from radio so long as radio offered so little tonal competition as exists at present.

J. J. Lamb and A.R.R.L. Staff announce new noise-silencing circuit

● One of the most important developments in radio circuits during the past several months is the noise-silencing system announced in the February issue of *QST* by J. J. Lamb and his associates of the technical staff of the American Radio Relay League. The circuit, shown in Fig. 1, is not radically new in principle, having been suggested more than ten years ago by Scott-Taggart, but it is the first practical and workable arrangement of its kind, and it contains many improvements on the original idea.

Briefly, the circuit is effective against noise peaks of higher amplitude than the signal envelope. The circuit operates by separating part of the noise energy from the signal energy in a biased diode circuit, and using this noise energy to block one of the i-f amplifiers. By this means, the receiver becomes inoperative for a short instant during the noise pulse, and "holes" of silence replace the bursts of noise.

The action is not perfect however, since there remains considerable residual noise from low-amplitude components and from cross modulation within the i-f amplifier and the second detector. This residual noise manifests itself as a hiss which is not objectionable to the ear, and which does not interfere greatly with the intelligibility of voice and c.w. signals.

The noise-silencing action of the circuit (see Fig. 1) takes place as follows: an i-f signal (supplied by a conventional first detector) consisting both of the desired signal and the noise, is fed simultaneously to an i-f amplifier which acts also as the silencer tube, and to a noise amplifier. The latter tube, a 6J7, amplifies the signal and noise and feeds them to a full-wave diode, a 6H6. The biases applied to the 6J7 and the 6H6 are controlled by a manually operated volume-control type resistor. The bias on the diode is adjusted until its value is equal to or slightly greater than the maximum amplitude of the envelope of the desired signal. No rectifying action takes place, therefore, until a voltage (e.g. the noise pulse) of higher value than this bias appears.

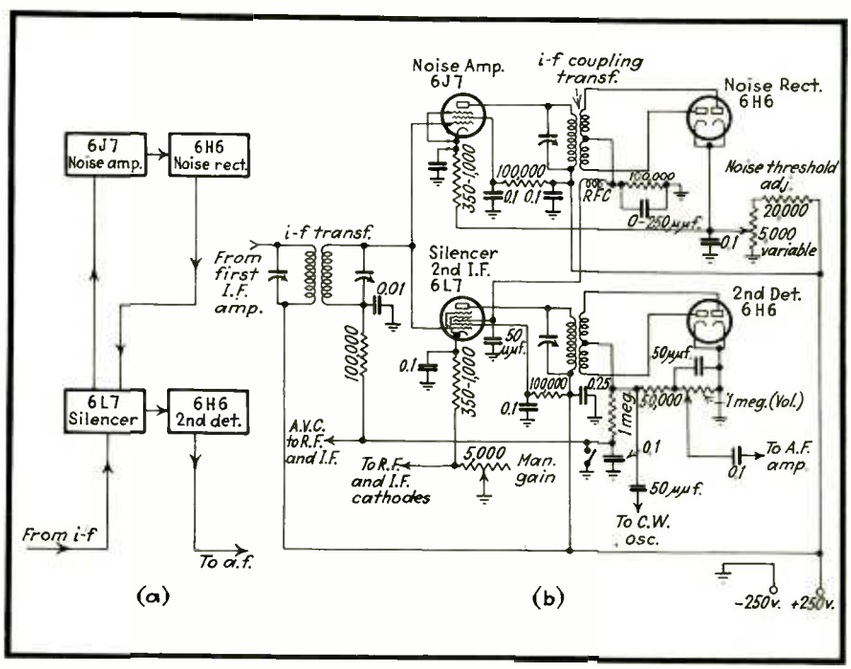


Fig. 1. Block diagram (a) of the noise-silencing circuit, and the complete connection diagram (b)

The noise pulse, above the signal envelope, is then rectified and passed to the No. 3 grid of the silencer tube (a 6L7). The connecting link between the silencer and the diode must pass d-c only (i-f must be filtered out) and it must have an extremely short time constant (practically, not more than a few hundred microseconds) otherwise the noise will have passed through the 6L7 before the rectified noise pulse can reach the suppressor grid. When the voltage does reach this element, the tube becomes blocked to a degree depending upon the amplitude of the rectified pulse, and for a length of time depending on the duration of the pulse. The receiver thus becomes inoperative for a period of time sufficient to remove the greater part of the noise which would otherwise pass through the 6L7 to the second detector.

Because of the finite time-lag in the connection between the diode rectifier and the silencer tube, complete elimination of the noise pulse cannot be accomplished, as shown in Fig. 2-C. The initial part of the pulse passes through before the 6L7 is blocked, but the energy associated with this initial part can be reduced to a very low value, especially if the noise voltage is of a steeply rising character, or if it is amplified sufficiently to produce blocking on the first portion of pulse. In other words, a strong noise acts to block the silencer quicker than a weak one. The strength of the noise may be great because its original value is high or because it has been amplified; as a result, multi-stage amplification of the noise before rectification will produce improved performance, but at the expense of a more complicated circuit.

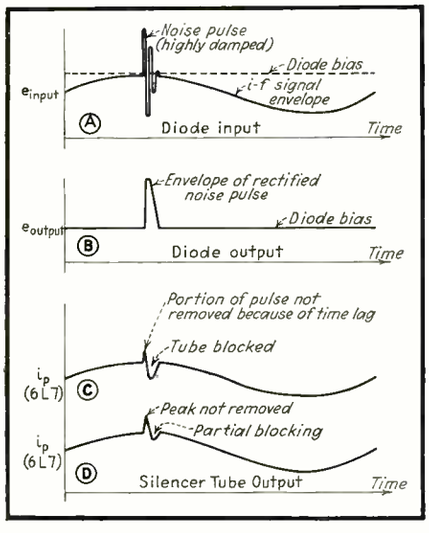


Fig. 2—(A) Diode input of signal envelope (only one edge shown) and noise. (B) Rectified envelope of noise peak applied to blocking grid of silencer. (C) Effect of blocking action on i-f envelope. (D) Incomplete blocking if noise is not sufficiently strong.

Light-bulb Volume Expander

● VOLUME EXPANSION has hitherto been accomplished by varying the gain of an amplifier tube in accordance with the average level of the program, in such a way that the gain is increased for loud passages and reduced for soft ones.

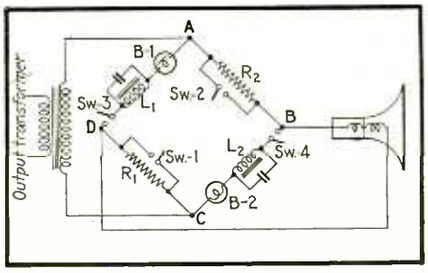
These bulbs expand the volume range of new Crosley receivers

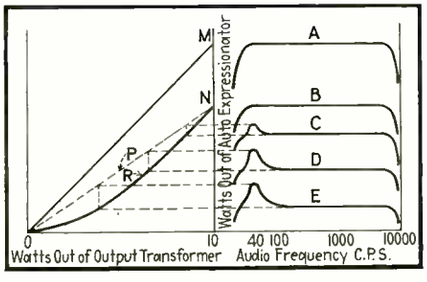
Recently it was announced by Crosley engineers that the same process of volume expansion could be accomplished without the use of tubes, in a considerably different manner. Between the output transformer of the last audio stage of the receiver and the voice-coil of the dynamic speaker is inserted a Wheatstone bridge circuit. Two arms of this circuit consist of two fixed resistors R_1 and R_2; the other two consist of two miniature incandescent bulbs with specially processed filaments, in series with bass-compensating tuned inductance and capacity. The filaments of the bulbs have the well-known property of increasing their resistance as the current through them increases; and they have been designed to possess a considerable degree of thermal inertia so that sudden changes of resistance cannot take place.

At frequencies above 200 cycles, the inductance and capacity in the bridge form an effective short circuit so that the bridge can be thought of as a straight resistance bridge. If this bridge were in balance, no matter what voltage was applied from the output transformer to the points *A* and *C*, no voltage would be passed onto the voice coil from points *D* and *B*. But the bridge is kept permanently out of balance by choosing R_1 and R_2 small (about one ohm each) compared with the resistance of the bulb filaments. When the bridge is thus out of balance, the voltage supplied to the voice coil is directly proportional to the voltage supplied by the output transformer, and an energy transfer is accomplished, except that part of the energy is lost by mis-match and in the elements of the bridge itself. As the voltage level from the output transformer increases, the average current in the bridge arms increases. As it does so, the bulb filaments become hot (not hot enough to glow except at high volume levels) and their resistance increases, throwing the bridge still further out of balance, and sending proportionately more current to the voice coil. Hence the louder the signal, the more of it is fed to the speaker, and the result is volume expansion.

At the low output levels, moreover, the lower frequencies need boosting to produce the proper sensation in the ear. This is accomplished by the tuned circuits in the bulb arms of

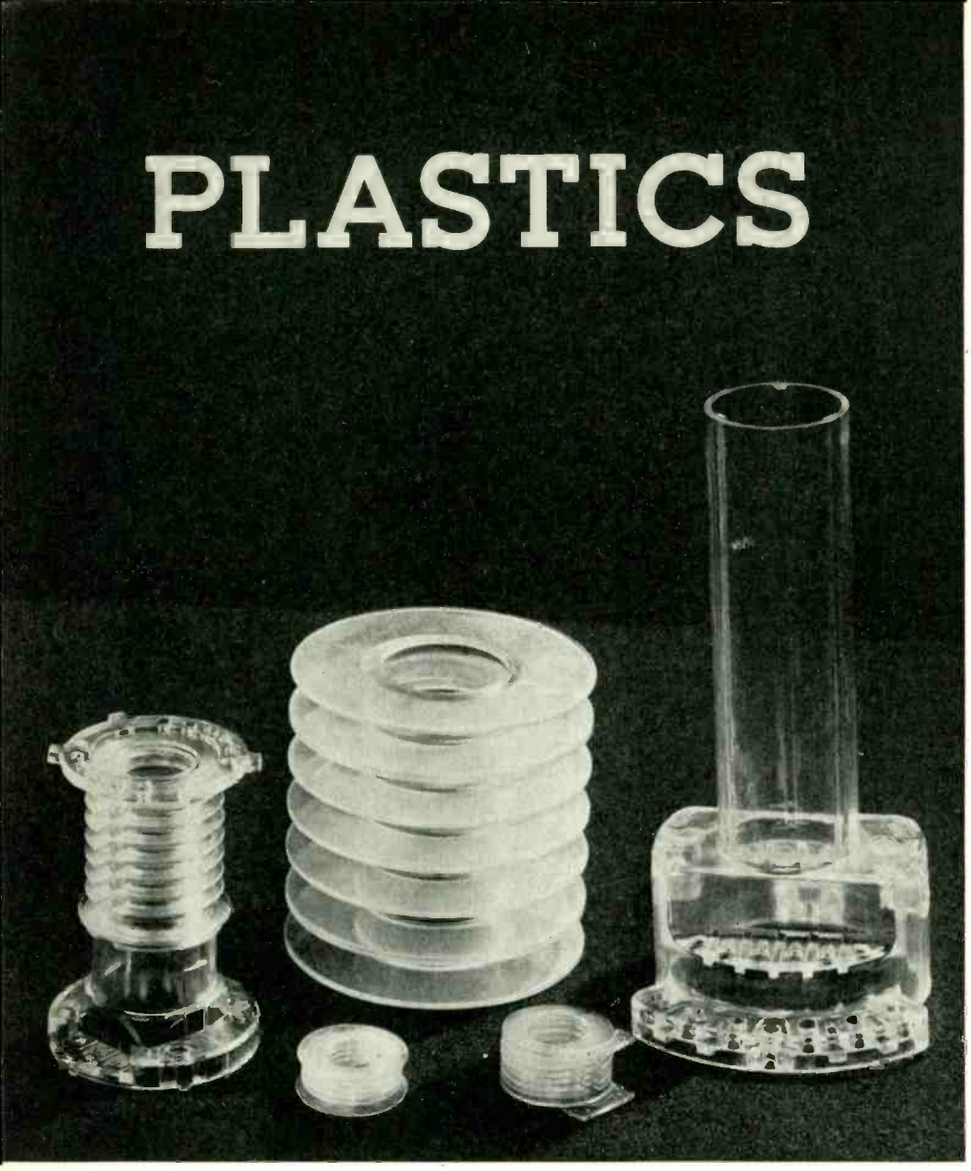
[*Please turn to page 48*]





Above, the bulb-expander circuit and below, the expansion and bass-boosting characteristics

PLASTICS



Transparent coil forms of the German plastic Trolitul of low power factor. On some parts the flange thickness is about 0.040 inch

Mechanical and electrical properties of phenolic, urea, cellulose acetate and styrol materials commonly used in electronic apparatus

By HERBERT CHASE, M.E.

PLASTICS have played an important part in the electronic industry since its inception. As the industry has grown the number of types of plastics has increased and the diversity of applications has multiplied rapidly. Those who have not had the time or inclination to follow the growth may well find it difficult to choose the best plastic for particular applications. It is the purpose of this article to give some typical illustrations of various uses and to outline the properties of several types of plastics as a guide to those not already familiar with diversified types.

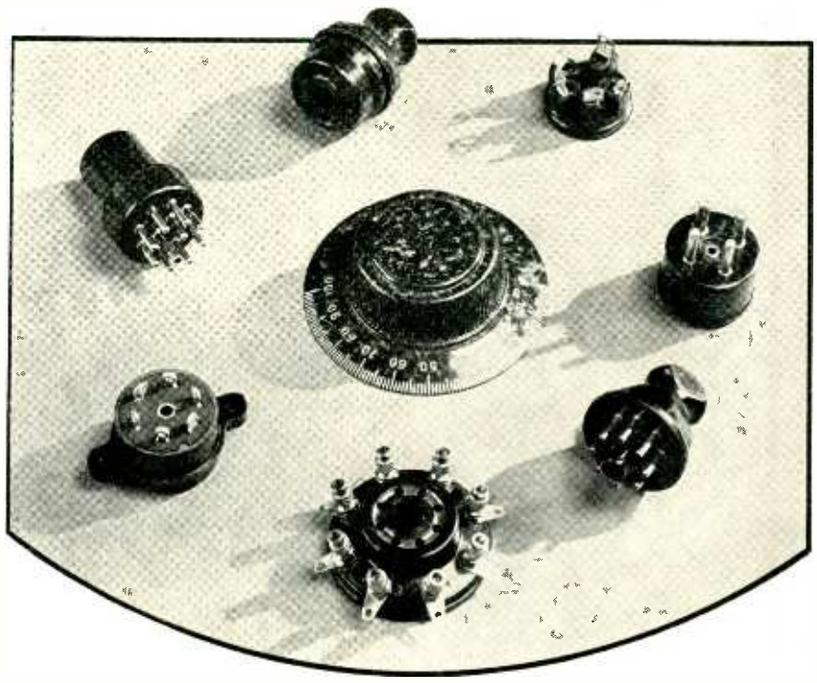
Plastics used in electronic applications differ widely according to their intended use. In general, the uses can be divided into two classes, those in which *mechanical* properties such as strength, color, and finish are of primary importance, and those in which *electrical* properties such as dielectric strength and losses are the primary consideration. Usually plastic materials suitable for the first group are not suitable for the second, and vice versa.

The structural plastics (those whose mechanical and non-electrical properties are of primary importance) are of two types, the phenol types and the urea types. The phenolic type (made under such trade names as Bakelite, Durez, Synthane, Resinox, Textolite, Micarta, Formica, etc., etc.) is the best known. At one time such materials were used almost exclusively for all insulation purposes in radio receivers and similar applications. At present they are used particularly for cabinets, translucent tuning dials, knobs, sockets, tube bases, and for insulation not exposed to high frequency electromagnetic fields. The urea plastics are newer than the phenolics and somewhat more expensive, but they offer some special advantages, particularly where color and finish are of primary importance. They are sold under the trade names Beetle, Plaskon, Unyte, etc. Both the phenol and urea plastics can be molded in pure form, mixed with wood or mineral fillers, or laminated with paper, fabric, or mica bases. Once molded, they set and cannot be softened by application of high temperature.

The low-loss plastics used for insulation in radio frequency circuits ("electrical" pastics) are of quite a different nature. The most important form of low-loss material is meta- or poly-styrol resins, which have extraordinary dielectric properties. The styrol types are made in this country under the name Victron. The material approaches fused quartz in its dielectric properties, and is of considerable importance in present-day developments in all manner of radio frequency apparatus. Both cellulose acetate (used in phonograph recording) and stryol types are thermo-plastic, that is, they can be resoftened after molding by the application of heat.

Phenol-formaldehyde plastics, commonly referred to as "phenolics" are produced from phenolic resins. Being low in cost and having excellent dielectric and mechanical properties, they have gained very wide use. Although these synthetic resins can be molded in their pure form, they are nearly always combined with some such filler as wood flour, asbestos fibre, mica or fabric, as such additions not only improve the properties of the molding but also reduce its cost in most instances. Molding is done as a rule under

Molded products well known in electronics. Below are shown terminal blocks made of transparent material, made in Germany

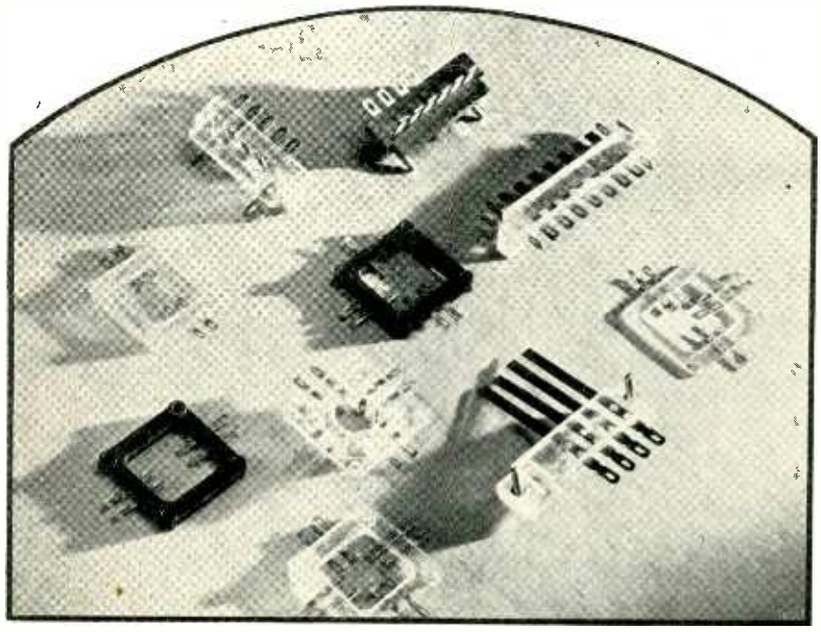


pressures of 2,000 to 3,000 lb. per sq.in., and at a temperature ranging in general between 285 and 330 degree Fahrenheit. Heating brings about a permanent chemical change which converts the resin from a soluble and fusible form to one which is insoluble and infusible and not subject to softening if subsequently heated.

"The laminated" form of phenolic plastic is made with similar resins but supplied in liquid form as a "syrup" or varnish. This is dissolved in a thinner and then is used to impregnate fabric or paper after which the solvent is evaporated. The cloth or paper, usually several layers of it, is then placed in a press between polished plates which are heated, and is subjected to heat and pressure. This has the same effect in respect to hardening as does molding and results in sheets of considerable strength and excellent dielectric properties. Tubes and rods are similarly made, but require appropriate changes in equipment to give the circular contour, the tubes being formed over a mandrel.

Pigment or other coloring matter is usually mixed with phenolic molding compounds to give the molding the desired hue, and plain-colored laminated products are similarly treated. As the resins themselves are amber in color and tend to darken with light exposure, light shades require considerable pigmentation and are not very much used. There has been developed recently, however, an unusually light-colored phenolic resin for laminating and this is being used (without pigment) by Continental-Diamond Fibre Company to produce thin translucent sheet suitable for and extensively used in making radio dials.

Urea-formaldehyde plastics, commonly referred to as "ureas," are similar in many properties and in their adaptability to molding and laminating to the phenolics. They are marketed in this country under the trade names Plaskon, Beetle and Unyte. They sell at a price somewhat above that of the colored phenolics (which, in turn are higher in price than black, brown and some dark-colored phenolics), hence their use is chiefly in white and light colors (chiefly pastel) in which translucency adds to depth and brilliance. They are used for exposed dielectric parts, but their chief electronic applications to date are in producing light-colored radio cases and parts and in decorative knobs.



Molded phenolics too are often used for cases of radio sets and of other equipment in the electronic field when dark colors are desired, but more important in some respects have been the purely dielectric applications. For these, mica and other mineral fillers are often employed, especially when a low-loss and/or heat-resistant or water-resistant material is desired. There are several of these low-loss phenolics and their properties vary to some extent with the filler as well as with the particular type of resin used. Power factors as low as 0.6 per cent are reported for certain forms of phenolic low-loss moldings, as against 3.5 to 15 per cent for the ordinary wood-flour-filled type, such as would commonly be used for a radio case. Most of the low-loss molding phenolics are very hard and somewhat

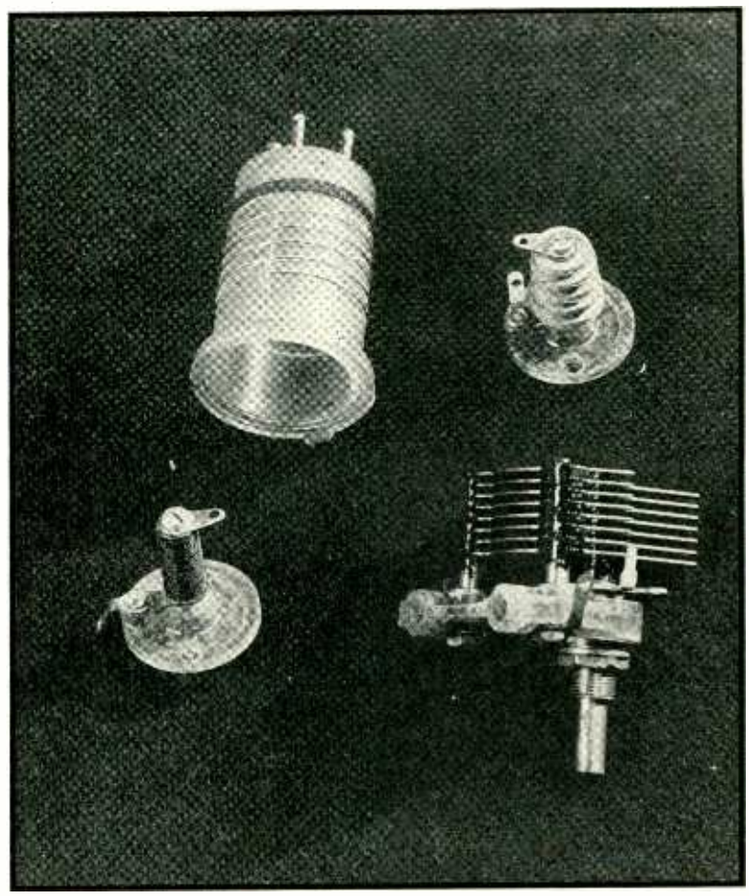
brittle and are quite difficult or impossible to machine. For this reason, if employed for coil forms with grooves for wires, the grooves should be molded into the form.

For parts in which considerable shock resistance is required and power factor is a secondary or negligible consideration, fabric-filled moldings are often employed. Their impact strength may be from 10 to 25 times that of the ordinary wood-flour-filled phenolic molding and their strength-to-weight ratio is very high, which may be an important factor in portable or aircraft equipment.

In general, the mineral-filled phenolics have greater heat resistance and lower water absorption than the types using wood flour or fabric fillers and may be chosen on this score. Insulation resistance of most materials decreases, of course, with moisture absorption, and some other dielectric properties are also adversely affected (the power factor, for example, is increased), hence the degree of moisture absorption especially from moist air (which is often higher than from submersion in water) should be considered in selecting phenolics as well as with other insulating materials.

Laminated plastics of the phenolic type are also available in a wide variety with dielectric and other properties differing to a considerable extent. Thicknesses available vary from 0.010 to 4 in. or more and finishes from dull to satin and glossy. There are at least four paper-base laminated phenolics in the N.E.M.A. classification that find more or less extensive use in the electronic field. These are known as X, P, XX, and XXX grades. Grade X has high mechanical strength, good machining qualities and can be punched while hot. Grade P has excellent cold punching and shearing qualities, consistent with fair mechanical and electrical properties. Grade XX has high insulating value, and good machining and mechanical properties. Grade XXX is characterized by low dielectric losses and low power factor under high-humidity conditions. Fabric-filled grades are stronger than the paper-filled types and are used chiefly where mechanical strength is important.

The colors most used in laminated stock are natural tan and black, but other colors can be had on special order, and where decorative or wood-grain effects are desired, these can be provided by using a top sheet of paper or fabric lithographed or otherwise prepared to show its grain or pattern through the thin transparent coating of resin on the surface. For pastel and other light colors, the urea resins are commonly used in laminating, as indicated above, the sheet being translucent if the paper is of a suitable type. For special purposes, opaque sheet is sometimes laminated to the translucent backing and is subsequently cut away in letters or patterns through which transmitted light may shine.



Na-Ald parts of low power factor made from Victron or imported poly-styrol. R-f chokes, a coil form, a variable condenser

As the table on page 36 indicates, the laminated plastics may have greater strength than the molded form and may possess a degree of toughness comparable to that of the fabric-filled molded form, especially when fabric is used in laminating. In some forms, the laminated material is almost as strong as aluminum sheet, but weighs only half as much. Machining properties vary with the grade, and though machining is sometimes considered difficult it is not really so when the proper type of tool, properly ground and arranged to cut at the proper speed is employed. Many radio parts are punched rapidly from thin sheet; parts from tubular and rod stock are readily produced in the screw machine and in other types of machines adapted to turning, threading, drilling and similar operations.

Data on heat resistance are not available for all forms of material but tempertures up to about 250 deg. F. do not affect most phenolics adversely, physically or otherwise, even though long sustained. The mineral filled forms will in some cases withstand short exposure to temperatures as high as 475 deg. F. without serious injury, but higher temperatures result in charring or decomposition. Baking at temperatures up to 250 deg. F. sometimes causes slight shrinkage and hardening of moldings but is likely to improve dielectric properties. Some colors are adversely affected at such temperatures, however. High tem-

peratures never produce softening in phenolics as they do with thermo-plastic materials. The phenolics are also comparatively free from cold flow (tendency to distort under load).

Thermo-Plastic Materials

All of the plastics thus far considered are of the thermo-setting type, that is, they set permanently when heated in molding, laminating or curing after casting. Other important types do not have this quality. They are hard when cold, but soften when heated above a certain temperature. From an electronic standpoint, the most important of these thermo-plastic materials are cellulose acetate and the meta- or poly-styrol resins. The styrol types have the best dielectric properties and the lowest power factor, as well as the lowest water absorption of any of the plastics and in respect to power factor are a close approach to fused quartz.

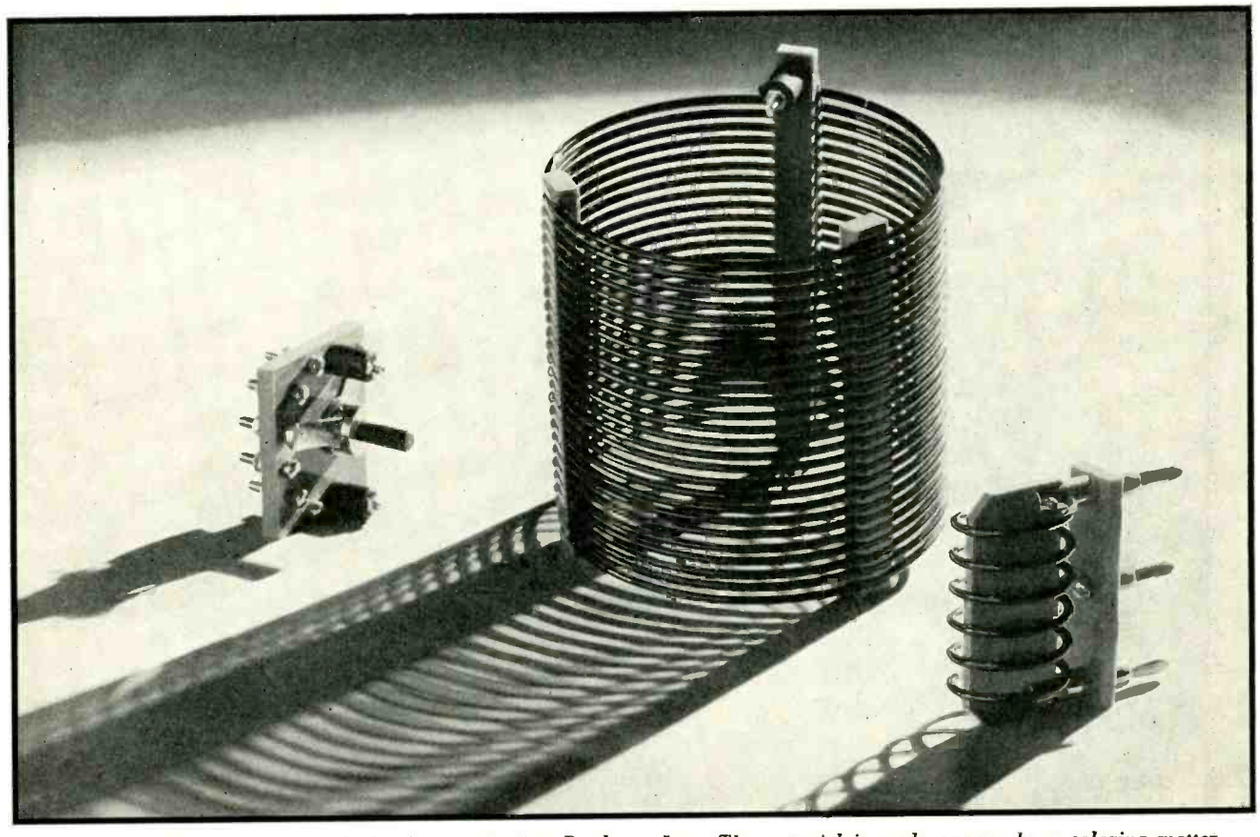
Since both cellulose acetate and the styrol plastics can be converted into somewhat viscous liquid form by heating, they can be handled in somewhat the same way as are molten metals in die casting; that is, they can be forced under heavy pressure into cold molds where they harden quickly and then are ejected in molded form. With plastics, this process is termed "injection molding" and is an important method of producing molding at a rapid and economical rate. The dies or molds are usually quite small and inexpensive, and as the rate of molding is high, the parts produced can be made quite rapidly even when molds with a single or very few cavities are employed. This is true, especially, in contrast with the thermo-setting plastics which are molded from powders and which must first be fluxed and then cured in a hot mold before the mold can be opened, hence the cycle is relatively long, usually one to three minutes even with small parts. In consequence, for rapid and most economical production, molds of many cavities are commonly required and are quite expensive. The thermo-plastic materials avoid this limitation in the injection process, but, of course, have certain limitations of their own, besides costing more per pound.

Both cellulose acetate and the styrol plastics can be had in sheets, rods and tubes which can be machined to shape. But they come also in flakes or granules for molding purposes, and are often molded, especially when complex or irregular forms are desired. As molding involves little or no waste, whereas machining often involves considerable waste, the former is preferred when the cost of a mold is justified. Molding of acetate and styrol plastics can be done in the same form of press and mold used with phenolic and urea parts, if provision for cooling the mold is made, but the process is much slower than injection molding. In general, the latter requires a special machine and is confined mostly to small parts.

Cellulose Acetate

Pure cellulose acetate is substantially water-white, but is often colored and rendered translucent or even opaque by the use of dyes or pigments. Sheet material can be made to take ink, as in printing radio dials and scales. A very important use of the material is in

[*Continued on page 34*]



Low-loss (Victron) parts made by Communication Products, Inc. The material is made opaque by a coloring matter to improve appearance and molding properties. It has no effect upon the dielectric properties

Deflection Control Tubes

A portion of a talk before the Emporium Section, I.R.E., in which Professor Hazeltine proposed applying electron beams to general purpose tubes—a most significant suggestion

By ALAN HAZELTINE

President, Institute of Radio Engineers

THE vacuum tubes in ordinary use for radio purposes all operate by control of electron emission. On the other hand, cathode-ray tubes operate by the deflection of electron streams, through either an electrostatic control or a magnetic control.

It is the purpose of this article to present a vacuum tube of such construction that the anode current will be greatly changed by a deflection of the electron streams through only a small distance, thus requiring only a small change in control potential. Moreover, the construction is such that the change in current tends to be directly proportional to the change in potential, thus avoiding the distortion inherently present with emission control, which depends on a three-halves power law.

One arrangement of the elements is illustrated in Fig. 1. Nearest the central cathode are two interleaved helical grids; and outside of these are two interleaved helical anodes, having the same pitch as the grids and in line with them. A metal shield surrounds the whole. The method of support shown is not material: each anode is supported by a pair of metal posts cut away to clear the other anode; and the grids are supported from the anodes by mica spacers.

In passing between adjacent grid turns (which belong to different grids), an electron will be repelled from the more negative one and so will tend to go to the anode nearest the other grid turn. Thus an alternating potential difference between the grids will cause an alternate deflection of the electron streams toward one anode and then toward the other, which is equivalent to an alternating component of current between the anodes. If there is an external impedance between the anodes, this alternating current will build up an alternating potential difference between the anodes, which will also tend to deflect the electron streams, but less strongly than does the potential difference between the grids. Thus, with deflection control, the vacuum tube will have three parameters corresponding to those commonly used in calculations of vacuum tubes having emission control: transfer conductance, anode conductance, and amplification factor. These relate the potential difference between the grids, the potential difference between the anodes, and the current flowing effectively between the anodes.

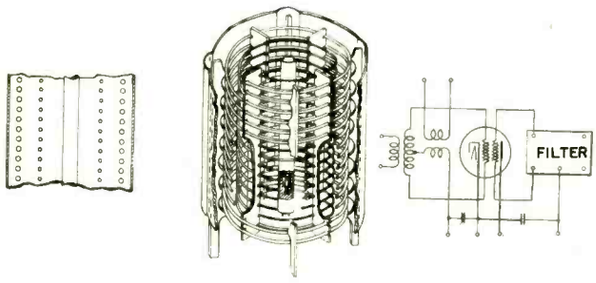
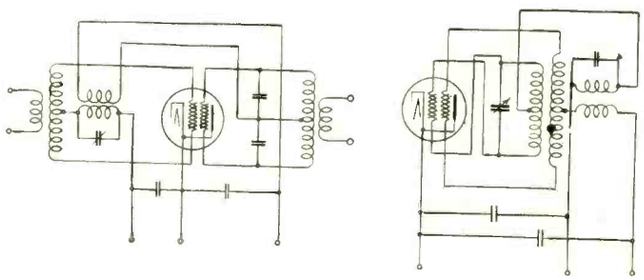


Fig. 1. The deflection tube and a typical amplification circuit

Figs. 2 and 3. Feedback circuits for oscillation and modulation



Amplification, Frequency Conversion

Deflection control can be used by itself for amplification, at any ordinary frequency. The input voltage is impressed between the grids; and the output voltage is that produced between the anodes. The tube of Fig. 1 is almost completely self-neutralized with respect to deflection control, because the symmetry of the two grids causes their capacitances to each anode to be nearly equal; and likewise the symmetry of the two anodes causes their capacitances to each grid to be nearly equal. Moreover, the grids partially shield one another; and the anodes do likewise, being supplemented by the outside shield. No screen grid is therefore needed.

However, deflection control can conveniently be combined with emission control to provide frequency conversion, as in a modulator or a detector. This is illustrated in all of the circuit diagrams, where the voltage for the deflection control is that of the transformer drawn vertically and the voltage for emission control is that of the transformer drawn horizontally. In Fig. 1, for

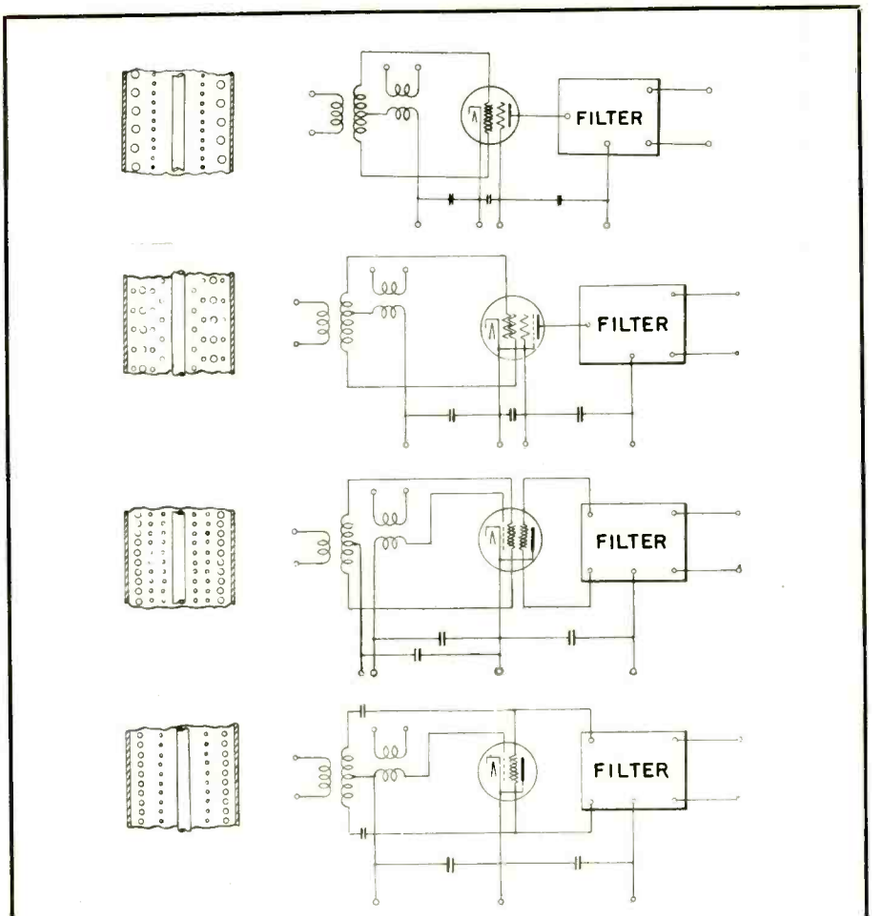
example, the deflection-control voltage is impressed symmetrically between the grids, so as not to affect emission; while the emission-control voltage is impressed from the cathode to the grids jointly, so as not to deflect the electron streams. The grids may be biased, as usual, through a source shunted by a condenser.

The transfer conductance above referred to depends on the emission; so, when the emission is varied, the alternating current and voltage between the anodes are correspondingly *modulated* and, as is well known, they contain components whose frequencies are respectively the sum and the difference of the input frequencies. Either of these frequencies may be selected by the filter indicated in Fig. 1. The anode voltage supply, shunted by the right-hand condenser, is supplied to the anodes symmetrically through the filter.

The shield of Fig. 1 may be given a slight negative bias, through the lead shown in Fig. 1, so that it will repel all electrons passing between the anodes, making them return to the anodes. If the initial velocities of the electrons are small and some current to the shield is not objectionable, the shield may be connected directly to the cathode within the tube, as shown in the following circuit diagrams. In either case, the shield serves as a suppressor, tending to prevent secondary emission from one anode to the other, and may be supplemented for this purpose by connecting to it helical wires interposed between the anodes.

Other arrangements of the elements, of course, are possible: for example, more nearly ideal performance is secured if the grids are edge-wound strips, instead of wires, and the anodes are flat-wound strips. And, in place of the helical form, the grids and anodes may be made up of conductors parallel to the axis of the cathode.

Regeneration may be applied with respect to either the deflection control or the emission control. Figure 2 shows an oscillator-modulator, as in a superheterodyne receiver, having a feed-back arrangement for an emission-controlled oscillation, the incoming signal providing the deflection control and the desired intermediate-frequency voltage appearing between the anodes. Figure 3 shows an arrangement having both feed-backs, independently controllable in frequency: the deflection-control feed-back gives a radio-frequency oscillation; the emission-control feed-back gives, say, an audio-frequency oscillation. The result is a radio-frequency oscillation modulated at audio frequency, which may be useful as a laboratory source. If the feed-back coupling in the deflection-control feed-back is strong, the electron stream will be almost completely deflected from one anode to the other; and the oscillation will then be stable down to very low emissions. This stability is advantageous either in the modulated oscillator shown or in an unmodulated oscillator, in which the emission-control feed-back is omitted.



Figs. 4 to 7 (Top to bottom): Tubes and circuits combining emission control with deflection control for modulation, etc.

Unsymmetrical Tubes

It may sometimes be desirable to arrange the grids or the anodes, or both, unsymmetrically. Figure 4 shows a simplified tube in which one anode is helical as before, but the other is the surrounding shield, which we now naturally call the "plate." A suitable circuit arrangement is shown where only the plate is used for the output, a fixed positive potential being impressed on the helical anode, which thus serves incidentally as a screen-grid. Figure 5 shows a tube in which the control grids also are unsymmetrical, having different radii; this prevents the self-neutralization previously described, but the use of the inner anode as a screen grid and the further interposition of a suppressor grid (represented by the outermost row of circles) effectively screen the control grids from the plate. To prevent the deflection-control voltage from affecting emission, with this dissymmetry of the control grids, the transformer secondary is tapped unsymmetrically, so that the outer grid will receive more of this voltage than the inner grid, to make up for its

lesser effectiveness in emission control. All of the grids in Figs. 4 and 5, of course, have the same pitch and are properly lined up.

To separate more completely the two types of control and particularly to permit separate biases to be used with each, a single grid may be arranged for emission control, as the innermost grid of Fig. 6, and the twin grids may then be used only for deflection control. If the emission-control grid is made up of two helical wires having the same pitch as the twin grids, as indicated, it will tend to prevent electrons from reaching the twin grids, which may therefore be operated with little or no negative bias.

Just as we sometimes abandon the relay action of the triode and employ the simple diode for frequency conversion, connecting the input circuit to the plate, so we may likewise abandon the relay action in a deflection-control system and use the anodes themselves for deflecting the electron streams. This is illustrated in Fig. 7, where the tube has only a single grid, for emission control, and the deflection-control voltage is impressed on the anodes through blocking condensers, the input and output circuits being in parallel. We may go further, omitting all control grids and impressing both control voltages on the anodes. If we use the unsymmetrical anode arrangement of Fig. 4 and 5, our tube will then have a cathode, a helical anode and a plate anode—in fact, it will be structurally the same as an ordinary triode, as represented in Fig. 8. In this figure the input and output circuits, for variety, are shown in series. To make up for the lesser effectiveness of the plate on the emission, more of the deflection-control voltage is impressed on it than on the helical anode (or grid), as indicated by the greater number of turns in its transformer secondary: this prevents the deflection-control voltage from affecting emission, as before. To provide a path for the alternating current between the anodes, a condenser is connected between the transformer secondaries. This current is thus bypassed from the emission-control circuit, where it might build up a voltage that would affect emission.

Frequency conversion is employed practically in the modulator of a transmitter, in the modulator of a superheterodyne receiver, and in the signal detector of a receiver. In all of these cases, a voltage having a single fixed frequency is combined with a signal voltage including a band of frequencies. To secure linear operation and thus avoid distortion, with the arrangements described above, it is preferable to use the signal voltage for deflection control and the fixed-frequency voltage for emission control. The essentially linear operation follows from the fact that the deflecting force on the electrons is directly proportional to the deflection-control voltage; and the proportion of the electrons deflected from one anode to the other will be nearly proportional to this voltage, up to the point at which the streams are completely deflected.

In a transmitter, the arrangement of Fig. 1, used as just described, gives an output with the carrier suppressed, such as is used for the

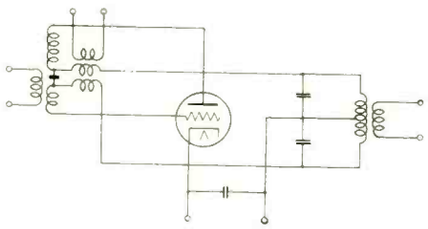


Fig. 8. Circuit with deflection tube similar to a conventional triode

quadrature modulated voltage in Armstrong's recently described frequency-modulation system. The arrangement of Fig. 4, however, includes the carrier, as in ordinary amplitude modulation.

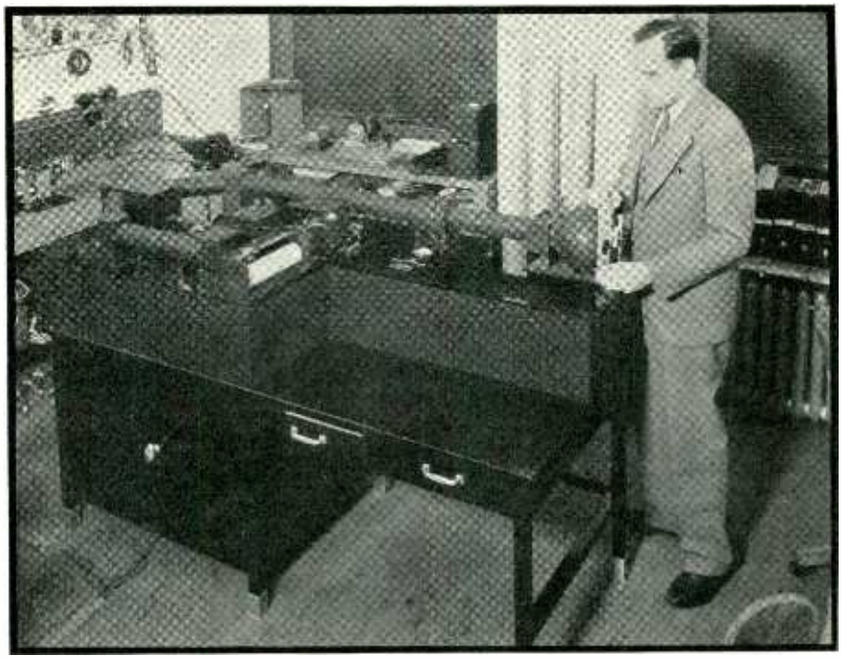
In a superheterodyne receiver used for frequency-modulated signals, the signal input to the modulator may be at such a high level as to completely deflect the electron streams from one anode to the other, thus giving the limiting action desired in the Armstrong system. When used for amplitude-modulated signals, the signal input should be at a sufficiently low level to give linear operation.

Tubes of the type here discussed may be used as signal detectors in two ways: (a) the signal carrier may be selected by sharply tuned circuits (employing crystals or regeneration) and used for the emission control; or (b) a local oscillation, synchronized with the signal carrier, may be used for emission control, giving homodyne, or zero-beat, detection. In either case, the emission-control voltage should be in phase with the carrier of the deflection-control voltage, so that the two side-bands of an amplitude-modulated signal will add in phase. When this phase relation exists, the signal carrier and the local oscillation will combine to give a maximum direct component of voltage, which can be used for automatic volume control.

Detectors having deflection control are particularly useful for signals which include only a single side-band; for there is absent the distortion inherent to the detection of such signals by an ordinary linear detector, consequent on the inequality of the intervals during which the signal voltage has one direction.

A special application of the present type of tube is in the automatic tuning control of a superheterodyne receiver. The tube is connected like the signal detector, except that its emission-control voltage is normally in *quadrature* with the carrier of the deflection-control voltage, so that their combination gives zero direct voltage. But when this phase relation is disturbed, a direct voltage will be produced in one direction or the other and can be led back to the preceding superheterodyne oscillator for correction purposes. If the emission control is obtained from the sharply selected carrier, this provides a correction of *frequency*; while if it is obtained from a local zero-beat oscillation, it will be *phase* that is corrected.

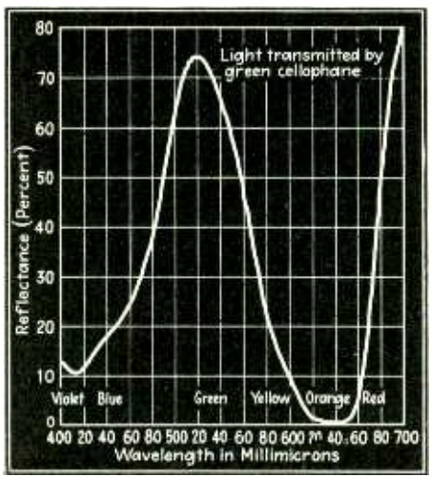
The preceding discussion does not exhaust the possibilities of deflection control. It may be attained in other ways and used for other purposes. For example, we may deflect the electron streams by a magnetic field, instead of an electrostatic field. And we may employ deflection control for frequency doubling, using the tube structure of Fig. 1, but connecting the two helical anodes together as one anode and arranging the shield as the second anode; the current to the shield will then be decreased by a deflection of the electron streams in either direction, so that it varies at twice the frequency of the deflection control. Perhaps enough has been said to suggest the wide range of application offered by deflection control.



The "photoelectric recording spectrophotometer" demonstrated by the General Electric Company at the A.A.A.S. meeting in St. Louis

Color Analyzer Plots Own Curve

The color reflection and transmission properties of any material can be analyzed by a machine which uses polarized light in conjunction with a single phototube, plots the complete spectral response in three minutes



A typical record produced by the color analyzer (the transmission properties of green cellophane)

PHOTOELECTRIC color analysis, by which the color reflecting and transmitting properties of any substance may be compared with standards or evaluated in absolute units, has become of great importance to all industries concerned with products whose color must be accurately controlled. Among the applications to which this technique has been put are cataloging the colors of different dyes, inks, and pigments, and also in controlling industrial processes such as the refining of sugar and lubrication oil. In the past four or five years several instruments for performing color analysis by means of photoelectric cells have been developed and announced to the public, but by far the most ambitious of them all is the one recently shown to the American Association for the Advancement of Science in St. Louis by the General Electric Company. This device, similar in all essential principles to that developed by Prof. A. C. Ilardy, of the Massachusetts Institute of Technology (See *Electronics* September, 1934, p. 285) is called a recording photoelectric spectrophotometer.

One of the unusual features of the device, and one essential to all accurate measurements of this type, is complete independence of the characteristics of the light source, amplifying circuits and photoelectric cell used. So long as these elements are in working order, variations in their characteristics do not effect the accuracy of the color analysis.

In operation, the material to be examined is placed in the instrument, the operation started, and in less than three minutes the machine prepares automatically a chart which shows exactly how much light of each wave length over the entire spectrum is transmitted or reflected by the sample. The curves thus obtained may be compared with the curves of a standard, and color correction made where necessary to make the sample agree with the standard. The extreme rapidity of the measurement makes it suitable for production control.

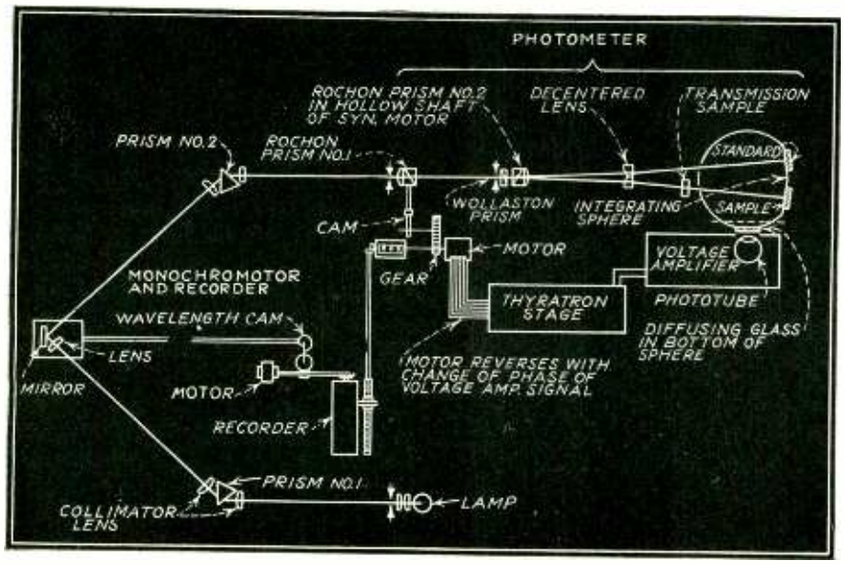
The schematic diagram of the instrument, showing the optical path

followed by the light from the original source lamp to the photoelectric amplifier is shown below. At the bottom of the diagram is the source lamp which provides ordinary incandescent white light. Two condenser lenses focus the output of this lamp upon the prism (marked No. 1) which separates the white light into the various spectrum colors, ranging from infra-red through the visible region to ultraviolet. From this prism the light, now separated into color bands, is directed to a mirror which reflects the spectrum to a second prism which still further disperses the colors so as to purify and make thoroughly monochromatic the light which then proceeds from the second prism to the photometer proper. The reflecting mirror between the two prisms is connected by a motor-driven gear and cam arrangement to the drum of the recorder. During the progress of the measurement the motor causes the mirror to be rotated slowly as the paper on the drum is revolved so that it presents to the recording pencil the proper coordinate corresponding to the color of the light being reflected by the mirror at that instant. In this manner the color of the light which leaves the second prism and enters the photometer always corresponds to the particular wave length indicated at that instant on the recording graph paper.

On leaving the second prism the monochromatic light enters a rochon prism which polarizes the light in two planes. This polarized light then goes to a second rochon prism which is mounted in the hollow shaft of a synchronous motor, rotating at a fixed speed. The second rochon prism acts as an analyzer for the polarized light, alternately permitting the polarized light to pass and extinguishing it, depending upon the angle of its rotation with respect to the first rochon prism. The light then passes through two decentered lenses and through two small openings into an integrating sphere. The object of the decentered lens system is to direct the light from the second rochon prism to a standard and a sample which are mounted in the side of the integrating sphere. By means of this arrangement the rotation of the second rochon prism serves to vary the light intensity of the incident beam on the sample and the standard from maximum to minimum, and in such a way that the light variation on the sample is out of phase with that on the standard. Also on the side of the integrating sphere is a small piece of frosted glass which is illuminated by the light in the integrating sphere. The brightness of the illumination on this frosted glass is a function of the product of beam intensity and reflectance for both the sample and standard.

A phototube of ordinary variety is used to view the ground glass surface. When the light reflected from the standard and the sample is not equal, an a-c component is present in the light output, and is thus translated into an alternating component in the phototube current. The phase of this alternating component with respect to the phase of the voltage supplied to the synchronous motor (which rotates the second rochon prism) depends on the relative reflectance of the sample and standard. The a-c component is amplified, applied to a thyratron power output stage, and finally to a balancing motor which is geared to the first rochon prism. This motor revolves until the first rochon prism has rotated through a sufficient angle to redistribute the light equally between the standard and the sample. The degree of rotation required is of course a measure of the photometric properties of the sample compared with those of the standard, i.e., the reflecting characteristic actually desired. By means of transferring the motion of the balancing motor to a geared pencil whose point rests on the recording drum, the degree of reflection for each individual wave length is thus automatically recorded.

When tests must be made of the color transmission (rather than reflection) of a sample the transmission sample is placed between the integrating sphere and the decentered lenses as shown. In this case the sample is made of the same material as the standard. The standard usually used is a "pure white" specimen of magnesium carbonate.



Schematic diagram of the automatic recording color analyzer, described in the text

Independent of Circuit Characteristics

Since the light which falls on the sample and the standard is derived from the same source, the strength and spectral range of the source lamp does not effect the measurements, so long as there is sufficient illumination at any desired wave length to actuate the photocell circuit. The phototube measures only monochromatic light, at any one instant, and hence the measurement is independent of the spectral response of the phototube. Likewise the voltage amplifier and thyratron-tube amplify the current due to light from both the standard and the sample equally, hence the characteristics of amplifier units do not affect the measurements.

The "Plate Circuit Theorem"

An application of the fact, known to all students of vacuum tubes, that a voltage on the grid e_g, is equivalent to μe_g in the plate circuit

By WALTHER RICHTER
A. O. Smith Corporation
Milwaukee

PROBABLY the most helpful conception in the analysis and design of circuits containing vacuum tubes is the well known relation that the application of a voltage e_g on the grid is equivalent to the introduction of a voltage $\mu\ e_g$ in the plate circuit, where μ is the amplification factor and is defined as

$$\mu = -\frac{\Delta e_p}{\Delta e_g} \quad \text{for } i_p = \text{constant.}$$

The proof for this statement is usually a purely mathematical one, and can be derived in several ways, the mathematical result then being interpreted in the above stated manner.

Mathematicians state that there are some 200 ways to prove Pythagoras' theorem, many of them probably having particular advantages. The addition of another proof of the equivalent plate circuit theorem may therefore be not entirely without value. It might be stated that the following treatment, giving the desired conception by observing the physical behavior of the tube, rather than by interpretation of the solution of a differential equation, might be preferred by those who like to solve their problems from a physicist's rather than from a mathematician's point of view; it has the added advantage that the basic conception needed for the proof of the theorem, is also very helpful in the solution of d-c amplifier problems, as will be shown on an example treating a Wheatstone bridge containing a tube in one arm of the bridge; for this problem the usual form of the equivalent plate circuit theorem is of no help.

What's in the Box?

If an electrical engineer were asked to determine the contents of a box with two terminals, without opening it, he would, after inquiring as to the maximum voltage and current permissible on the terminals, probably proceed to take the "volt-ampere" characteristic by an arrangement like that shown in Fig. 1, which is simply a means of applying a variable voltage to the apparatus connected at X and noting the current it takes. Attention should be called to the polarity of the meters: If, connected as shown, both meters give positive deflections, the apparatus at X acts like a resistance, or consumes energy; if on the other hand the ammeter gives a reversed deflection, (or indicates a negative current), there is a current or energy-source at X. If the measurement is made with a-c, oscillograph elements should be used in place of the meters.

Now assume that our hypothetical box would furnish the following voltage and current values:

e	i
200	10 ma
150	5 ma
100	0 ma
50	— 5 ma
0	—10 ma

which are plotted in Fig. 3.

Since the current is zero at 100 volts there must obviously be a battery of 100 volts in the box, bucking the voltage applied from the outside; furthermore since a 100 volt change produces a 10 ma current change, there must also be a 10,000 ohm resistor in it. Whatever may be actually in the box we would certainly be justified in stating that it acts exactly like a battery of 100 volts with a resistance of 10,000 ohms in series with it, as shown in Fig. 2. The reader will easily convince himself that the arrangement shown in Fig. 2 will give a volt-ampere characteristic completely coinciding with the one measured and plotted in Fig. 3.

Now assume that another box was handed to us, giving the volt-ampere curve shown to the right in Fig. 4, which coincides with the one in Fig. 3 between approximately 120 and 200 volts.

There obviously is no such simple arrangement in it, as before, but if the prospective user told us that he intended to use it only between the above stated limits of voltage, we nevertheless could state that for the purpose of analysis and design a battery of 100 volts and a resistance of 10,000 ohms can be substituted for it in any circuit, as long as the operation of this circuit does not cause the voltage to go beyond the above limits.

Our curiosity getting the best of us we open the box and find that the two terminals lead to the plate and cathode of a vacuum tube; the grid being held negative with respect to the cathode by a battery of e_g volts. Within the above voltage limitations we can therefore substitute for the tube a resistance of 10,000 ohms and a battery of 100 volts. From the definition of the plate resistance, sometimes also called the dynamic resistance as $\frac{\Delta e_p}{\Delta i_p}$ for e_g = constant, it is obvious that this substitute resistance, obtained as it was by dividing the plate voltage change by the plate current change, is identical with the plate resistance as given by the manufacturer.

Now let us change the grid voltage a small amount Δe_g, say 0.5 volt in such a way as to make the grid less negative, which is equivalent to introducing into the grid circuit $+\frac{1}{2}$ volt, superimposed on the existing bias. When repeating our previous measurements we obtain a new plate characteristic displaced against the

first one toward the left, as shown in Fig. 4. Our tube is now equivalent to a battery of 90 volts and a resistance of 10,000 ohms. This decrease from 100 volts to 90 volts of the fictitious battery could also be thought to be the result of introducing a battery or generator of —10 volts in series with the 100 volt battery. The introduction of $+\frac{1}{2}$ volt in the grid circuit is therefore entirely equivalent to introducing —10 volts in the plate circuit, and all that must be proven yet, is that the ratio of these two values is equal the amplication factor. The latter is defined mathematically as $-\frac{\Delta e_p}{\Delta e_g}$ for i_p = constant or physically as the negative ratio of the plate voltage change necessary to offset the effect of a grid voltage change on the plate current, to this grid voltage change. Referring to Fig. 2 a grid voltage change of $+\frac{1}{2}$ volt was equivalent to diminishing the battery by 10 volts. If we wish to keep the current through the tube constant, it is obviously necessary to drop the applied voltage by exactly the same amount. The amplification factor of this particular tube is therefore $\left(-\frac{-10}{.5}\right) = 20$, which proves our equivalent plate circuit theorem. Incidentally for the solution of more complicated problems it is essential to have a clear picture of the polarity of these voltages, something usually neglected; the introduction of $+ e_g$ on the grid is equivalent to $-\mu e_g$ in the plate circuit, both voltages to be measured from the cathode. (That the signs are correct is obvious when considering the phase reversal taking place in a tube.)

Application to the Wheatstone Bridge

When it is desired to use a vacuum tube for the detection of small d-c voltage changes applied to the grid, it is customary to have a compensating or bucking arrangement in the plate circuit; one of many possible variations is shown in Fig. 5; when the plate current is such that it produces a voltage drop across R_1 equal to the voltage of the bucking battery E_d, no current will flow through the galvanometer; but a change in the plate current will practically all flow through the instrument. Instead of obtaining the bucking voltage E_d from a battery, a voltage divider suggests itself, as shown in Fig. 6. This arrangement is obviously nothing but a Wheatstone bridge with resistance R_2 replaced by a tube. If a sensitive galvanometer is used as indicating instrument, it is found that small changes in the plate supply voltage E_b cause the galvanometer to deflect, which is undesirable. Replacing now the tube by our newly found substitution, that is, a resistance and battery in series, we obtain Fig. 7. This picture shows at once why a balance independent of changes in E_b cannot be had. To obtain such a balance, R_1/R_p would have to be equal to R_2/R_4; but if we choose the ratio of these resistances equal, then due to the presence of E_f points A and B would not be at the same potential, and upon connecting them over an instrument, a current would result. The arrangement first given by Wynn-Williams avoids this dilemma by using a tube in place of

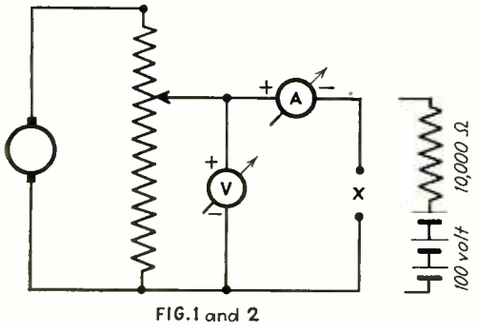


FIG. 1 and 2

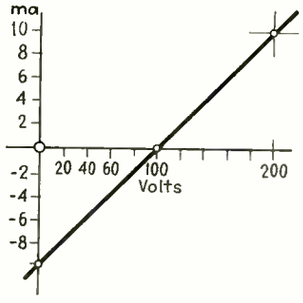


FIG. 3

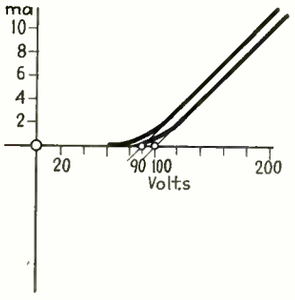


FIG. 4

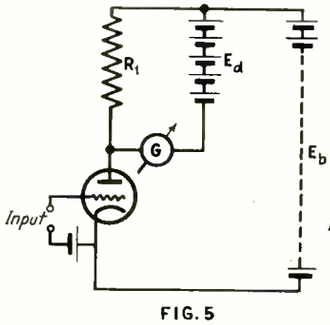


FIG. 5

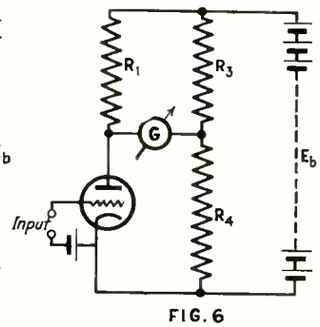


FIG. 6

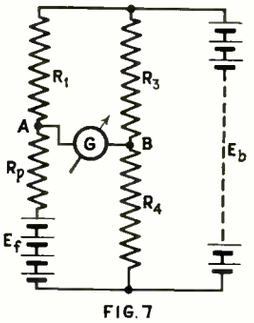


FIG. 7

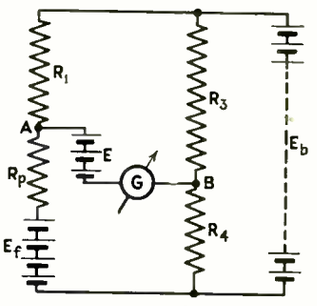


FIG. 8

Given a box with two terminals, an engineer would determine its E-I characteristic as in Figs. 1-3 deciding that Fig. 3 represented Fig. 1 and 2. But given Fig. 4, the problem would not be so simple. Mr. Richter shows how the plate circuit theorum can be applied practically to a bridge circuit with a vacuum tube in one arm—or to other circuits

R_4, which necessitates the finding of two tubes with identical R_p. Another possibility would be to introduce a battery E_f in series with R_4; but there it would be subjected to a charging current flowing through R_3 and R_4, which would be liable to cause voltage variations in it. A better solution is to introduce into the branch A B a battery E with a voltage equal to the potential difference between these points; zero current through the galvanometer will then result, even with the ratios R_1/R_p and R_3/R_4 equal. With the circuit as shown in Fig. 8 a balance independent of small voltage changes of E_b is therefore obtainable. The necessary voltage E can easily be calculated, since it is the difference between the potentials of points A and B; we have

$$E = E_f + \frac{(E_b - E_f) \times R_p}{R_p + R_1} - \frac{E_b \times R_4}{(R_3 + R_4)} \quad (1)$$

Since $R_1/R_p = R_3/R_4$ to obtain balance, we also have

$$\frac{R_p}{R_p + R_1} = \frac{R_4}{R_3 + R_4} \quad (2)$$

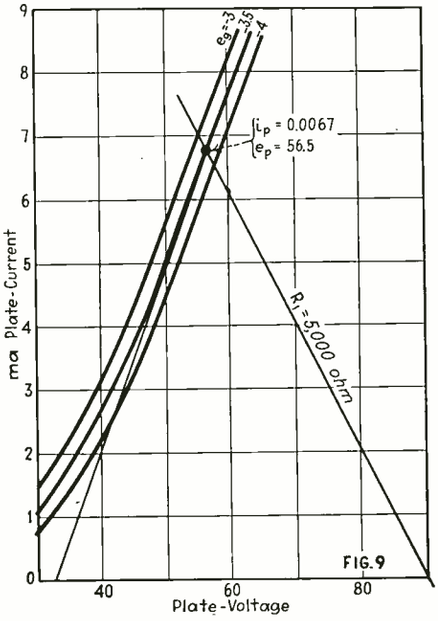
Introducing this into (1) it reduces to

$$E = E_f \times \frac{R_1}{R_p + R_1} \quad (3)$$

A Practical Example

The plate voltage-plate current curves of a 49 type tube in triode connection (Grid No. 2 connected to plate) were obtained and are plotted in Fig. 9. It was decided to operate the tube with a 5000 ohm load across 90 volts, which load line is drawn in Fig. 9. At 3.5 volts negative grid bias, as shown, the tube is equivalent to a battery of 32 volts and a resistance of $\frac{\Delta e}{\Delta i} = \frac{56.5 - 32}{.0067}$ = 3660 ohms. According to (3) we need then a battery of $E = 32 \times \frac{5000}{5000 + 3660} = 18.5$ volts between points A and B. We avoid the use of a potentiometer by choosing 18 volts (as a multiple of 1.5). Exact balance can always be obtained by changing the grid bias slightly, the latter being obtained from a source with higher current capacity and better stability.

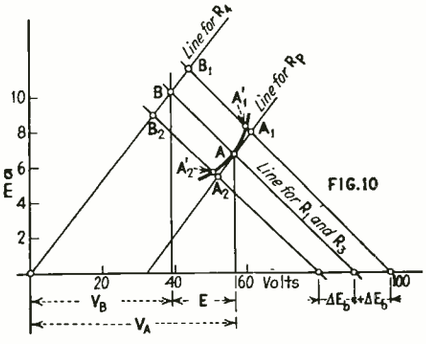
The circuit as shown in Fig. 8 was then set up with $R_1 = R_3 = 5000$ ohm and $R_4 = 3660$ ohm. The final adjustment of the circuit is then obtained as follows: Obtain zero current in the instrument by changing the grid bias; then change E_b by a small amount (about 2 volts) and observe the amount and direction of the galvanometer deflection. Bring E_b back to 90 volts and change R_4 by about 100 ohms, bringing the galvanometer current back to zero by



A 49 type tube connected as a triode provides a practical example of using the circuit of Fig. 8

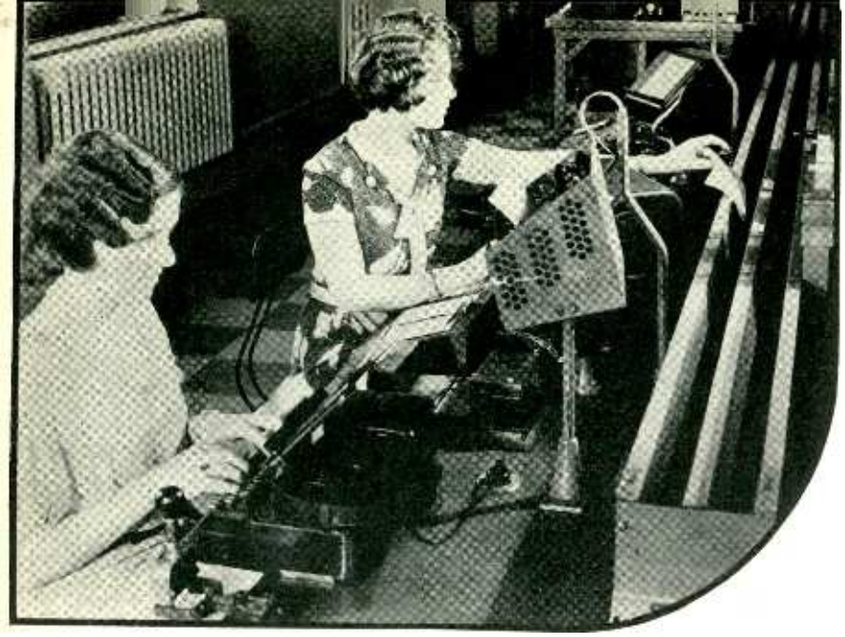
adjustment of the grid bias; observe again what effect a small change of E_b has. By successive adjustments of R_4 a point finally is reached where a decrease *or* increase of E_b causes a small deflection of the galvanometer in the *same* direction. This change cannot be eliminated since it is due to the curvature of the characteristic. However, the circuit is then stable enough for most laboratory measurements. In the particular set-up described above final equilibrium was reached with $R_4 = 3770$ ohms. A 5-volt increase or decrease of the 90 volt battery—obviously much more than will ever be encountered even if power is obtained from a rectifier system—caused a deflection of 1.5 microamperes. For comparison the battery E was left out and the circuit as shown in Fig. 6 was used. Balance was then obtained with $R_4 = 8546$ ohms, but now a change of only 1.2 volts of the B—supply caused a current of 24 microamperes through the instrument. In both cases a 50 millivolt grid-change caused a deflection of 15 microamperes.

It may be of interest yet to explain why in the case of exact balance the galvanometer deflects in the same direction no matter whether E_b is increased or decreased. In Fig. 10 a part of the plate characteristic is shown with an exaggerated curvature, to make this clear. In this figure the characteristics for R_3 and R_4 are also drawn in; the abscissa of the intersection B for R_3 and R_4 gives the potential V_B of point B, while the abscissa of the intersection A of the line for R_1 (coinciding with R_3) and the tube characteristic gives the potential V_A of point A; the difference E between these two potentials is the battery needed for zero current. If the plate supply E_b changes now by $\pm\Delta E_b$, the intersection B changes to B_1 and B_2 respectively; if the tube characteristic were a straight line, A would change to A_1 and A_2 and since for balance $R_4 = R_p$, the lines for these resistances are parallel so that the potential difference E between points A and B would remain constant, causing the galvanometer to remain at zero deflection. However, due to the curvature the actual inter-



Explaining why the galvanometer of Fig. 8 deflects in the same direction whether E_b is increased or decreased

sections with the tube characteristic are A'_1 and A'_2. The abscissae of these points minus the abscissae of points B_1 and B_2 are both less than E, causing the galvanometer to deflect in the same direction for both an increase or decrease in E_b. Incidentally this phenomenon may serve as a method of determining the curvature of the tube characteristic if the latter is desired accurately.

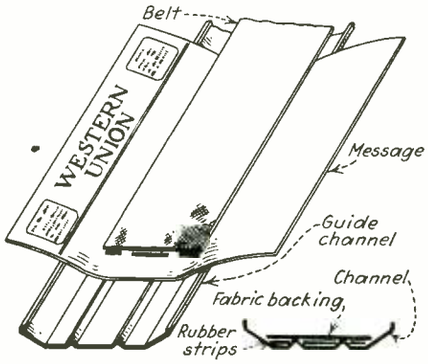


Operating table conveyor. At 60 Hudson Street, New York, there are 3 miles of belts carrying messages among 5 floors

By PHILIP C. BENNETT

"Electric-eyeing" Telegrams

How Western Union uses phototubes to give an alarm when a message strays from the straight and narrow path—and to measure belt transmitting efficiency



Drag conveyor

PRACTICAL uses of the popularly termed "electric eye" are so numerous and diverse that almost any function can be expected from it in some form.

The tube is almost instantaneous in action; it is accurate and safe. Western Union uses these characteristics in the business of telegraph service in four very practical developments in its central office at 60 Hudson Street in New York City.

Here is an office which accepts and dispatches over a million messages a week. It is necessary to have an expeditious way of transporting the messages from the receiving positions to other parts of the building where they are transmitted. The network of belt conveyors meets this need.

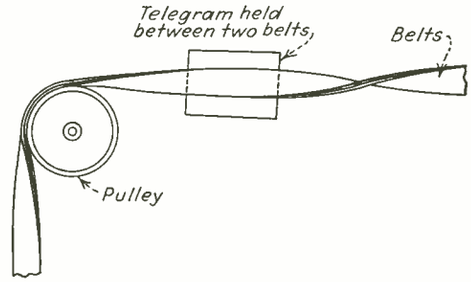
Phototubes are located at various points on the three miles of belt conveyor for the physical transfer of messages which the company employs on five floors of the central office. They are used to eliminate time delay. But before describing the instruments and their functions it is necessary to get a picture of the conveyor system.

A telegram is filed, either by messenger, automatic telegraph typewriter in a private office, over the counter of a telegraph branch office, or by telephone. An operator in the central office receives it and immediately places it upon the operating table belt.

The operating table belt discharges the telegram on a fast "pick up" belt which runs past its discharge end. The pick up belt makes its long journey to another part of the room, or to another floor, and delivers the message to a slow moving wide flat belt at one of the two distributing centers in the system. Here, a sorting clerk reads the address on the telegram, to know to what transmitting point it must be sent, and reroutes it on one of the 14 local "routing" belts, or on one of the 14 trunk "routing" belts. The belt troughs are painted different colors to help the clerks transfer messages quickly.

The message is again picked up by a fast moving belt at the discharge end of the table belt. It spins overhead and around rooms and arrives at the sending operator's station within a few seconds. For all of these operations approximately a minute is used. Often messages come through from the receiving to the sending points in half a minute, which means that no time may be lost anywhere on the belts.

It will make for a clearer understanding of the electron tube instruments if the belts are described first.



An operating table conveyor is known as a V-belt. It consists of a 1¾ inch wide combination fabric-rubber belt running in the flared out bottom of a V-shaped trough. This carries telegrams in an upright position. The trough is smooth inside and presents an unbroken surface, making it impossible for the edge of a telegram to get underneath the belt and become torn or delayed. This type of conveyor is run at speeds up to 500 feet per minute, and is particularly useful at distributing centers, for its compactness.

A "drag" conveyor consists of a 1¾ inch belt having a fabric backing with three longitudinal rubber strips fastened to it. The belt travels along a shallow steel trough of three channels, to avoid contact with the rubber, and two ridges for the fabric. The rubber grips the message, holding it by friction, as the fabric backing slides along the ridges smoothly, and the message skims along the very smooth surfaced trough uninterrupted. The drag conveyor readily runs from one level to another and turns corners. It travels at speeds up to 1,000 feet per minute.

Recently a twist belt conveyor for overhead runs was developed, in which the message is carried between two adjacent belts twisted together. It does not use supports between rollers, corners and turns, and can go without sagging for as much as 50 feet between intermediate supports. It transports messages at speeds up to 1,200 feet per minute.

Over 400 of these different individual belts are used. Critical points are where those of different speeds and sizes cross each other to pick up or drop off messages. It is here that the phototubes are placed to detect trouble. Rarely, however, do messages get seriously delayed, because the belts are so well designed.

One tube is located across a narrow chute where a V-type conveyor unloads a message to a faster belt. A beam of light passes through two small holes in the steel sides of the chute. The light shines on a mirror on the other side and is reflected back to the photo tube circuit which is timed for a delay of eight seconds. The ordinary passage of the message takes only a fraction of a second.

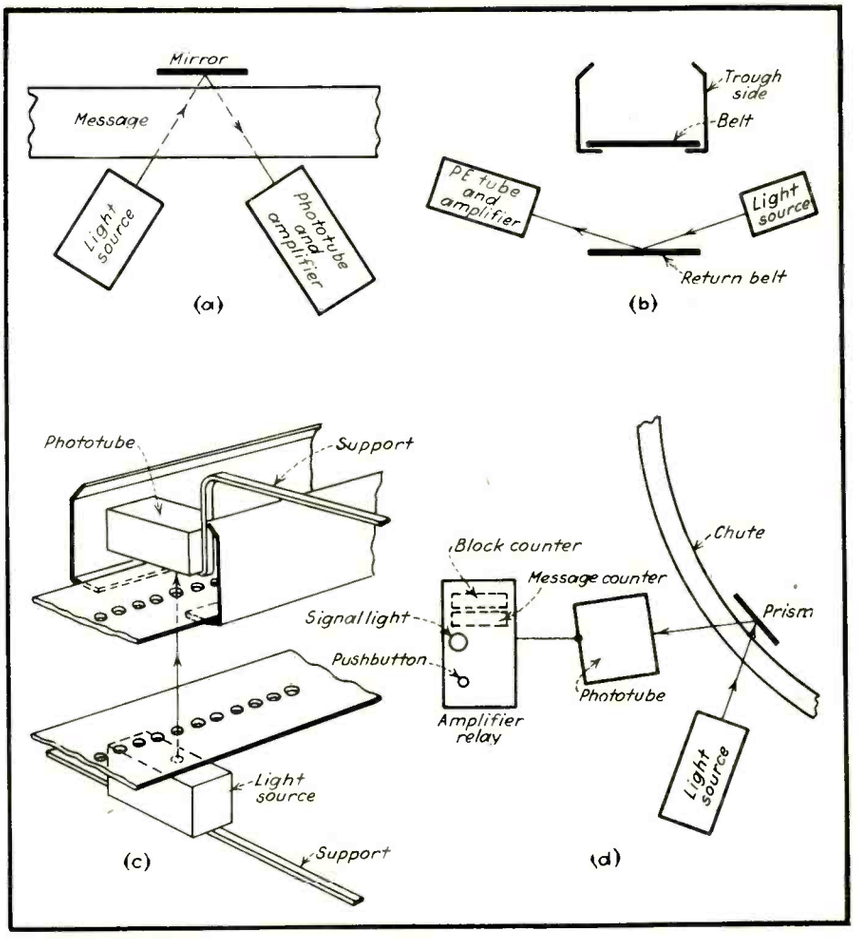
When the beam of light breaks for more than eight seconds, the photo tube amplifier gives an alarm simultaneously on a buzzer and a red electric light bulb.

Another place where messages might be delayed, and where it is important to have protection, is between the top belt of a wide flat conveyor and the return, or bottom, side of it. Here a light beam shines at an angle on the belt surface and is reflected to a photocell unit on the other side. The reflection of the light across the dull gray surface is steady, and the tube is sensitive to any increase above that. If a message happens to circulate to the return side of the belt its bright surface momentarily increases the reflection of the light beam to operate a signal.

The increase in light reflection varies with the different colors of the telegrams, blue being the poorest reflecting color. The circuit is adjusted so that an increase in current of seven ma. will trip the relay. This provides for all colors. The relay is arranged with a locking circuit for the signal to stay on until released through the push button by an attendant. The belt is stopped temporarily and the message removed.

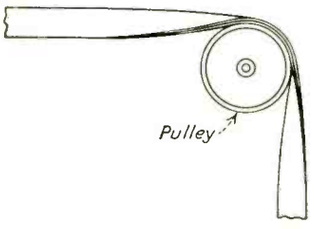
Another phototube is used to detect messages between flat belts, such as at the tail end of a belt where messages should not be. The surface of each belt is perforated with evenly spaced holes. The light

[*Continued on page 34*]



A and B—Light beams are projected through a belt—or across its surface. C—If the rate at which beam is interrupted decreases, an alarm sounds. D—How the phototube measures the ratio between messages successfully transmitted to those that stuck temporarily

Twist conveyor



A Two-way Horn System

. . . . . for theaters but with potential applications to public address systems and home radio. Highly efficient, wide range, low distortion

By JOHN K. HILLIARD
Transmission Engineer
M.G.M. Sound Dept.
Culver City, Calif.

THE art of modern reproduction of sound in motion picture theatres is now about eight years old. During this time there has been considerable improvement, but there has been only one major change in the standard theatre installation. This change was the adoption of the Wide-Range[1] and High-Fidelity systems after 1933. The principal modifications involved were: First, a partial fulfillment of greatly needed increase in amplifier carrying capacity; second, the adoption of speaker systems which provided for the division of power between two or more groups of speakers, each operating over a limited frequency range; third, improvements in the sound head which reduced flutter. While these improvements considerably raised the standard of reproduction in the theatre, it was felt that the loud speaker system still constituted the principal limitation to naturalness of reproduction. An investigation was accordingly made to determine whether a speaker system could be developed which would economically replace the present systems while providing the much needed increase in fidelity. This was found to be the case, and it is the purpose of the present paper to describe this system and the results obtained with it, and to compare it with previous systems.

Since it was not known how great a departure from a full range linear response could be tolerated for the purpose in hand, it was considered advisable to start with a system as near this as so far achieved even though the form of apparatus available by its size and cost would prohibit its use for theatre installations. From this it was determinable how much deviation was allowable and necessary to obtain a commercially practical system. Such a linear system was made available[2], and a series of tests led to the following specifications which were found to be adequate for theatre reproduction.

Frequency Characteristic. The system shall not deviate by more than plus or minus 2 db, from 50 to 8000 cycles over the entire angle of distribution within ten feet of the mouth of the horn.

High Electro-Accoustical Efficiency. It shall approach fifty per cent so that the required amplifier capacity may not be too great.

Volume Range. The volume range shall be at least 50 db and preferably 60 db.

Reasonable Cost.

Absence of Transient Distortion and "Fuzziness." The electro-acoustical transducer shall be of such construction that it shall not generate objectionable harmonics up to the peak power required, and the phase delay between units shall be such that the sound will be equivalent to that coming from a single source.

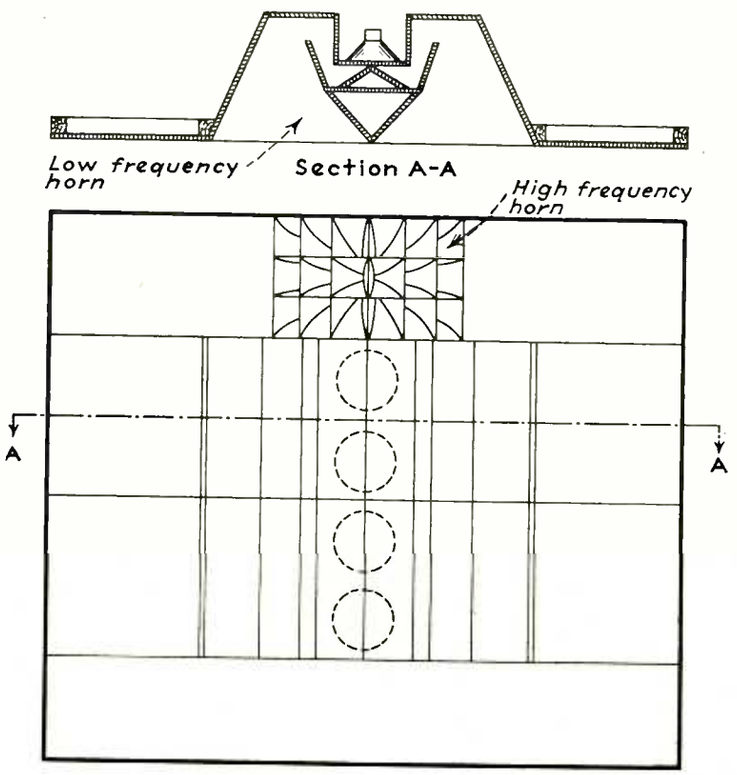
Suitable Angular Distribution Characteristics. The sound shall be radiated through a horizontal angle as great as 110 degrees and a vertical angle of 60 degrees with nearly uniform response at all positions.

Reasonable Compactness and Portability. Low weight.

The installed amplifier capacity shall be such that one acoustic watt per one thousand square feet of floor area can be delivered when the auditorium is adjusted for optimum reverberation time.

A system which will conform to or exceed these specifications has now been developed, and can be constructed at moderate expense.

To take advantage of these characteristics it has been found that



when film is reproduced over a system such as this, it is necessary to keep the flutter from the sound head no greater than 0.1 per cent. Although the problem of flutter has been satisfactorily solved, and heads are commercially available which will pass the 0.1 per cent flutter specification, it should be pointed out that by far the largest majority of heads in use today will not meet this specification.

Power and Frequency Requirements

The history of the electrical reproduction of sound has been one of continual increase in amplifier carrying capacity, and in this respect, the theatre installation is no exception[3]. Originally, output powers from 2.5 to 12 watts were considered adequate for most houses. With the advent of the later systems now in use, these powers were recommended to be increased from 3 to 6 db. It has been found from this investigation that it is both practical and eminently desirable to make a further increase of at least the same amount. The figure given of one acoustic watt per one thousand square feet of floor area is felt to be the minimum which will do justice to the advanced conception of reproduction with modern recording technique.

The advisability of extending the frequency range of a reproducing system must be determined by balancing the gain in naturalness against the resulting increase in noise and extraneous sounds. At present a characteristic flat to 6,000 cycles is the least that will do justice to the film; an extension to 7,000 or even 8,000 cycles is advisable, and a further extension is not. Further extension becomes of less and less value, due to the decreasing sensitivity of the ear and the small amount of energy in this region, and especially because above 8,000 cycles, noise, flutter and harmonics due to recording deficiencies becomes decidedly the limiting factor. Incidentally, since practically all recording systems include a low pass filter with a cut-off in the neighborhood of 8,000 cycles, there is nothing on the film at high frequencies to be reproduced.

Once the high frequency limit is chosen, the low frequency limit is automatically fixed. It has been found that for ideal balance the product of the two cut-off frequencies must be fairly close to 400,000, so that for an 8,000 cycle upper cut-off, the lower becomes 50 cycles.

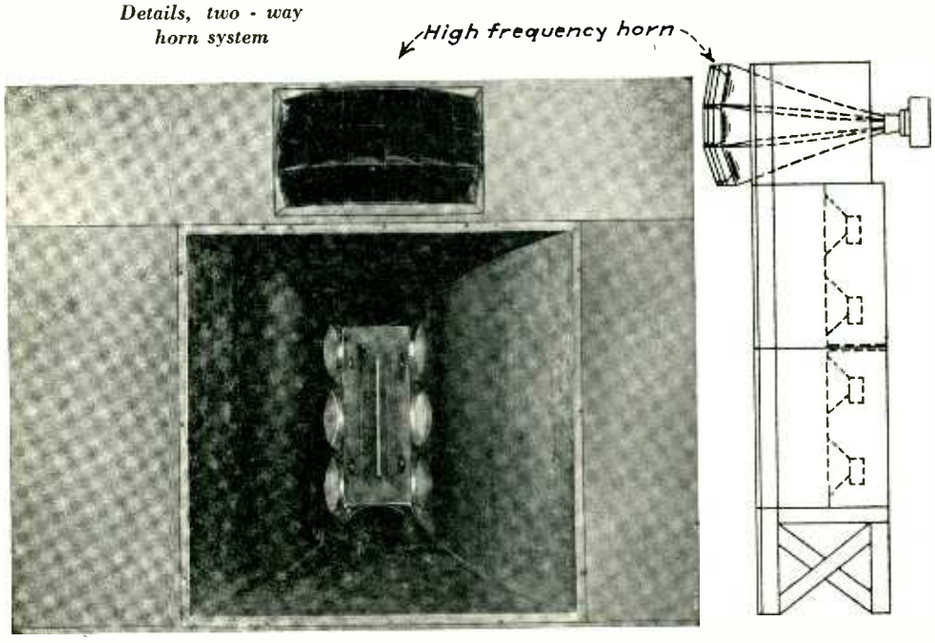
High Frequency Horn

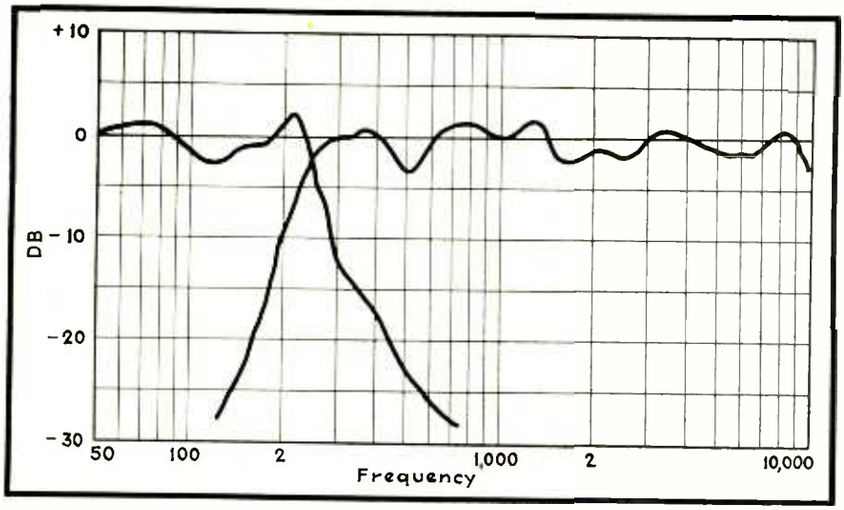
One of the principal limitations of present theatre installations is bad directional characteristics. The plain exponential horn has a directivity which varies with frequency; low frequency sound is projected fairly uniformly over a wide angle, but as the frequency is increased this angle decreases rapidly until at frequencies of several thousand cycles practically all of the energy is emitted in a narrow beam. The result of this is that the reproduction becomes very "drummy" or "bassy" for that portion of the audience whose seats lie well off the axis, while the opposite is true for seats located directly on the axis. In the present system this effect is eliminated by using a radiating system for the high frequency unit which is composed of a cluster of small exponential horns, each having a mouth opening of approximately sixty square inches. These individual units are stacked in layers to form a large horn, the mouth opening of which is spherical in shape. The principle of this high frequency unit can best be likened to a further compacting of the typical cluster of loud speakers, as customarily used in auditoriums and stadiums for public address systems and announcing, except that the whole array is fed from a common header and driven by two dynamic units. This type of high frequency radiation is also a feature of the aforementioned reference system[2]. However, the reference horn having been developed to a very limited angle and being driven by a single mechanism, was not adaptable to theatre use as more than one horn became necessary for full coverage. This would result in non-uniform distribution as well as complete loss of coverage for a large part of the auditorium should one unit fail during a performance.

One of the features of the reference system is the use of a single diaphragm to reduce phase distortion. In as much as theatres require parallel operation as protection in the case of failure of one unit, experiments were made with a Y throat and two units. As a result of these experiments, it is now recognized that any increase in phase distortion which may be introduced by the Y throat is negligible.

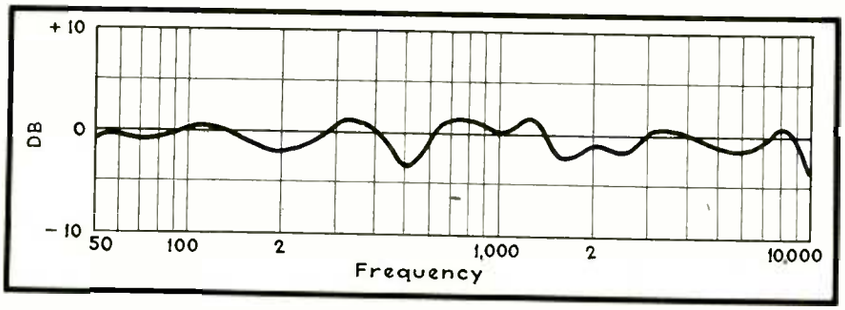
The diaphragms are made of duraluminum .002 inches thick and have an area of six square inches. The diaphragm is mounted on the back of the assembly and by the use of an annular opening[2], the sound that is admitted to the throat within the unit has a minimum phase distortion. This is still further reduced by having this throat exponential beginning at the annular opening and avoids a sharp discontinuity that may exist with a tubular throat. Two units are connected by means of a Y throat to the multi-channel horn which tends to reduce the distortion

Details, two - way horn system





Acoustic breakdown analysis—250 cycle crossover



Output characteristics measured on normal axis 10 feet from horn

of high throat pressure. The field excitation requires twenty-five watts per unit.

The directional characteristics of the resulting unit are very satisfactory as found in theatre installations. It should perhaps be emphasized that lack of good distribution can not be corrected by equalization in the electrical circuits, since for any given adjustment, the overall response is a highly varying function of position in the house. Although the characteristic can be made flat for any given position, it can not be made so for all or even a large part of the house by this method.

Directivity

For both the low and the high frequency units a certain amount of directivity is desirable. For most houses there should be but little energy radiated at angles greater than about forty-five degrees from the axis, since such energy will be reflected from the walls, and since for the best illusion the ratio of direct to reflected sound must be high.

There is one additional consideration with regard to directivity. Dr. V. O. Knudsen[4] has shown that at the higher frequencies, e.g., at 10,000 cycles, absorption of the atmosphere may become very serious, being as great as 0.2 db per foot under certain conditions of humidity and temperature. In large and deep houses this would result in a serious loss of high frequencies in the rear seats. This effect can be considerably reduced by increasing the high frequency radiated from those horns of the unit which serve these seats. It may be done by putting a suitable amount of absorbing material in the other horns and re-equalizing to bring the overall response up to standard for the front seats. These artifices will probably not be required in most houses.

Harmonic Considerations

One major defect of commercial loud speakers is their large amplitude distortion. One of the striking improvements in the new system is its cleanness of reproductions at low frequencies. The measured harmonic content is less than four per cent at 40 cycles for 30 watts output. This is due in large part to the use of a thick and comparatively soft cone which can be driven to full excursion without breaking up into separate zones and consequent harmonic production. It was found by actual listening tests that with a pure tone of forty cycles impressed, most of the cone speakers investigated gave a greater apparent loudness than the speaker finally adopted. However, when a direct comparison was made by keying the amplifier from the new unit to the unit under test, it was at once obvious that the output of the new one was fairly pure forty cycle tone, while that of the other speakers consisted of, in most cases entirely, the second and higher harmonics. Direct measurement of the acoustic output showed that in spite of its low apparent loudness, the fairly pure output of forty cycles was actually about 6 db higher than that of the other speakers.

Phasing

Another important advantage of the new system is that it can easily be made to fulfill the requirements that the virtual sources of all the components of the reproduced sound shall coincide in vertical plane. This condition is impossible to obtain with divided frequency range systems now in use in which the axial length of the several types of horns in a given system are widely different. In this respect, a two unit system is much easier of adjustment than a three-way system[1]. It might be thought that since the time delay is so small, of the order of a few milliseconds, the effect would be inappreciable. This is true for certain types of sound such as sustained music pasages, but on dialog and especially certain types of sound effects which are of the nature of short pulses, a very objectionable distortion is usually noticeable. A striking demonstration of this fact was obtained by recording a tap dance. When this was reproduced it was found that the system with a very small time delay gave a naturalness of reproduction, but that systems which had an appreciable delay reproduced the scene with far less realism.

This effect sounds somewhat like that of transient distortion due to the use of a filter with too sharp a cut off, but it is actually more analogous to the echo effect often observed on long lines and with certain types of phase distortion networks.

It should be pointed out that the overall frequency response curve of

the system should not fall off too rapidly beyond the cut-off frequencies, or objectionable transient distortion will result. Probably the maximum slope that can be tolerated is of the order of 20 db per octave, or roughly, that of a single section constant-k filter.

Dividing Network

The frequency chosen for the critical frequency of the dividing network is governed by several factors. If this frequency is too low, it leads to uneconomically large values of capacity in the network, and to impracticably large horns for the high frequency unit. If too high, there is danger of running into the characteristic dip which seems to be always present in large cones, and also, it would result in dividing the prime energy of speech sounds between the two units, which is objectionable from the standpoint of good presence. If the critical frequency is chosen as approximately 250 cycles, a good compromise results.

A dividing network was chosen which gave fairly rapid attenuation, 12 db per octave, in order to keep any appreciable low frequency energy out of the high frequency unit, and to minimize the effect of irregularities encountered in the response-curve above the designed range of the low frequency cones. This lies somewhat above 400 cycles for an efficient low frequency unit.

Low Frequency Horn

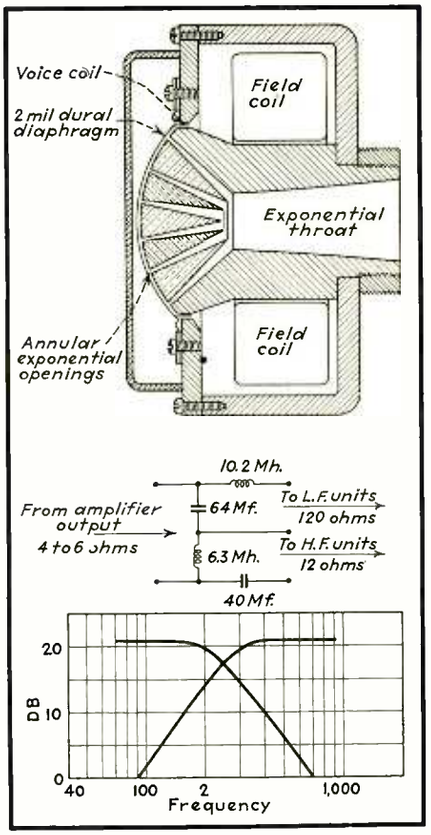
In the case of a low frequency unit, a suitable driving mechanism was not available, and it became necessary to develop one. The unit finally adopted consisted essentially of an exponential horn with a mouth area of fifty square feet, and an axial length of forty inches, driven by four fifteen inch dynamic units of special design. The mouth opening was extended laterally to form a flat baffle 10 ft. x 12 ft. The paper cones are dipped with lacquer to prevent them from absorbing moisture, which would vary their response. They are connected in series-parallel to give a desirable impedance characteristic as well as to provide insurance against complete failure of the system in the event any individual unit would fail. The angle of distribution is uniform through an arc of fifty degrees on each side of the axis. The use of a horn instead of a flat baffle board for low frequencies has several advantages. The efficiency is raised from ten or fifteen per cent to better than fifty per cent which effects an enormous reduction in amplifier capacity. Undesirable radiation from the rear of the unit is considerably reduced and as a result the usual objectionable back stage low frequency "hangover" is decreased to a negligible amount[1]. For purposes of further compactness and rigidity the low frequency horn may advantageously be folded and in this form retains the same characteristic, if the air path length be maintained unchanged. This modification was contributed by Dr. H. F. Olson of RCA Manufacturing Co. The loading provided by the air column of the horn decreases the excursion of the diaphragms as compared to the excursion necessary to produce equivalent output from a flat baffle array, and distortion is correspondingly reduced.

With the low frequency horn length maintained approximately equivalent to the length of the high frequency horn, there is no time delay between the component sounds from the two horns.

While it is recognized that indoor response measurements do not have the degree of precision that may be had in free space, they nevertheless do represent conditions under which the loud speakers must actually be used for motion pictures. Also, for the purpose at hand, comparative measurements are sufficient and were verified by listening tests, which in the end is the final criterion.

Irregularities in the sound pressure at the microphone due to standing wave patterns in the room are minimized by the use of a conventional warble frequency, varying plus and minus twenty-five cycles at a ten cycle rate. Tests have been run which indicate that the warble is only effective below 2,000 cycles. Above this point, the standing waves do not interfere with the correct interpretation of the response curve.

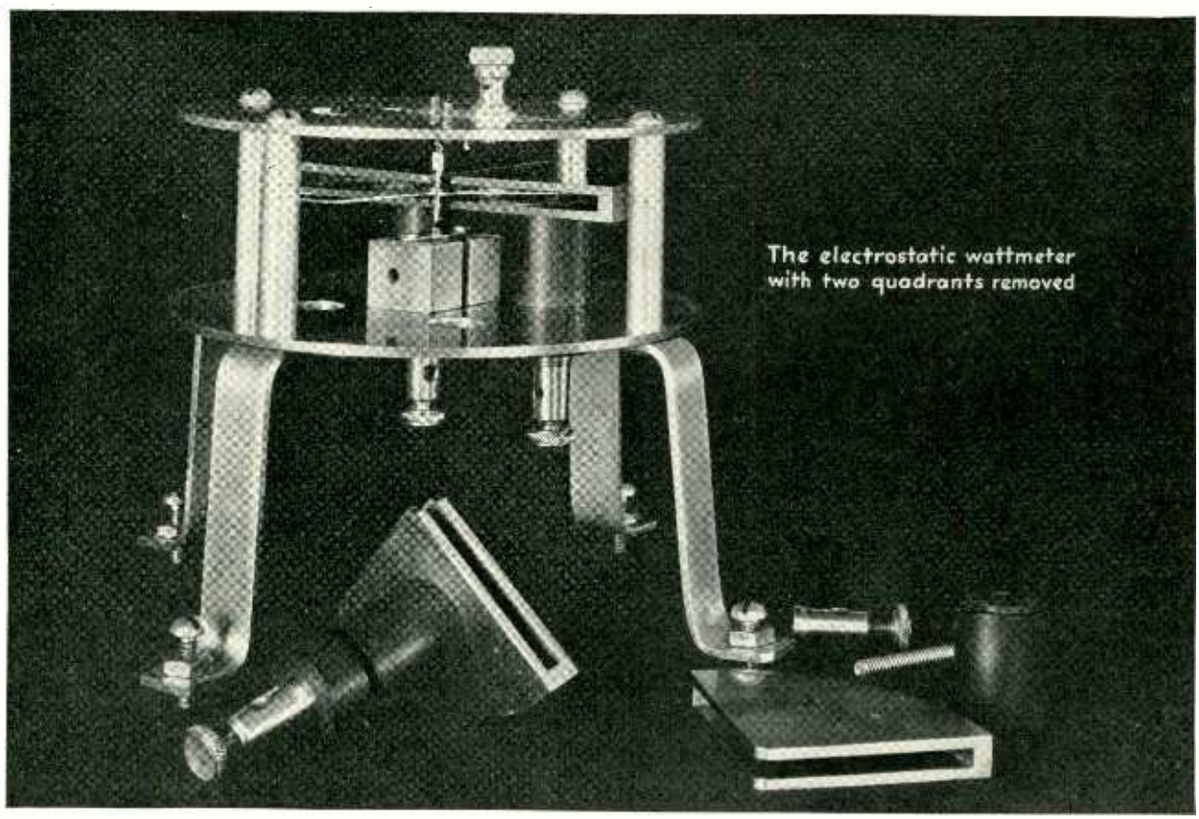
The measurements were taken in a stage 100 ft. x 70 ft. x 35 ft., having a reverberation time of one second at 512 cycles per second. By making these measurements indoors, tests could be made rapidly on a large number of units without the interference from outside noises due to a 60 db insulation between inside and outside provided by the building. The response curves were measured using a high speed level indicator[5] capable of responding to a change in level as rapid as 300 db per second.



High frequency unit (Lansing) and series-type dividing network

Douglas Shearer, head of the Metro-Goldwyn-Mayer Sound Department, brought about and directed this project which was engineered by the writer and contributed by Metro-Goldwyn-Mayer Studios. The cooperation of the following companies is gratefully acknowledged: Electrical Research Products, Inc.; RCA Manufacturing Co.; Lansing Manufacturing Co.; and Loew's, Inc. These companies assisted by making available test equipment, the reference system, staff and theatres, which greatly facilitated the work and produced a co-ordinated result not otherwise possible.

[1] "Wide Range Reproduction in Theatres," J. P. Maxfield and C. Flannigan—Journal of Society of Motion Picture Engineers, Vol. XXVI, No. 1—January, 1936, Page 67.
[2] "Loud Speakers and Microphones," Wente and Thuras—Electrical Engineering—January, 1934, Pages 17 to 25.
[3] "Acoustic Power Levels in Sound Picture Reproduction," Wolfe and Sette—The Journal of the Acoustical Society of America, Vol. II, No. 3—Pages 384 to 398.
[4] "The Effect of Humidity Upon the Absorption of Sound in a Room," V. O. Knudsen—The Journal of the Acoustical Society of America,—July, 1931, Vol. III, No. 1, Part 1—Pages 126 to 138.
[5] "High Speed Level Recorder for Acoustic Measurements," Wente, Bedell & Swartzel Jr.—The Journal of the Acoustical Society of America,—January, 1935, Page 121.



The electrostatic wattmeter with two quadrants removed

A Low-level Wattmeter

A tube-aided electrostatic wattmeter filling a need for a method of directly measuring power at levels occurring in communication.

By ARTHUR L. ALBERT
and
HOWARD P. BECKENDORF
Oregon State College

THE excessive power consumption and the poor frequency characteristics of the ordinary electrodynamometer wattmeter limit its use in communication circuits. This paper describes an investigation made to study the suitability of the electrostatic wattmeter for measuring power in communication and other circuits operating at low power levels, and at audio frequencies.

Methods[1] using thermionic tubes and special circuits have been developed for making power measurements in communication circuits. Furthermore, a paper[2] was recently published in which an electrostatic wattmeter was used for measuring power at radio frequencies, but at high power levels, such as in transmitting antennas. This device was an adaptation of the conventional electrometer using a delicate suspension.

A thermionic-tube amplifier is used with the wattmeter described in this paper. The instrument is, therefore, very sensitive and can measure small amounts of power. Also, the amplifier overcomes the necessity for a sensitive suspension. The wattmeter here described has conventional jewelled bearings and, therefore, is reasonably rugged, readily portable, and hence well adapted to commercial use.

Theory of Operation

The principle of operation of the electrostatic wattmeter is well known and will not be discussed in detail. Furthermore, the theoretical considerations involved at communication frequencies are fully discussed in the paper[2] by Bradford previously mentioned.

A diagram of the electrostatic wattmeter as used in this investigation is shown in Fig. 1, and its construction in the photo. Each of the four quadrants consists of two parallel brass plates rigidly fastened together mechanically and electrically at the outer edge. Each quadrant is carefully insulated from the other quadrants and from a metal vane which is supported by a shaft operating in jewelled instrument bearings.

As Fig. 1 shows, the current taken by the load passes through a 20-ohm resistor. The voltage drop

across this resistor is proportional to the load current. This voltage is amplified in a three-stage resistance-coupled amplifier and then impressed on the quadrants as shown.

The load currents in this investigation varied from about 1.0 to 5.0 milliamperes, giving voltage drops across the series resistor of from 0.02 to 0.10 volt. These were amplified to about 4.0 and 20.0 volts respectively before being impressed on the quadrants. It is apparent that the error introduced by the 20-ohm resistor is negligible in most circuits. If the impedance of the circuit is so low that the effect is appreciable, the error introduced can be calculated and a correction made.

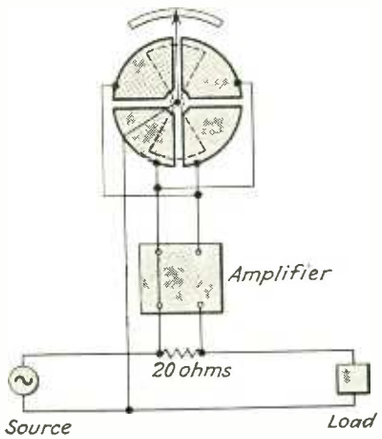


Fig. 1—Connections for measuring the power taken by a load

The voltage across the load is impressed directly between the moving vane and the quadrants. In these tests this voltage varied between 5.0 and 25.0 volts.

When the quadrants are at a difference of potential proportional to the load current, and when the load voltage is applied to the movable vane, this vane will turn and the needle will show a deflection which is a measure of the power taken by the load. If the load current and voltage are not in phase, the voltages impressed on the electrostatic wattmeter will not be in phase, and the deflection will be determined by the true power.

Results of Tests to Determine Commercial Suitability

Many tests were made to determine the suitability of the instrument for commercial use. These included (1) measurements at several frequencies of the power taken by loads of various resistances; (2) measurements at various frequencies of the power taken by an inductive circuit; (3) measurements at various frequencies of the power taken by a capacitive circuit.

In making these tests the load current was measured with a thermocouple, and the power consumed was calculated from I^2R, where R is the effective resistance of the load. These tests showed that at various frequencies and power factor angles, the deflection of the instrument was determined by the power taken by the load. (See Fig. 2.)

As is shown in the photo, the deflection was indicated by a beam of light reflected from a small mirror mounted on the shaft supporting the vane. This was done for simplicity; a needle moving over a suitable scale could have been employed. A deflection of 14 centimeters corresponded to an angle of about 20 degrees. This angle could, no doubt, be increased in a commercial form of the instrument.

Conclusions

1. The electrostatic wattmeter can be satisfactorily used to measure power in communication and other circuits in which the power level is low and the frequency high.

2. The thermionic-tube amplifier meter makes possible the use of jewelled bearings and the measurement of very low values of power.

3. The electrostatic wattmeter with its associated amplifier can be used for measuring power in both resistive and reactive circuits.

4. The electrostatic wattmeter with its associated amplifier can be used over a very wide frequency range, although these tests were only extended to 5,000 cycles.

5. An instrument more sensitive and better adapted to commercial work than the one described here can be built by an experienced instrument maker. The electrostatic element and the amplifier could be combined into one compact unit in a single carrying case. The completed instrument could have two voltage and two current terminals, and a flexibility and ease of operation approaching that of the wattmeter now available for measurements in commercial power circuits.

6. It is hoped that commercial instrument manufacturers with adequate production facilities will further develop this device and provide the communication field with a satisfactory wattmeter.

[1]G. W. Barnes, "A Vacuum Tube Wattmeter." Thesis on file at Oregon State College. Presented in May, 1930.

H. M. Turner and F. T. McNamara, "An Electron Tube Wattmeter and Voltmeter and a Phase Shifting Bridge." *Proc. I.R.E.*, Vol. 18, pp. 1743-7, October, 1930.

K. R. Eldredge. "A Wattmeter for Communication Circuits," *Electrical Engineering*, Vol. 54, pp. 279-81, March, 1935.

T. B. Wagner, "A Thermionic Tube Measuring Instrument," *Electrical Engineering*, Vol. 53, pp. 1621-3, December, 1934.

[2]C. I. Bradford, "Radio-Frequency Power Measurements with the Quadrant Electrometer," *Proc. I.R.E.*, Vol. 23, pp. 958-71, August, 1935.

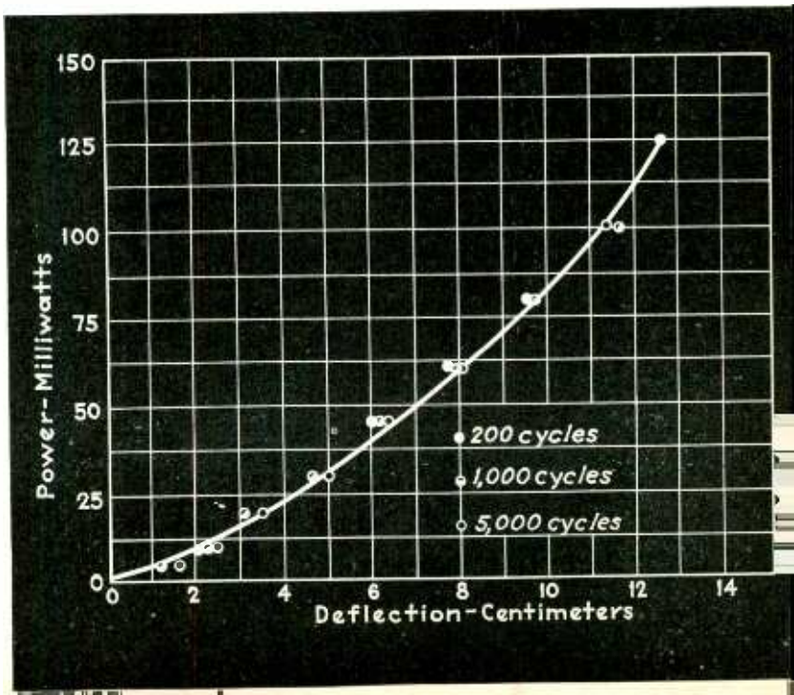
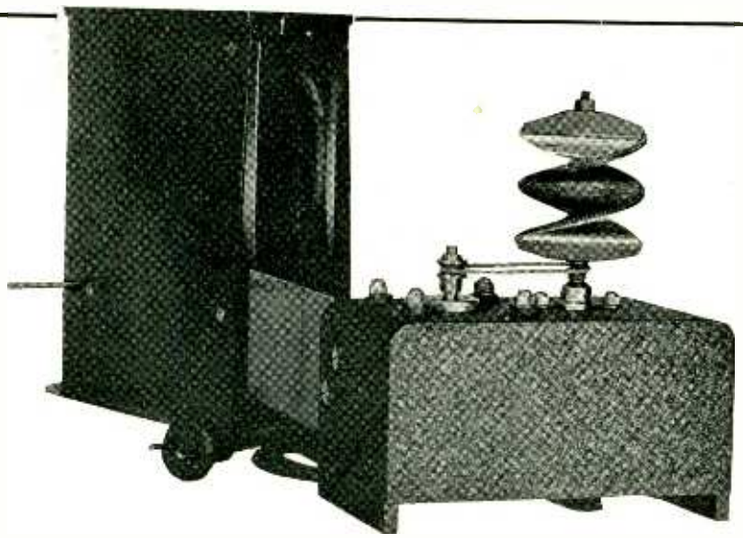


Fig. 2—Calibration curve. Load resistance 5,000 ohms, inductance 0.147 henry. Phase angles: 200 cycles, 2° 7′; 1,000 cycles, 10°27′; 5,000 cycles, 42° 45′

Scophony Television

Details of a high-definition system developed in England; the "split-focus" optical arrangement; and a double-image Kerr cell



An early model of a 90 line mirror screw receiver made by TeKaDe, showing the Kerr Cell container and cylindrical lens

THE term "Scophony" derived from the Greek denotes "picture and sound." Those responsible for coining this new word conceived "Scophony" as a new stage in communications: there was first "telegraphy," the next stage was "telephony" by wire and later on by radio. "Scophony" was in their opinion the stage when pictures combined with sound by wire or by radio would serve as means of bridging over distances between continents and nations.

Very little technical information has so far been made public about the inventions being developed by Scophony Limited of London, a company started in a very modest way by a few enthusiastic pioneers. Since the ideas underlying the Scophony inventions differ from previously known methods, the patents are of comparatively recent nature and reticence in publishing technical details of the inventions had obviously to be the established policy of the Scophony Company.

One is however in a position to indicate the basic company conception and that is that television could not and would not establish itself as a *commercial* service for the home unless and until pictures approximating the definition, brilliance and size of the home cinema could be offered. Size is not the least deciding factor, and therefore *projected* pictures are, in the opinion of this company, an imperative necessity. Now, the optico-mechanical methods employed in this system actually give *projected* television pictures for the home and are holding out the promise of large screen *direct* (as distinct from any "intermediate" methods) television pictures for cinema theatres.

A theoretical description of some of the optical principles of this system, which are already the subject of published patents, was published in England in *Television* Nos. 73-77, Vol. VII. by G. W. Walton. The following is almost the first comprehensive description of some of the practical results obtained in the Scophony laboratory and now available for the public and television experimenters. It deals with high definition film television transmitters and with some of the Scophony means for increasing light efficiency.

The material found in the following several pages has been supplied by engineers of the Scophony company, of London, and is presented to the readers of *Electronics* as an interesting example of a mechanico-optical system of scanning for television that seems to have distinct advantages.

The Split Focus

One of the basic Scophony principles incorporated in the television transmitters and receivers is known as the "split focus." This is an optical arrangement of crossed cylindrical lenses which gives more light with a reduced size of moving part or parts. In scanning a given area to produce a required apparent illumination of that area the spot must have concentrated into it the same quantity of light as would be necessary to give the same illumination without scanning, e.g., if a picture size one meter square is required with an illumination of one lux (one lumen per meter) then one lumen

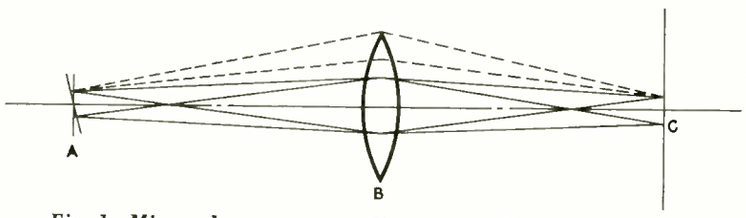
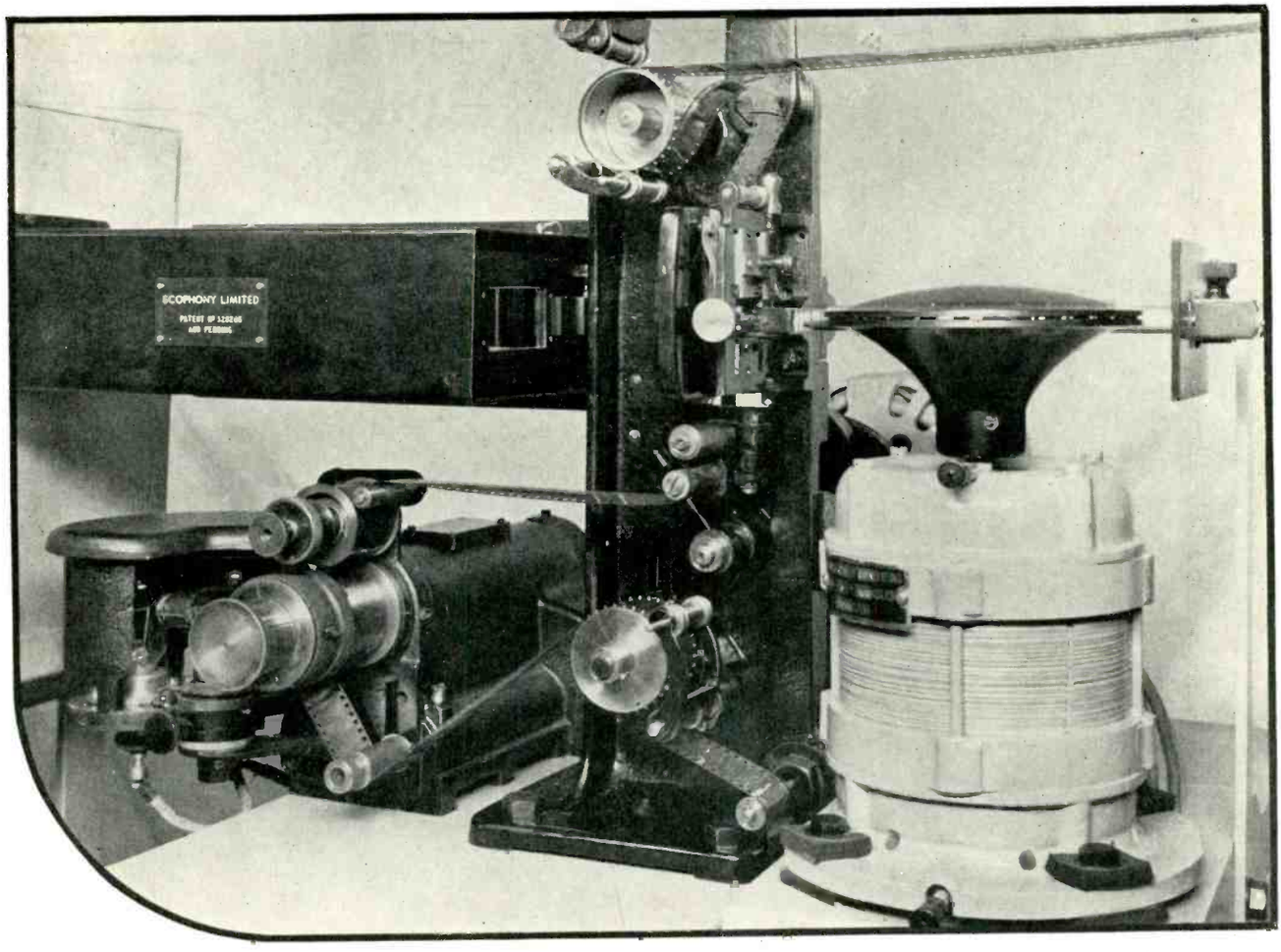


Fig. 1—Mirror, lens, screen to illustrate the "split-focus" systems



Close up view of the high speed scanner and motor, projector head and sound head showing a film threaded up ready for operation

of light is required in the spot no matter what definition (and therefore size of spot) is to be used.

The amount of light that can be concentrated into the spot is directly proportional to the brightness of the light source, the optical transmission efficiency, and to the size of the solid angle of the cone of light at one point of the spot. The last of these is all that is of importance in the present discussion, and is inversely proportional to the square of the distance between the scanning spot and the last optical surface and directly proportional to the area of the simultaneously active area of the last optical surface. In the common mirror drum system the last optical surface is a mirror of the drum, and usually the whole area is simultaneously active so that the quantity of light concentrated into the spot is directly dependent on the area of the mirror.

The same is equally true for any optical scanning arrangement, with the result that for high definition pictures and using available light sources quite formidable sizes of moving parts have been necessary to obtain adequate illumination of the picture.

Returning to the example of scanning by means of a mirror which is oscillated or mounted on a rotating drum it is possible to vary the mirror size in the direction of scanning provided that the size in the direction at right angles to the scanning direction is also varied to maintain the required area of mirror.

In endeavoring to reduce the area of the mirror the first idea that occurs to one is to concentrate the light on the mirror by focussing, i.e., a lens is placed between the mirror and the spot. Suppose the lens to be fixed and the image of the scanning spot at the mirror to be the same size as the spot, then apparently the mirror need not be larger than the spot. This is quite true when scanning is not taken into account. When it is, it will be found that there can be no scanning action at all. This will be understood from Fig. 1, where A is the mirror, B the lens, and C the spot on the screen. The rays shown as solid lines show how light from A is focussed on C with A in one position. Now suppose A is tilted. Then the rays will be as shown by the dotted lines and B focusses those rays also on C, i.e. there is no scanning at all. From this it will be seen that in order to obtain scanning there must not be a focal plane at the mirror.

There is a necessary addition to the last statement which is "in the plane of scanning." That is, there may be a focal plane in a direction where no scanning action is required. This is the Scophony principle of "split focus" which may be defined as the utilization of focussing on a scanner in a direction where no scanning action is required by the forma-

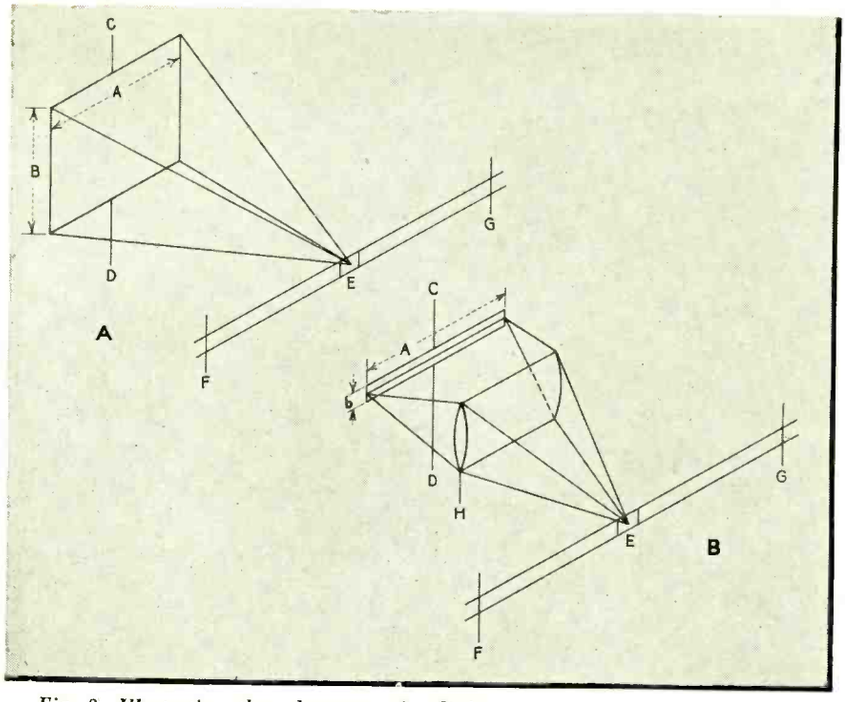


Fig. 2—Illustrating the advantage of split-focus system in reducing scanner dimensions, or increasing illumination

tion of a cylindrical image on the scanning optical surface, while focussing in a direction in which scanning is required is in some plane before and/or after the scanning optical surface.

Scanning Efficiency

An example will show the advantage of using this principle. In Fig. 2A the mirror *AB* oscillating or rotating on the axis *CD* is illuminated by convergent light from a source not shown so that it focusses to a spot *E* and it is required that the movement of the mirror shall cause the spot to move transversely from *F* to *G*. It was shown in connection with Fig. 1 that there must be no focussing at the mirror in the direction of *A* if maximum scanning action is required. Consequently in Fig. 2B, *A* is equal to *A* in Fig. 2A. In Fig. 2B a cylindrical lens *H* is placed between the mirror and *E*, say midway and has conjugate focal planes at *E* and the mirror. *H* subtends at *E* in Fig. 2B the same solid angle as *AB* does in Fig. 2A so that other things being equal the same amount of light is concentrated in *E*. As *H* is midway between *E* and the mirror, then the cylindrical image of *E* at the mirror has the same vertical size *b* as *E* has, i.e., the mirror in Fig. 2B need only have an area of *Ab* as compared to the area *AB* in Fig. 2A for exactly the same amount of light in *E*, and for precisely the same scanning action. Suppose the picture has 200 lines and *B*, Fig. 2A, is the vertical height of the picture; then $E=B/200=b$ in Fig. 2B, i.e., the area of the mirror in Fig. 2B is 1/200th of that in Fig. 2A for exactly the same results.

The principle of "split focus" thus makes possible an enormous reduction in the size of scanner, or alternately an enormous increase of light for the same size of scanner.

In Fig. 2B it is assumed that the mirror is suitably illuminated by a source equal to that in Fig. 2A, i.e., is concentrated on the mirror by focussing in the direction *b* by means of a suitable lens system between light source and mirror.

It is sometimes said that with such cylindrical systems one cannot obtain sharp focus because of aberrations. This is not correct. All lenses have aberrations, which have to be corrected. Those of cylindrical lenses are not exactly the same as those of spherical lenses but can be corrected in analogous ways.

The high definition film transmitters in the photographs utilize the split focus. One of these is designed for 120 lines definition and the other for 180 lines, and both utilize a single scanner only 12 cm. in diameter. The light source in each case consists of a standard talkie exciter lamp consuming only 32 watts.

High Definition Film Transmitters

With these high definition transmitters the light on the photocell after passing through standard density film stock is sufficient to require only relatively small amplification to fully load the radio gear. The optical system of these transmitters is very similar, a small talkie exciter lamp is used with the filament burning vertically. This is focussed by means of cylindrical lenses in one dimension directly on the film and in the other dimension is the lens scanner. This consists of a number of cylindrical lenses placed side by side around the periphery of an aluminum wheel. Behind the scanner is a series of cylindrical lenses which focus the line of light down to the requisite scanning width on the film. By this arrangement using the split focus, very much more light is obtainable using only a small scanner. In these transmitters the scanner wheels are driven by synchronous motors running at the requisite speeds according to the number of lines in the picture. The scanning in the other direction is done by the film itself, which moves past the gate at 25 pictures per second. The drive is accomplished by means of a synchronous motor running at a speed of 1500 r.p.m. The scanners are dynamically balanced so that there is no vibration at all, in fact, when the transmitter is working, there is considerably less noise than that obtained from a standard cinema projector.

A form of direct coupling is used with special gas discharge tube voltage stabilizers, making the whole amplifier gear constant under varying conditions.

Scophony Receivers

It is impossible as yet, for patent reasons—to publish technical details of the Scophony receivers. They use optico-mechanical methods but they do not follow standard conceptions. The split focus as above explained is used, apart from other optical features resulting in a substantial increase in light. The light source is either a small filament lamp, say a

talkie exciter lamp of 32 watts or an automobile headlamp, while for light control purposes the Scophony laboratory is fortunate in having two new types of light control. Information about one of them employing a fundamentally new principle may be available for publication soon, while the second, the double-image Kerr cell—is explained in the following paragraph.

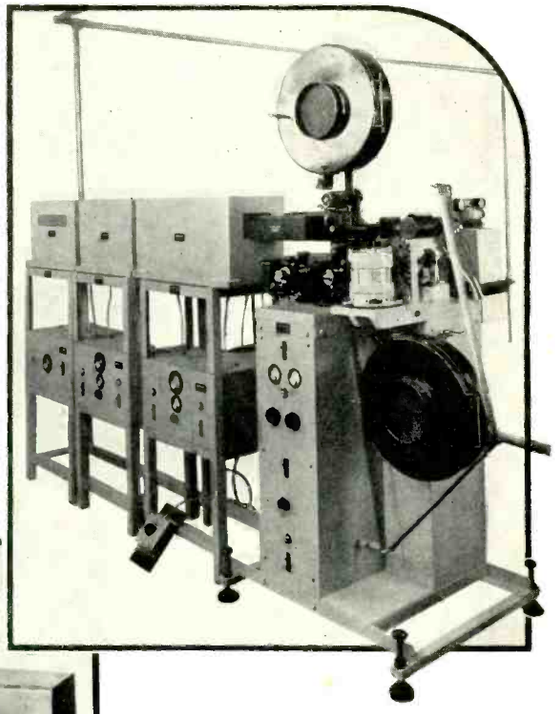
Double-Image Kerr Cell

One of the many advantages in light in the Scophony television receivers is obtained by what is now well known as the double-image Kerr cell. This principle uses the extraordinary and ordinary rays from a polarizer passing through separate gaps and then being re-combined by the analyzer. Polarizer and analyzer are identical Wollaston prisms cemented to the container and have lenses cemented to them. This was to be used in a split focus system according to the fundamental Scophony methods, therefore it was necessary to have a big aperture in the Kerr cell itself. It had to have a line aperture about 1½ cm. high by a fraction of a mm. wide. The two gaps are of paraboloidal shape to give the maximum light transmission for a given electrical effect with a minimum capacity. The following approximate figures show the measure of success achieved with the Kerr Cell employed. Capacity of cell about 250 micromicrofarads; operating mean voltage 800 volts. Controlled light equivalent to a line 0.3 mm. x 6 cm. at F6 with 33 per cent losses due to geometrical obstruction of the gaps and used with an arc of 18000 stilb brilliancy, the cell passes about 50 lumens controllable light. For high definition work over 180 lines the double-image Kerr cell has been lately superseded by a light control which only requires fractional voltage for complete operation through from black to white.

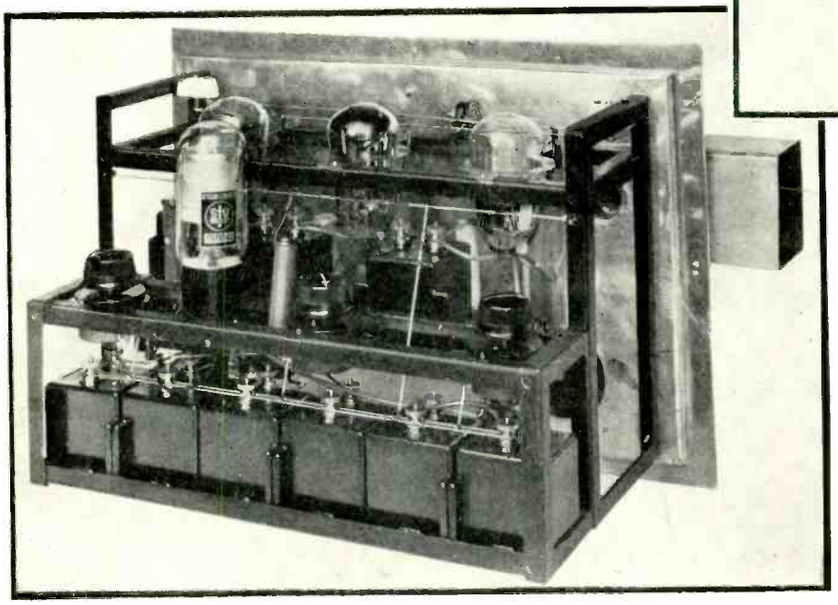
The Mirror Screw

The simplest form of television receivers using the Scophony methods is the mirror screw. This is a scanner which consists of a series of flat long mirrors arranged in a spiral formation in such a way that the number of mirrors determines the number of lines. The thickness of each mirror gives the width of the lines and the length the width of the picture. Each mirror is correctly fixed at an equal angle to the next, for example in a 180 line mirror screw each lamination is spaced 2 degrees. When the mirror screw is rotated at picture frequency and a suitable line of modulated light is placed at the side, by looking directly at the mirror screw a picture will appear. With suitable lenses the picture can be projected onto a screen utilizing the split focus.

The practical development of the mirror screw started in the former Telehor laboratory in Berlin by Dr. V. Okolicsanyi (at present with the TeKaDe Company of Nurnberg) and Mr. Wikkenhauser (at present with Scophony). It was further developed by the TeKaDe Company of Nurnberg.



180 line television film transmitter showing the control panels, projector head, high speed scanner, sound head, etc., controls for d-c excitation of the television and sound exciter lamps, fader control for the sound amplifier



Interior of an intermediate amplifier showing low loss construction and the use of a neon stabilizing device. The amplifier boxes are double screened and sound proof

Plastics

[*Continued from page 13*]

making transcription records for broadcasting purposes, in which application it competes with vinyl acetate in the form of Vinylite. The latter is non-inflammable and has good molding properties, but to date has little or no electronic use, except for transcription records.

Cellulose acetate for molding and other purposes is produced in this country under the names Tenite, Plastacele, Lumarith, and Masuron, and sheets, rods and tubes, at least, can be had also under the names Fibestos and Nixonite.

Styrol (Victron) Plastic

The only styrol plastic manufactured in this country, so far as the writer is aware is the polymerized styrene or meta-styrene known as Victron. Being made in rather small quantities, this material is rather expensive, but its excellent dielectric properties and its low loss at radio frequencies (less than 0.04 per cent at 900 Kc.) has gained for it a considerable use in electronic applications. In Europe, and especially in Germany, the poly-styrol known as Trolitul is similarly employed and has similar properties, and some imported poly-styrol is used for electronic purposes. An important consideration in the use of styrol plastics is that they have substantially zero water absorption and hence maintain their dielectric properties despite atmospheric changes.

A disadvantage of the styrol plastics is commonly supposed to be a rather low softening point, but according to the makers, this point (as defined by the A.S.T.M. specification D48-33) is 93 deg. C. (199.4 deg. F.) for Victron, which is 15 deg. C. above that for some forms of hard rubber. Victron, it is stated, can be heated even in boiling water without distortion, but becomes soft and can be distorted so as to take a permanent set at that temperature. Victron is normally light amber in color, but undergoes surface yellowing as a result of oxidation if exposed to sunlight.

Styrol plastics are well adapted to injection molding and can be molded also in the ordinary press. As they become quite fluid when soft, they require less pressure for molding than most other plastics, 300 to 1,000 lb. per sq.in. being sufficient. The recommended temperature for molding Victron is 145 to 200 deg. C. When machining is preferred to molding, it is readily done, but tools should be sharp, have plenty of rake and in general are arranged to cut at about the same speed as for brass. The work should be kept cool, using water or lubricating oil as a coolant if necessary. Victron is not considered inflammable, but will burn if ignited. The power factor of Victron is given as 0.0346 per cent at 446 Kc. and 0.0276 per cent at 877 Kc., but it is understood that these figures may be exceeded slightly when the process of manufacture is varied to give the highest resin yield, hence the figure, 0.04 per cent given above.

Accompanying illustrations show numerous parts molded from acetate and styrol plastics. Many of those produced in Germany are made in the Eckert & Ziegler injection-molding machine and have rather delicate inserts of metal which would be difficult if not impossible to mold direct from powder placed in the mold be cause the surge of the powder would be likely to displace or bend them. With injection molding, however, the plastic enters the mold in a liquid state and readily flows around the inserts without displacing or bending them. Some of the moldings shown, especially the small coil forms, have sections not over 0.020 in. in thickness, and are so light that the cost per piece must be very low even though the material itself is quite expensive. The specific gravity of Trolitul is given as 1.04, one of the lightest of all plastics.

Although plastics are commonly and properly considered quite separate and distinct from varnishes, lacquers, dipping compounds and cements, it may not be amiss to point out that the same basic materials are often used in both classes of product and some of them are used in liquid form for coatings for radio parts with qualities comparable in some respects to those of the corresponding plastics.

Tables showing physical and electrical characteristics of typical plastic materials will be found on Page 36.

Electric Eyeing Telegrams

[*Continued from page 23*]

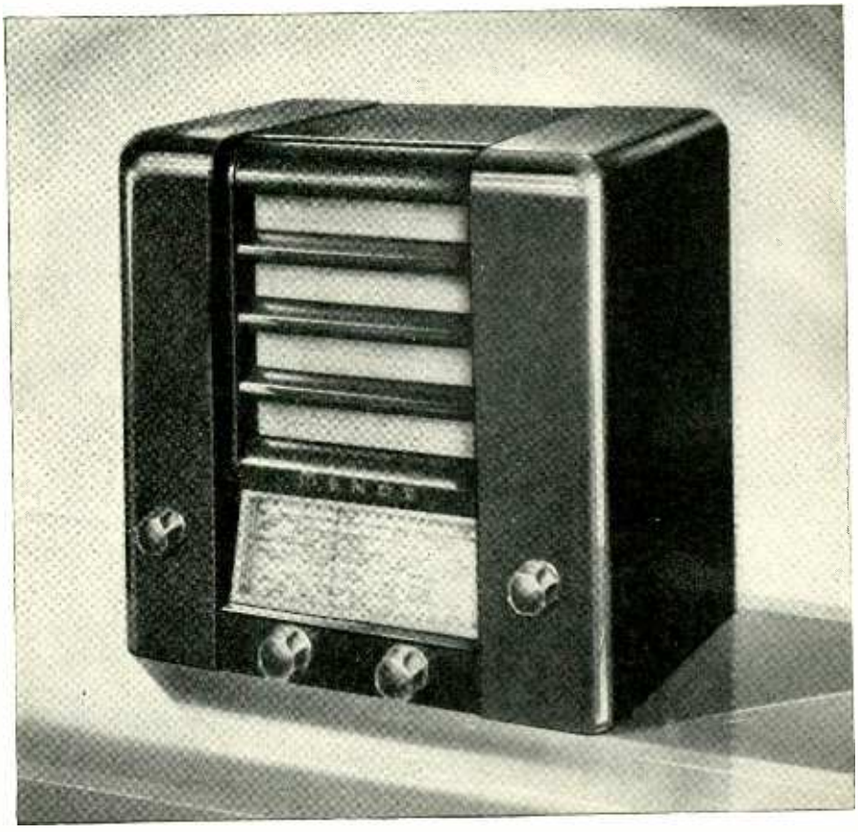
beam passes through the perforations to the phototube. The tube current fluctuates with the interruptions of light. The electrical circuit is so designed that the relay will not trip at the 960 light interruptions per minute but will trip at 720, or less. Covering one hole changes the interruptions to 480 per minute. When a message is on the belt it covers several holes. This breaks the beam of light, actuating the relay and signal, which lock.

A fourth type of phototube device measures the efficiency of belts and chutes. It registers the number of messages the belt or chute handles and the number which may be temporarily delayed. The ratio of the two figures gives the efficiency. In the setup the beam of light crosses the chute sides through small holes, shines on the prism, and is reflected back to the photo tube. Each time the beam is cut by a message the amplifier registers it on a small automatic counting machine.

This circuit too, is timed to eight seconds for delays. Each delay registers on a counting machine. A condenser on the delay counting relay, in series with the message counting relay, regulates the time interval desired for the delay counting machine.

Western Union states that where these phototubes have been installed the equipment has been so successful in indicating trouble and delays to messages that delay periods have been cut down to only a few seconds and can hardly be considered delays.

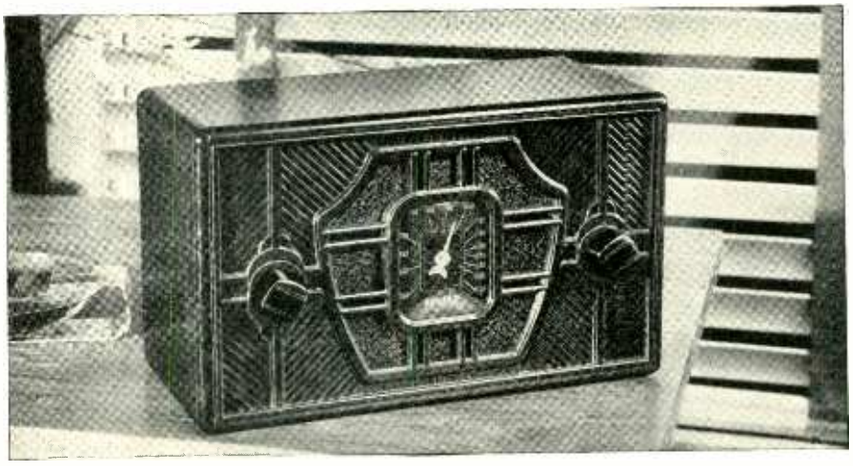
New Freedom of Design
for Large or Small Sets . . .



ADVANCES in the technic of plastic molding now make it possible for the radio cabinet designer to break away from styling traditions formerly imposed by limitations of materials. With Bakelite Molded, new opportunities are offered for the expression of original ideas regarding color, style and form.

The two Bakelite Molded cabinets pictured indicate the wide adaptability of this material to the forming of either simple or ornate designs. They also show the practicability of forming compound curves as well as plane surfaces, and large hollow shapes as well as small.

In the larger set, at the side, the lustre of black Bakelite Molded emphasizes the pleasing simplicity of the cabinet design. Below, the Remler "midget" set, with its elaborately embossed front panel, gains warmth of color from the use of a rich walnut brown Bakelite Molded.



Available in a selection of attractive colors, and capable of unlimited surface textures, Bakelite Molded broadens the designer's opportunities for unusual color and finish effects. In addition, it provides ease, accuracy and economy in production.

Radio manufacturers and designers are invited to consult us for information or cooperation in applying Bakelite Molded. Write for our helpful 48-page booklet 13M, "Bakelite Molded".

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THE MATERIAL OF A THOUSAND USES

Properties of Plastic Materials

Compiled by
HERBERT CHASE

Mechanical and electrical properties of phenolic, urea, cellulose acetate, and styrol materials commonly used in electronic applications. (See article on page 7, this issue, for description of manufacturing processes and application of these materials.)

PROPERTY	PHENOLIC MATERIALS						
How produced	Molded	Molded	Molded	Molded	Laminated		
Type	Common		Impact	Low-Loss	X	P	XXX Low-Loss
Kind of filler	Wood flour	Mineral	Fabric	Mineral		Paper	
Specific gravity	1.34-1.52	1.8-2.0	1.37-1.40	1.9		about 1.36	
Tensile strength lb. per sq.in.	6,000-11,000	5,000-10,000	6,800-7,200	6,100	12,500	8,000	7,000
Compressive str. lb. per sq.in.	25,000-36,000	18,000-36,000	20,000-30,000		31,000	23,000	35,000
Impact strength ft. lb./sq.in. (Izod)	1.-3.5	1.5-4.5	25-30	2.5			
Flexural strength lb./sq.in.	10,000-20,000	8,000-20,000	10,000-13,000	9,300	21,000	15,000	15,000
Dielectric strength (inst.) volts/mil	300-500	200-400	200-400	640	700	600	650
Volume resistivity megohm /c.c.	10^4-10^6	10^3-10^5	½ to 1x10^5	over 10^8			
Power factor %							
at 1,000 cycles	4-15	10 up	8-20	0.9-1.2			
at 1,000,000 cycles	3.5-10	5-10	5-10	0.75	5	6	3.5
at 1,000,000 cycles after 24 hr. in water					7.5	9	4.5
Water absorption % in 24-hr. immersion.	0.2-0.6	0.01-0.3	1.0	0.002	2.0	3.0	1.0
Colors available	various	limited	limited	limited	tan & black	tan & black	tan & black

	UREA MATERIALS		CELLULOSE ACETATE	STYROL (especially meta styrene)
How produced	Molded	Laminated	Molded	Molded
Kind of filler	Cellulose pulp	paper		
Specific gravity	1.48-1.55	1.45-1.49	1.27-1.56	1.04-1.054
Tensile strength lb./sq.in.	4,000-12,000	8,500-9,300	2,800-5,000	6,000-7,000
Compressive str. lb./sq.in.	10,000-30,000		4,000-16,000	
Impact strength ft. lb. /sq.in.				
(Izod)	2.0-2.4		0.5-1.2	
(Charpy)			2.2-5.2	
Flexural strength lb./sq.in.	9,000-16,000	16,800-24,000	6,000-7,000	12,000-14,000
Dielectric strength (inst.) volts/mil.	60-400	482-600	470-800	517-1,200
Power factor %	1.3 (at v.f.)	2.88-3.69 at 500 kc.	5.7-5.9 at 550 kc.	0.0276-0.04 at 877 kc.
Water absorption % in 24-hr. immersion	0.4-0.9	2-1	1.4-1.7	zero
Colors available	unlimited	various	unlimited	amber and others

(Most of the data given are as furnished by the manufacturers and in general are as obtained by A.S.T.M. test methods. As the wide range of properties given in some cases indicates, materials in the same classification vary considerably. Optimum properties under all heads seldom if ever apply to any one material. The styrol materials are widely used in lacquer or varnish form for coating radio frequency coils, etc. In the United States at present the widest use of styrol materials is in these liquid forms.)

TUBES AT WORK

TUBE time-delay circuits, public address for bridge traffic signals, missing pipe detector, a new bias circuit, selenium cell data—this month's practical applications.

Time-Delay Circuits

By CHARLES FELSTEAD
Consulting Sound Engineer

IT IS DESIRABLE in the operation of all radio transmitters, and necessary in the operation of those employing mercury-vapor tubes as rectifiers, that the filament voltage be supplied to the tubes a definite time interval before the plate voltage is applied to them.

The time delay required with a mercury-vapor rectifier tube depends on the filament construction. If the filament is of the exposed type, a delay of 15 to 20 seconds is sufficient; but if the filament is of the heater type, a delay of 30 to 45 seconds is required to permit the cathode to become thoroughly heated.

In the circuit shown in Fig. 1, when *S* is closed, voltage is supplied to the rectifier and transmitter tube filaments by *T1*, and to the filament of the time-delay tube *VT* by *T2* (which can be a bell-ringing or toy transformer of the correct secondary voltage). When the time-delay tube filament reaches a temperature at which sufficient plate current to operate *R1* is flowing through the tube, the relay closes and applies voltage to the plate-supply transformer *T3*.

The length of the time delay can be governed by choosing a tube having the proper filament characteristics, and regulating the filament voltage to a value that provides the required delay. The relay winding should have a resistance of several hundred ohms, and must operate reliably on a current of a few milliamperes. The time-delay tube serves as a rectifier for the current flowing through the relay winding.

The disadvantage of this circuit is that if *S* is opened and then closed again within a few seconds, the slow-heating and slow-cooling filament of the time-delay tube will still be hot enough to pass sufficient current to close the relay and apply high voltage to the rectifier tubes, despite the fact that the rectifier tube filaments will have had time to cool while the switch was open. In such a case, the plate voltage will be applied at the same instant as the rectifier filament power.

Figure 2 overcomes this disadvantage by the addition of the relay *R2*. When *R1* closes it actuates *R2*, which disconnects *T2* and permits the filament of the time-delay tube to cool. Relay *R2* assumes the duty of carrying the plate transformer primary current through its heavy contacts, relieving the lighter contacts of the *R1* relay of that load.

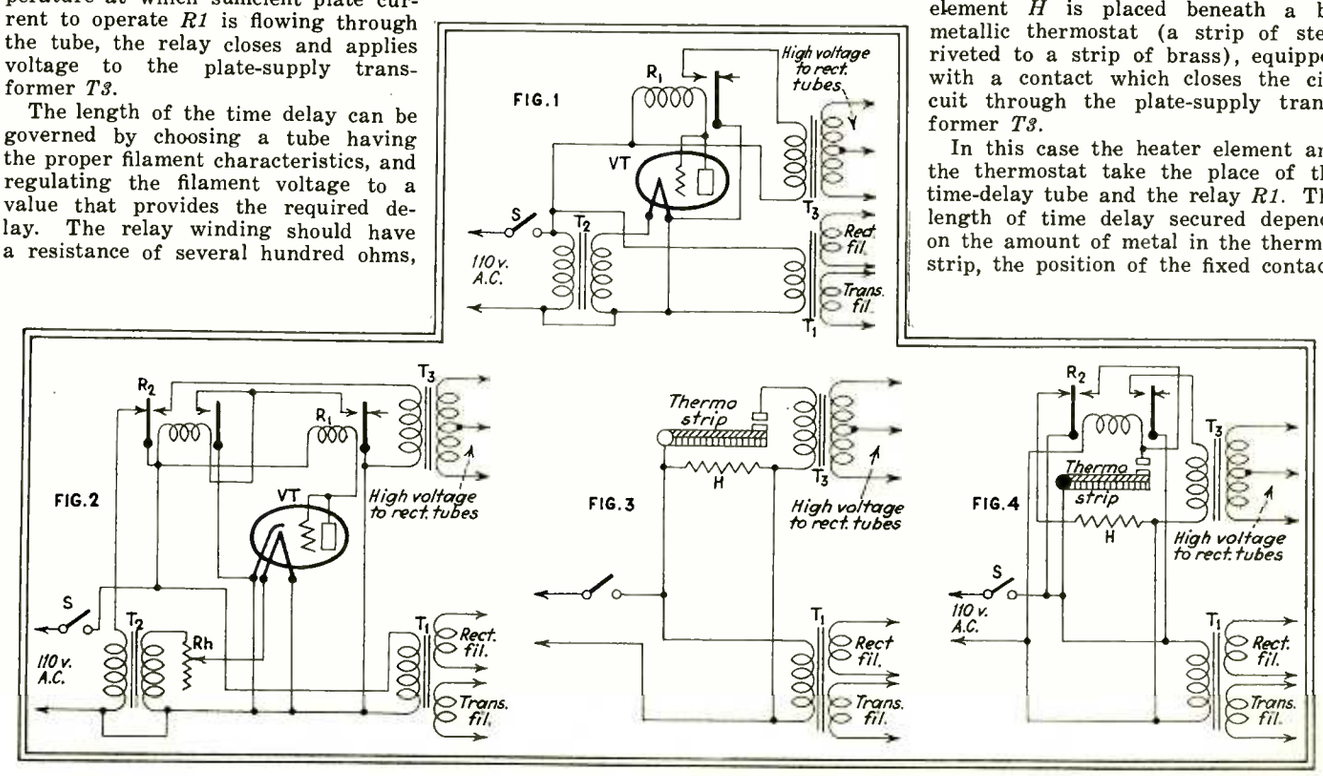
If, during the operation of a transmitter, *S* is opened and closed again quickly, the time-delay tube, having cooled in the meantime, would have to heat all over again before plate voltage would be impressed on the rectifier tubes. The only possible failure of the time-delay equipment to work with this circuit would be in the event that the line switch was opened and quickly closed in the five or ten seconds before the time-delay tube had a chance to cool after the actuating of the *R2* relay.

Employing a type 27 tube for the time-delay tube, a heavy-duty, one-ohm rheostat *Rh* in the filament circuit will afford sufficient latitude in the time adjustment to provide for either type of mercury-vapor rectifier tube. The cathode of the tube is connected to the filament, and the grid and plate are tied together.

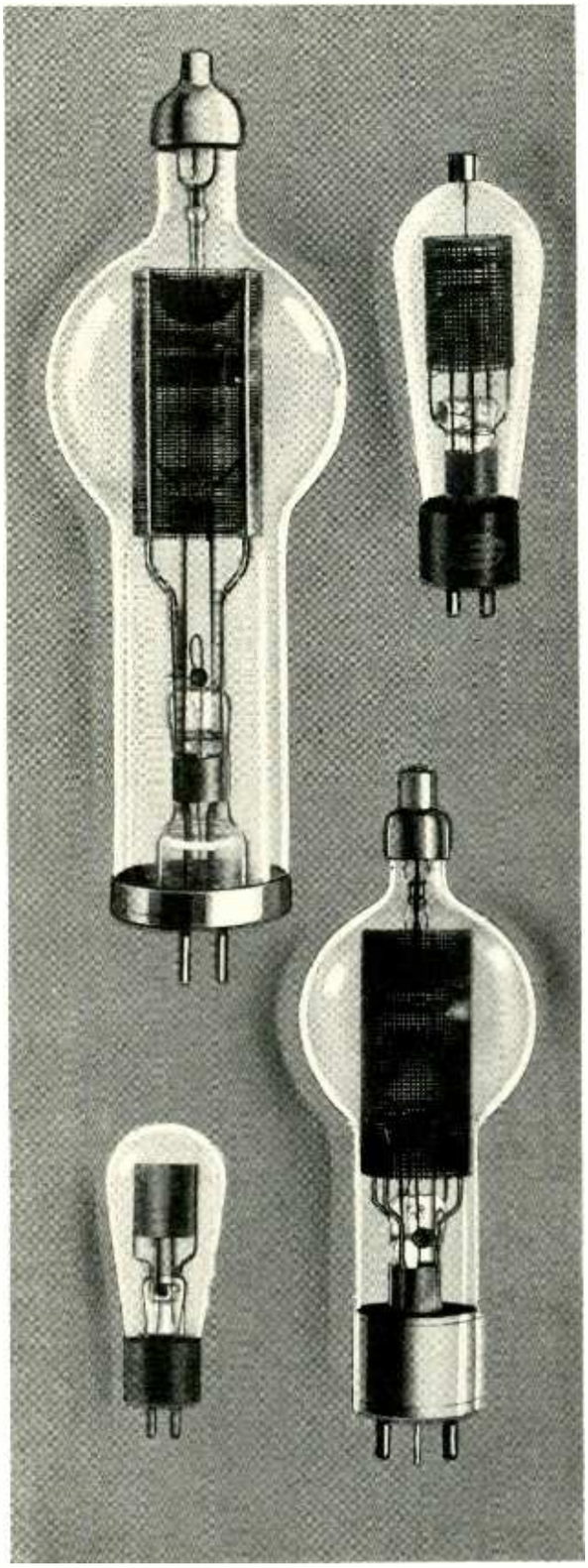
The average 27 tube will close the relay about eight seconds after the filament voltage is applied, if there is no resistance at *Rh*. At a filament terminal voltage of 2.2 volts, there will be about 18 seconds delay, which is approximately correct for a mercury-vapor tube of the exposed filament type. At 1.9 volts, the time delay will be about 35 seconds, which will be right for the heater-type mercury-vapor tube. A much shorter delay can be obtained by using a 45 tube in place of the 27.

In Fig. 3, a small 110-volt heater element *H* is placed beneath a bi-metallic thermostat (a strip of steel riveted to a strip of brass), equipped with a contact which closes the circuit through the plate-supply transformer *T3*.

In this case the heater element and the thermostat take the place of the time-delay tube and the relay *R1*. The length of time delay secured depends on the amount of metal in the thermo-strip, the position of the fixed contact,



Circuits for introducing a time-delay in the application of high voltage to the plates of mercury-type rectifier tubes



LOW GRID CURRENT

•

When the energy available for control is of extremely low value use Westinghouse Grid Glow Tubes.

These gas or vapor filled grid controlled rectifiers are designed and processed with special care so that they operate with very minute grid current. Tubes are available which will operate directly from the output of a vacuum type photo tube.

This is one of the many features that makes this line of tubes outstanding in quality.

WRITE . . .

Division 108, Westinghouse Lamp Company, Bloomfield, N. J., for technical data on Westinghouse Electronic Tubes.

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There is a Westinghouse Electronic Tube for every application

Westinghouse *Electronic Tubes*

and the degree of heat delivered by the heater. This circuit has the same disadvantages as Fig. 1.

An improvement is illustrated in Fig. 4. A 110-volt relay *R2* is combined with the thermostat. When the expansion strip is sufficiently heated to bend and make connection between the contacts, this relay is actuated, closing the circuit through *T3*, opening the heater circuit (thus permitting it to cool) and closing a keep-alive circuit that keeps the relay winding supplied with current until the line switch is opened. Upon opening and closing the line switch again, the action begins all over. A rheostat, the resistance of which is dictated by the type of heating element used, is connected in series with the heater. By carying the rheostat, the amount of current passing through the heater can be controlled, thereby regulating to some extent the amount of time delay provided by the thermostat.

• • •

Public Address System Aids Bridge Operator

THE NEW PARK STREET BRIDGE between Oakland and Alameda, California, an electrically operated drawbridge of the double-leaf bascule type, has been fitted with several public address speakers mounted above the bridge roadway and along the piers. The operator of the bridge control mechanism is provided with a microphone through which he can give instructions to traffic or ships passing through the bridge. A small public address amplifier is also mounted in the control room. This feature, in addition to completely interlocked safety control of the motors controlling the bridge, insures that emergencies can be met with a minimum of hazard to highway and river traffic.

• • •

Telephone-radio Set-up Used for Lectures at Dispatchers Institute

STANDARD A-C RADIO RECEIVERS are now being used in Dispatchers Institute, Oneonta, New York, for delivering lectures to students. By removing the detector tube from the radio receiver and inserting a plug connected to the private telephone system of the Institute, the set is connected to a central distributing point where the lecturer is located. The receivers are located on the desk of each lecture room. Radio receivers are also employed for loud speaker purposes in dispatchers offices. The use of loud speaker has considerable advantage over the use of telephone since it largely eliminates the severe acoustic shock frequently received on ordinary telephone instruments during severe system disturbances, which sometimes occur in the electric transmission network over which the dispatcher has control.

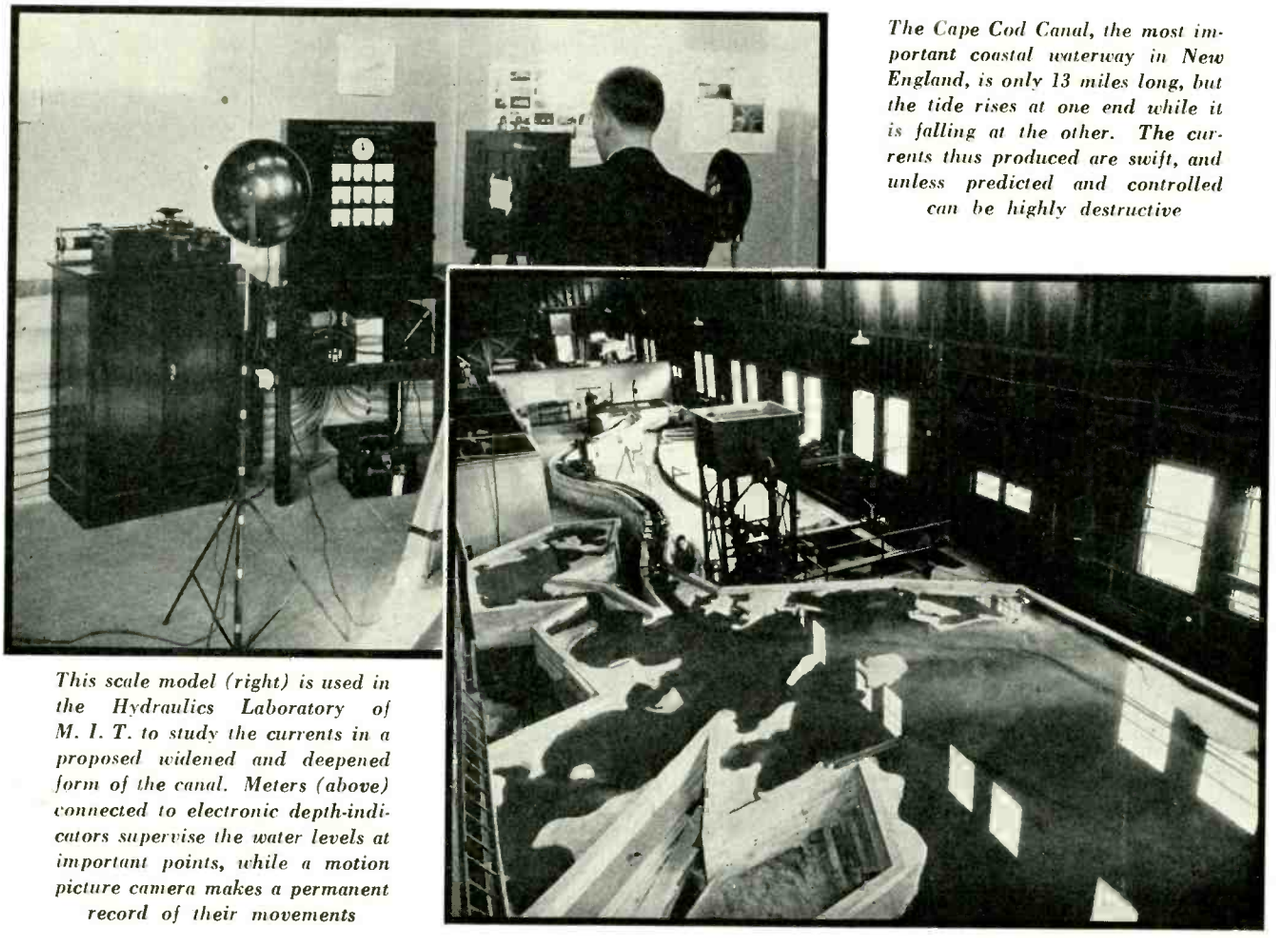
• • •

Pipe Detector Makes Use of High Permeability Alloy

DETECTION OF "missing" pipes by the use of a magnetic compass needle, which has been one of the methods used for many years, has recently been considerably improved by the development of a new instrument having a sensitivity one hundred times as great as the ordinary magnetic needle. The detector which reveals the presence of steel or iron pipes by their magnetic characteristics, is capable of revealing structures buried as deep as 7 feet under the ground and at horizontal distances of 100 feet.

The detector is essentially a surveying compass which is provided with an adjustable bar magnet for reducing the effect of the earth's field, thus making the needle more susceptible to magnetic disturbances produced by a pipe. Two

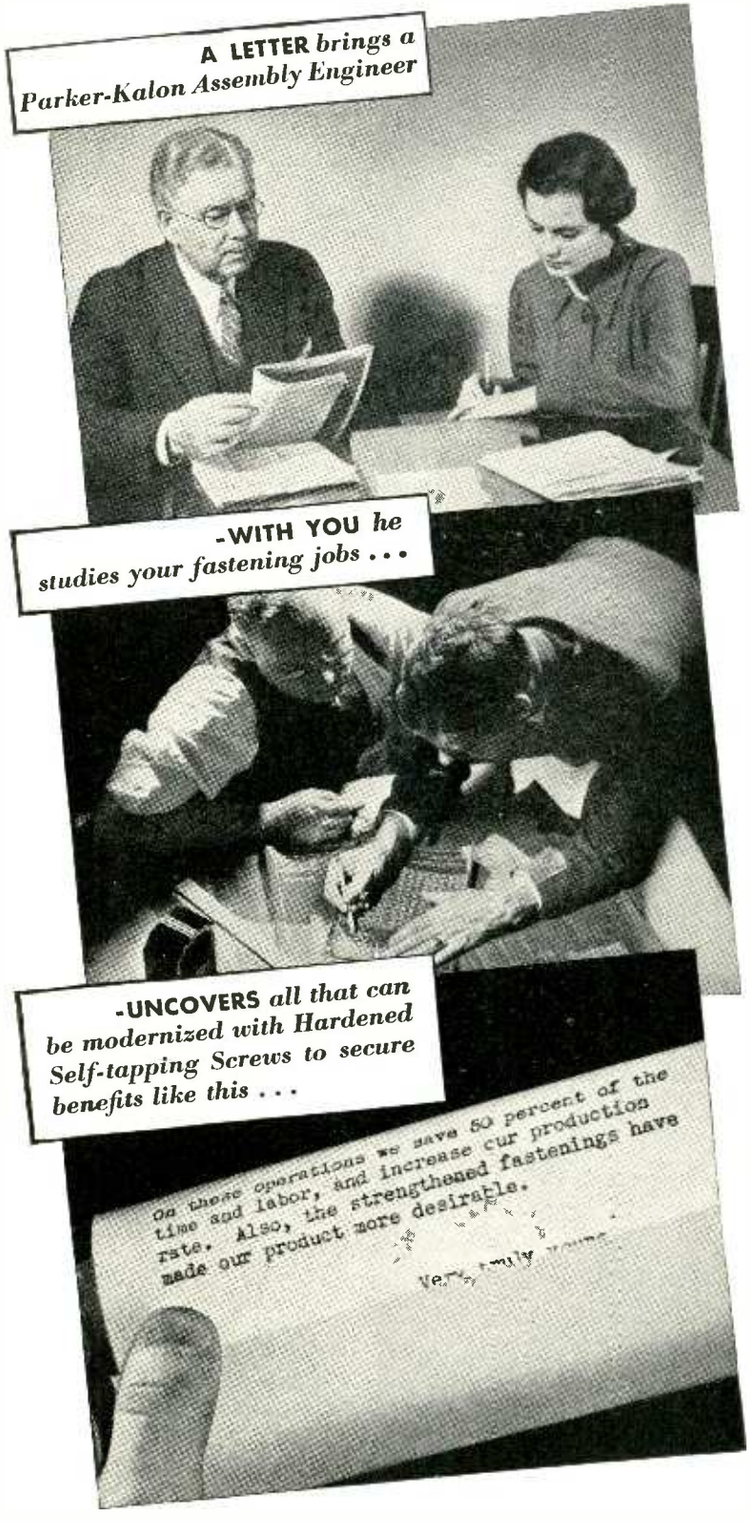
MONITORING A MODEL OF THE CAPE COD CANAL



The Cape Cod Canal, the most important coastal waterway in New England, is only 13 miles long, but the tide rises at one end while it is falling at the other. The currents thus produced are swift, and unless predicted and controlled can be highly destructive

This scale model (right) is used in the Hydraulics Laboratory of M. I. T. to study the currents in a proposed widened and deepened form of the canal. Meters (above) connected to electronic depth-indicators supervise the water levels at important points, while a motion picture camera makes a permanent record of their movements

7 out of 10 win New Economies



This simple, cost-free ASSEMBLY MODERNIZATION has led to new economies and better products for 7 out of 10 concerns who investigated.

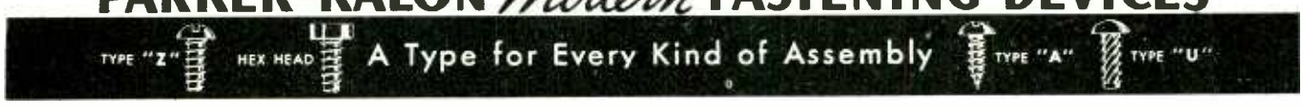
It may be hard to believe that some of your own assembly methods can be modernized . . . some of your fastening jobs simplified and made better at lower cost. But the odds show that it is more than likely . . . judging from the results obtained by Parker-Kalon Assembly Engineers in hundreds of plants where they have been invited to investigate metal and plastic fastening jobs.

In seven out of ten such plants, opportunities have been uncovered for cost reduction, design simplification and product improvement. And no added expense or radical changes were necessary to bring them about. It required only the substitution of Parker-Kalon Hardened Self-tapping Screws in place of more costly and complicated methods.

Even though plant executives know "something" about these unique Screws and use them to simplify certain fastening jobs, a Parker-Kalon Assembly Engineer usually can point out where money-saving opportunities have been missed. This is understandable, for he not only has a thorough knowledge of general assembly practice, but is a specialist in the application of Self-tapping Screws. Naturally, he can recognize possibilities for using them to save time and labor which plant engineers might overlook.

The services of one of these Parker-Kalon Assembly Engineers is available to you. *He sells nothing.* His job is to help design engineers and shop executives make the fullest, practicable use of one of the most important modern aids to production speed and economy. It will not obligate you to have him go over your fastening jobs with you, and see where you can advantageously employ this simple method that in most cases also produces stronger assemblies. Write us and he will call next time he is near your plant. PARKER-KALON CORP., 198 Varick St., New York

PARKER-KALON *Modern* FASTENING DEVICES



The magnetic pipe-locator

radial fins of high permeability, low hysteresis, magnetic material are attached to the compass box and turn with it. These fins, mounted on the cross bar, as shown, considerably increase the magnetic flux density at the compass needle, thus greatly increasing the sensitivity of the instrument. Iron and steel pipes may be detected at a considerable distance, and even non-magnetic pipes may be found provided a current can be sent through them to produce the necessary magnetic field. The accuracy of the device is such that pipes can be located at positions accurate to within one diameter of the pipe itself.

• • •

Data Curves on G.E. Blocking Layer Photocells

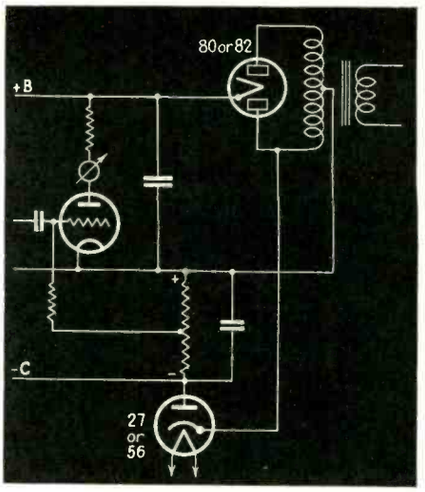
THE DIAGRAMS SHOWN at the right furnish detailed quantitative information on the General Electric blocking layer photocell, recently announced in these columns. The cells are of the selenium type, with a light sensitive area of approximately two square inches. A semi-transparent layer of platinum is deposited on the selenium, with a considerable increase in sensitivity as a result. An efficiency of about 1/20 of a watt per square foot in direct sunlight can be obtained.

• • •

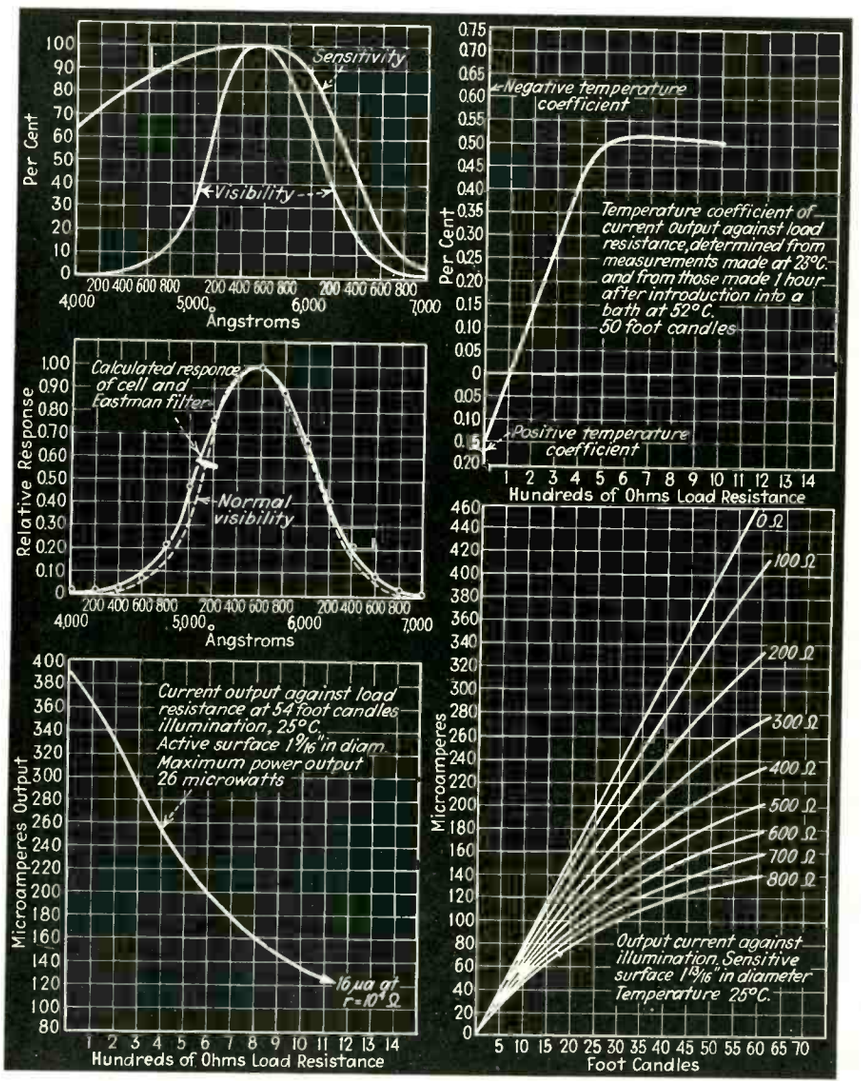
Grid Bias Scheme Eliminates Feed Back Trouble

THE CIRCUIT SHOWN in the accompanying illustration has been devised by Mr. Walther Richter, Director of Electrical Research of the A. O. Corporation. It provides a means of obtaining grid bias voltage by the use of an extra tube connected as a diode. A type 27 or 56 tube is connected as a diode across one-half of the high voltage transformer winding which supplies the usual full-wave rectifier tube, the plate of the 56 being connected to the center tap of the transformer through a dropping resistance shunted by a high capacity. The voltage which appears across this dropping resistor may be used for biasing the grids of tubes supplied by the rectifier, the proper voltage being obtained by the potentiometer arrangement shown.

This means of obtaining grid bias voltage is particularly useful for direct current amplifiers, since changes in the current taken from the full-wave rectifier do not affect to any great degree the values of bias voltage appearing across the dropping resistor. It is usually desirable to heat the filament of the 56 diode by means of a separate transformer, in order to avoid high voltage across the heater insulation. If fuses are used, however, it is possible to connect the diode heater directly to the common filament transformer the fuses acting as a protective device in case the insulation of the heater breaks down.



Grid-bias circuit



Quantitative data on the G. E. Blocking Layer selenium-platinum self-generating photocell

TUBE DETAIL 20C
BROADCAST TRANSMITTER

A transmitter manufacturer and a maker of scientific instruments have much in common. Both must be able to solve technical problems of the first order—both must be able to measure the performance of their products with precision—both have a very limited clientele—both depend upon their reputations for technical integrity to obtain acceptance of their products.

Recognizing this parallel, the Collins Radio Company is engaged in the highly specialized field of building transmitting equipment. Its engineering staff is uncompromising in its work of building a fine product. Statements as to rating and performance are made with the scientist's regard for accuracy. Knowing that customers for a single model are numbered in the hundreds and not in the tens of thousands, efficient small scale factory methods are used, since mass production methods are unsuited. Its workmanship is worthy of the best traditions of the instrument maker.

COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA ★ NEW YORK, 11 West Forty-Second Street

THE ELECTRON ART

EACH month the world's technical literature is scanned to see what physicists and engineers are doing with tubes, for presentation in tabloid form to Electronics' readers.

Adjustable Band Pass Filter with Flat Top

[H. FRUHAUF]. The ratio input to output voltage measured across the condensers, is in the case of an ordinary inductivity coupled band pass filter with identical elements in both halves equal to

$$= \frac{I_p}{I_2} = - \frac{C}{M} ((R + j X)^2 + p^2 M^2)$$

where $X = pL - 1/pC$

is the reactance of each tuned circuit. Flattening and sagging of the top of the transmission curve occurs as soon as pM/R exceeds unity. In improved receivers M is desired to be adjustable; it may be written $M = xR/p$. Assuming that in the worst conditions for reception x must be reduced to unity, the ratio t becomes apart from the phase equal to

$$t = - 2 p R_1 C_1 \sqrt{1 + 4\left[\frac{dL}{R_1}\right]^4}$$

at the frequency p, which lies d cycles from the carrier frequency P. For an arbitrary x

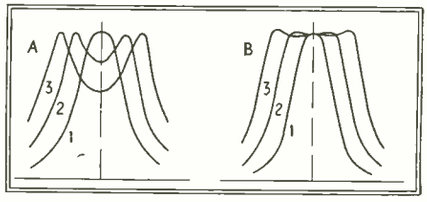
$$t = 2p R_1 C_1 \sqrt{\frac{(1 + H^2)^2}{4} + 2 (1 - H^2) \frac{d^2 L_1^2}{R_1^2} + \frac{4 d^4 L_1^4}{R_1^2}}$$

For $d = 0$, the value t is $2p R_1 C_1$. In the case of critical coupling, that is when $H = pM/R = 1$, t increases steadily from t_0 as d is increased; in the case of an arbitrary H, t may first increase, then decrease and increase again when H is larger than unity and d is large. The formation of the double hump then produced could be prevented by a change in the circuit which would suppress the term $2 (1 - H^2) d^2 L_1^2 / R_1^2$.

One way of achieving this is to use a tuned circuit in the plate of the tube following the band pass filter. The ratio t of the filter must then be multiplied by the ratio t_0 of the amplifier. Taking moreover into account that a.v.c. will maintain the carrier amplitude regardless of the value given to H, so that $H = 1/H$ is constant, with $d = 0$ in this case, a formula results which contains d^2, d^4 and d^6. The term in d^2 disappears when

$$\frac{8 (1 - H^2)}{(1 + H^2)^2} + \frac{4}{a^2} = 0,$$

where a is the ratio of the resistance in the tuned circuit to the resistance



(A) Typical band-pass response curves showing humps produced by increasing coupling

(B) Curves produced when band-pass filter is followed by amplifier with tuned circuit

R_1 in the filter. When H varies between 1.5 and 4, the value of a remains at about 2.5, that is, within this range the modified filter has a nearly flat top. It remains to be seen how it is to be connected in the set.—*H. Fr. Tech. El. Ak.* 46: 160-164. 1935.

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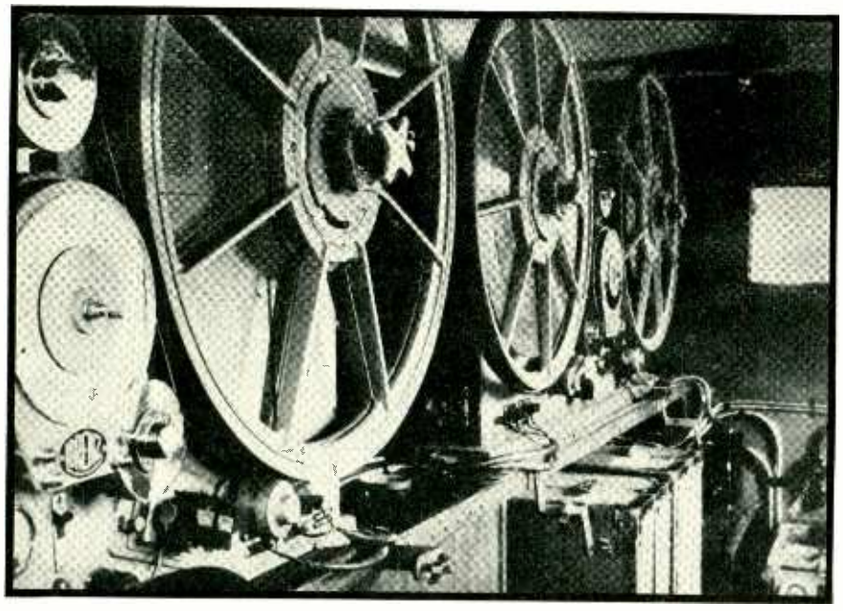
TRUCK-RECORDER FOR GERMAN BROADCASTS



This self-contained steel-tape magnetic recorder, installed in a truck, is used in Berlin to gather opinions from the man in the street, news events, etc., which are later broadcast in an evening program called "The Echo of the Day"

Comparison of Properties of Electrons, Positrons, etc.

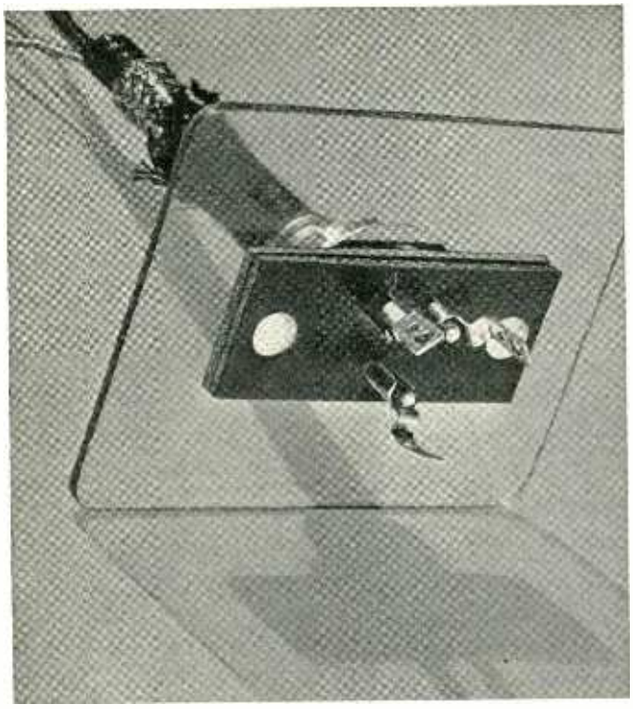
FOLLOWING IS A LIST of the physical and electrical dimensions of the fundamental particles now known to science, compiled by Dr. Richard E. Ruedy of Ottawa, Canada.

Fundamental Particles

	Electric Charge	Mass	Spin	Magnetic Moment	Year of Discovery
Electron	$-e$	$0.00054H$	$h/4\pi$	$1m$	1890–1900
Positron	$+e$		$h/4\pi$		1932
Proton...	$+e$	$1.0072\ H$	$h/4\pi$	$2.5\ m$	1900
Neutron..	0	$1.0080\ H$	$h/4\pi$		1932
Deuteron	$+e$	$2.0131\ H$	$h/2\pi$	$0.85m$	1933
Alpha....	$+e$	$4.0011\ H$	0	0	1896–1900

Where $H = 1.649 \times 10^{-24}$ gram
$e = 4.77 \times 10^{-10}$ e.s.u.
$m = 0.92 \times 10^{-20}$ ergs/gauss
$h = 6.55 \times 10^{-26}$ ergs/sec.

In studying the different fundamental particles use is made of the fact that when possessing high speeds they break up atoms into electrons and positively charged particles which favor the condensation of water vapor in the form of droplets which can be photographed. A magnetic field de-



NEW "CINCH" PLUG

SMALL—CONVENIENT—ELIMINATES PICK-UP INTERFERENCE

For antenna, pilot light, tone control, "A" leads and speaker cables of automotive receivers, use this shielded-grounded plug with positive contact. Small, this new "CINCH" plug is handy, efficient, a great space-saving convenience.

WILL PASS THRU A 5/8-INCH HOLE

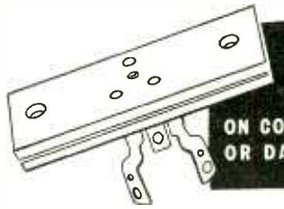
Choose "CINCH" and solve a problem. The component parts of this "CINCH" plug are easy to attach to the chassis and cables. And with a considerable saving in assembly labor! Consider these advantages (a) vibration-proof electrical contact; (b) positive grounding of plug and cable assembly to automotive receiver; (c) complete metal shielding with positively no leakage at point of plug insertion; (d) grounding ring and socket mounted at the same time. These "CINCH" plugs supplied in polarized two, three and four-prong styles.

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

No. 2710 PLUG CAP WITH CURLED EDGE, CONVENIENT SURE GRIP FOR A HAND PULL.

No. 2735 MALE 3 PRONG POLARIZED PLUG WITH SMALL .093 DIAMETER PINS SECURELY ASSEMBLED IN BAKELITE.

No. 1110 GROUNDING RING WITH EIGHT GRIPPING FINGERS FOR A POSITIVE GROUNDING SPRING CONNECTION WITH MALE CAP AND ITS SHIELDED CABLE.



No. 2633 SOCKET WITH ORIGINAL "CINCH" FLOATING CONTACTS, WITH CUTTING EDGES. SOLDERING TAIL ON CONTACTS, IS PROVIDED WITH POCKET OR DAM TO RECEIVE SURPLUS SOLDER.

CINCH

MANUFACTURING CORPORATION

2335 West Van Buren St., Chicago, Ill.

Subsidiary: United-Carr Fastener Corporation, Cambridge, Mass.

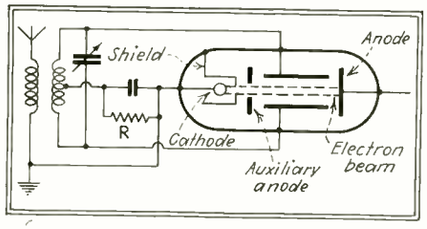
flects swift charged particles. Electrons make up the "atmosphere" of an atom, all the other particles form part of the central core and are much more difficult to obtain. In the same units, the mass of the earth is 5.97 x 10^{27} grams, its charge—4 x 10^{15} e.s.u., its magnetic moment 8.4 x 10^{25}.

• • •

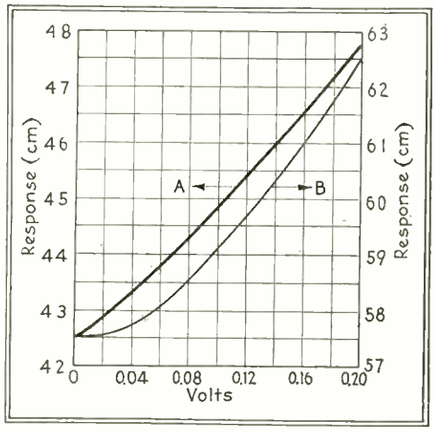
Cathode-ray Tube Detector

COMING FROM DENMARK is a new tube, described in *Wireless World*, November 8, 1935, which presents a most interesting design. It will remind American readers of the 6E5, the cathode ray beam tube used for tuning meters in this country.

This new tube is shown in circuit and cross section in the figure. A cathode is shielded from an anode except for a small hole much as in a cathode ray tube gun. The cathode shield



known as the concentrator is operated at a negative potential. Two plates running the length of the tube again correspond to cathode ray tube practice and may have various voltages applied to them thereby deflecting the beam of electrons emitted by the cathode. For example in the circuit, the electrons are alternately directed to one and the other plate forming a full-wave rectifier or detector. As the curves show, the tube has a much more linear characteristic for detection than a typical pentode. It is said that as an r-f amplifier, less damping is placed upon the tuned circuits and that the



voltage gain is slightly higher than with conventional tubes. The tube is called the "renode."

• • •

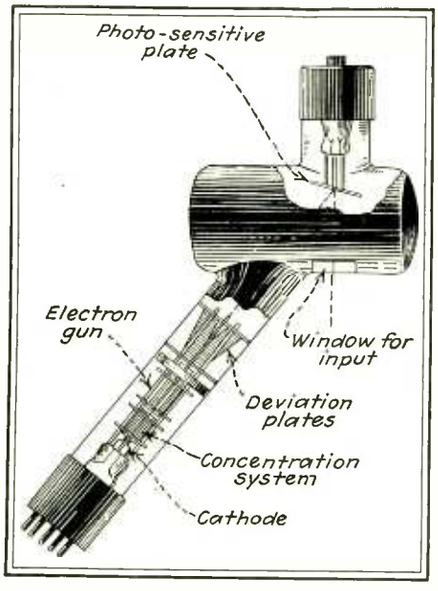
Television in France

[P. HEMARDINQUER]. On November 18, 1935, a regular service of high definition television was started. The wave-length used is 7 meters, the power 2.5 kw., to be increased to 20 kw. next April. The station is housed in the northern edge of the Eiffel tower and is connected with the antenna, on the top of the tower by means of a concentric cable 330 meters long, 10 cm. in diameter. The program may now be received within a radius of 20 km., later within a radius of 50 to 60 km. The studio is in the building housing the Ministry of Post, Telegraphs and Telephones, 2.5 km. from the tower. The picture consists of 180 lines with 25 cycles per second, a scanning wheel with double spiral each with 90 holes being used. The studio is provided with six projectors at 5 kw. each; the heat which they produce within a short time is carried away with the aid of a powerful air-conditioning system.—*La Nature*, No. 2968: 1-3, 1936.

WEIGHT BY VOICE

This weighing machine, recently exhibited at Brussels, announces the exact weight of the customer by means of a loudspeaker and record system

NEW ITALIAN TELEVISION SCANNER



Arturo Castellani with his télépantoscope, a cathode ray television scanner similar to those developed in this country by Zworykin and Farnsworth. Italian television experiments by the Safer Company in Milan have made use of a 500 watt, 7 meter image transmitter in conjunction with a 50 watt, 5 meter sound transmitter. A receiver (240 lines 25 frames per second) is available for approximately 640 dollars

• • •

Receiver Tube Measurements at 60 mc.

FOR SEVERAL YEARS Philips of Holland has distributed to a selected list of customers throughout the world a most excellent bulletin known as their *Set-makers Bulletin*. The issue of February 1936 contains much data on measurements giving the properties of vacuum tubes on frequencies between 1.5 and 60 mc.

Methods by which anode impedance, mutual conductance, grid impedance,

and reaction of anode on grid for typical Philips tubes, are given in the bulletin as well as the results of the work. A diode voltmeter of special construction, good to 70 mc. was employed.

A screen grid tube (AF3) showed an anode impedance of 1.2 megohms at 62.5 meters, 0.54 megohms at 20.4 meters and 0.054 megohms at 5.05 meters. Mutual conductance did not change appreciably at any frequency up to the highest at which tests were made; grid impedance decreases as is well known. The AF3 had an input. The capacity remained at 7.0 μf from 230 to 5.6 meters, but the resistance decreased from 3.3 x 10^6 ohms to 0.0097 x 10^6 ohms at 5.6 meters. The absolute value of the impedance between grid and plate changed from 11 megohms at 58.5 meters to 0.34 megohms at 12 meters to 25100 ohms at 5.2 meters.

In the same issue of the Bulletin is the first part of a dissertation on precautions for reducing the damping effect caused by a diode on the preceding circuit and some remarks on grid emission.

The March of Electronics

[*Continued from page 9*]

the bridge which throw the bridge out of balance at the low frequencies when the bulb resistance is not high, i.e. at low levels. The resulting expansion and bass-boosting characteristics are shown in the figure.

Automatic Frequency Control

DURING THE PAST months considerable interest has been shown in circuits insuring that selective superheterodynes be correctly tuned. Greatly simplified circuits are now available, and it is highly probable that sets will be on the market using a.t.c. by mid-summer.

Early systems (see ELECTRONICS, January, 1935) used "side" circuits tuned above and below the i-f frequency so that rectified potentials produced by signals differing from the i.f., differed in polarity depending upon which side of the resonance frequency they happened to be. The circuit shown, from a paper given by S. W. Seeley of the RCA License Laboratory at the Emporium Section, I.R.E., recently shows a newer method. Here the action depends upon the fact that a 90 degree phase difference exists between the primary and secondary of a double tuned, loosely coupled transformer when the resonant frequency is applied and that this phase angle varies as the applied frequency varies.

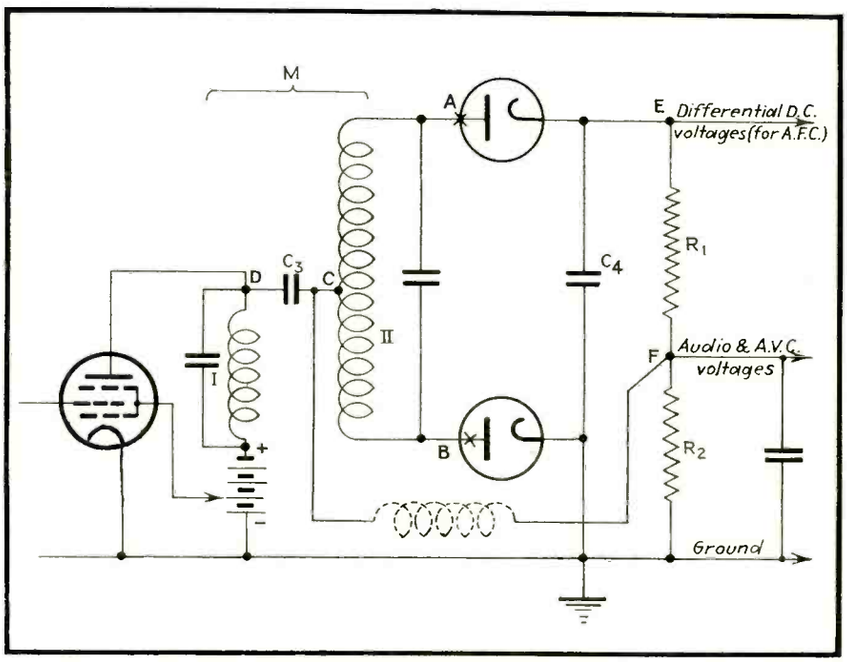
Referring to the figure, circuits I and II, tuned to the same frequency, are mutually coupled and connected together. The reactance of C_3 between C and D is small at the frequency of operation and isolates the d-c plate potential of the primary. The diodes are conventional except that they must have separate cathodes. Type 6H6 tube fulfills this condition. The diode cathodes are connected together by C_4 which is connected to ground. C_4 must have low impedance at the operating frequency and it is desirable that it be low at modulating frequencies. The resistances R_1 and R_2 are equal (.5 or 1.0 megohm). The center point F between them is connected to the center tap C on the secondary.

If the resonant or "center" frequency is applied to the grid of the amplifier tube, equal amplified voltages will exist between A and ground and between B and ground. These are rectified by the diodes and direct currents will flow in R_1 and R_2 in opposite directions with respect to ground. Thus, the net d-c potential produced by the two IR drops between E and ground is equal to zero. If, however, the applied frequency departs from resonance the potentials across the diodes will be unequal in magnitude, unequal IR drops will be produced in the two resistors and a d-c potential will exist between E and ground, the polarity of which will depend upon the sign of the frequency departure.

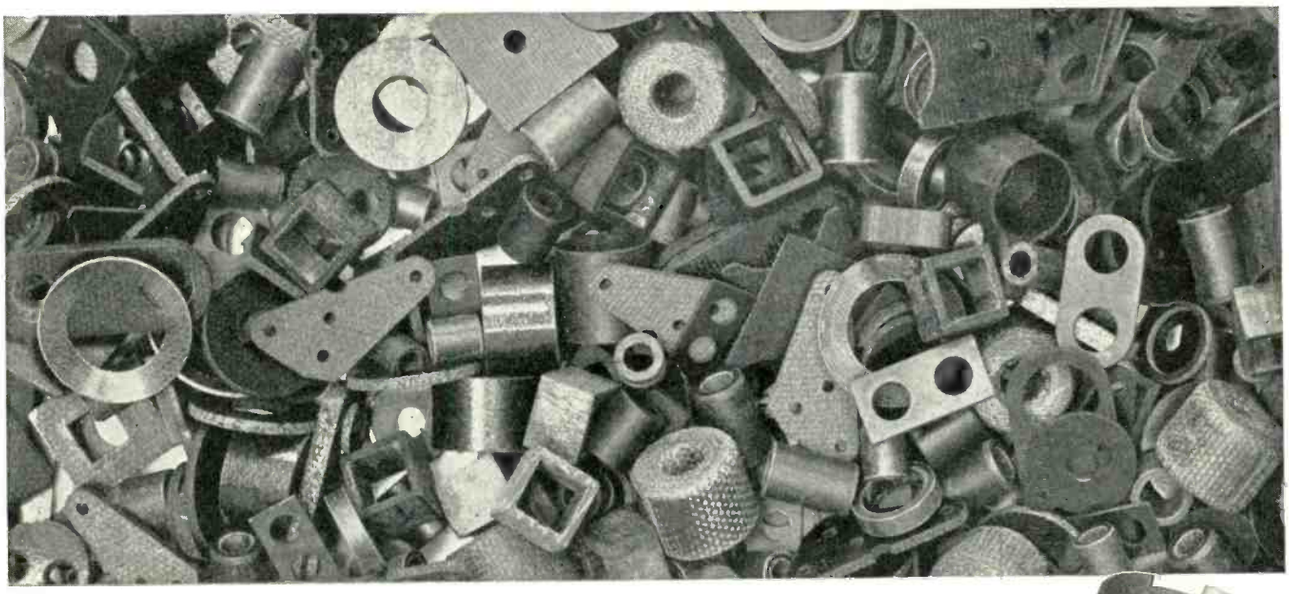
The diodes act as detectors and a-v-c tubes also, so that a-f and a-v-c voltages also may be derived from the rectified output of this circuit, as well as differential d-c potentials, avoiding the use of additional tubes and tuned circuits.

The d-c potentials resulting from this action may be used to affect the bias voltage of a controlled tube, say the oscillator, thereby affecting its tuning frequency and bringing it back to a frequence from which it may be tending to drift. Or, the d-c voltages may be used to drag the oscillator into correct tuning when the set operator adjusts the tuning control to the vicinity of the proper tuning adjustment.

Thus the system provides automatic frequency control which compensates for frequency drift of oscillators and other parts, from any cause, is assurance of correct tuning, and makes possible automatic tuning where the operator accomplishes tuning merely by pushing buttons or levers which turn the condensers to approximately correct settings after which the a.f.c. takes command and completes the tuning process.



Automatic frequency control circuit. The choke is optional



Easy-to-Work
TUBING AND INSULATING PARTS

FORMICA YRT tubing is the easiest to work of any tubing Formica has ever made—30 per cent more flexible than previous tubing. Formica also has sheet material, like cold punching stock, developed to emphasize machining and working qualities.

For big production Formica can provide the materials that will go through your factory fastest, with least loss through spoilage. And these grades are thoroughly adequate from the electrical point of view.

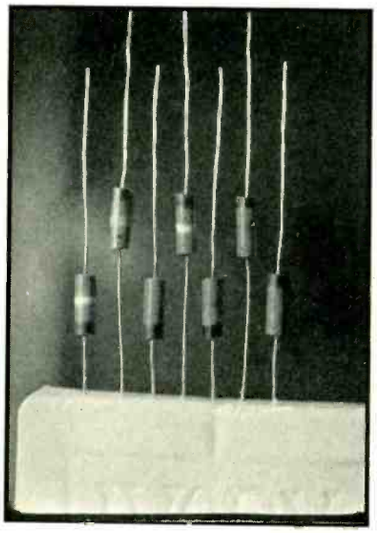
Send us your inquiries for sheets and tubes or your blue prints for machined parts.

FORMICA

THE FORMICA INSULATION COMPANY
4638 SPRING GROVE AVE. • • CINCINNATI, OHIO

MANUFACTURING REVIEW

New Products



Insulated Resistors

STACKPOLE CARBON COMPANY, St. Marys, Pennsylvania, announces a new insulated resistor, with the following physical dimensions:

Body of resistor is $\frac{5}{8}$x13/64 in., lead wires are No. 20 B&S gauge and extend 2 in. from the body of the resistor. The insulation around the resistor unit consists of a high grade of phenolic resin. This resin is molded around the resistor and end connections so as to fully enclose and insulate the entire body of the resistor. This insulation will safely withstand 1,500 volts and permanently seals the resistor against outside effects, such as high humidity, oil, etc.

This new resistor is conservatively rated at $\frac{1}{2}$ watt and may be used in any circuit, in which the load across the resistor unit is $\frac{1}{2}$ watt or less, with assurance that the resistance value will remain unchanged.

Resonance Indicator

A METAL ENCASED resonance indicator making use of the 6E5 electron eye tube is announced by the Technical Appliance Corp., 17 E. 16th St., New York City. This device may be used to indicate the degree of resonance for accurate tuning of a set or individual r.f. and i.f. circuits. This may also be used as an output meter, checks for "opens" or "shorts" in component parts and circuits. Uses two 6H6 metal tubes in conjunction with the 6E5 electron-eye tube. One 6H6 is used as a linear diode detector, the rectified signal of which is amplified by the triode section of the 6E5 and applied to the control element of the latter's electron ray section. The second 6H6 is used in the voltage doubling circuit to supply the plate power for the 6E5.

Vibrators

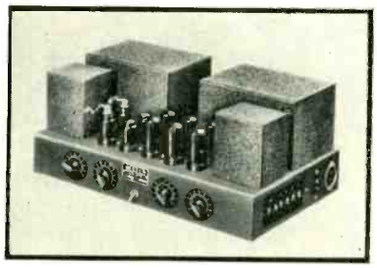
A NEW LINE of heavy duty vibrators, designed especially for police radios and transceiver work, has been announced by Electronic Laboratories, Inc., of Indianapolis.

These new vibrators use large contact points, approximately twice the diameter of the contacts used in standard types. These larger contacts, electronic engineers advise, increase the current carrying capacity and life of the heavy duty vibrators. Tests conducted over the past several years, under actual operating conditions in police car radios throughout the country, have demonstrated that these new heavy-duty units have a life of two and a half to three times of ordinary vibrators.

The non-synchronous models are plug-in units on a four-prong base, while the synchronous types are on a standard five-prong base. Any of the heavy duty units will be built to order for police radios in which the vibrator base wiring is not standard. The new heavy duty vibrators will list only slightly higher than standard vibrators.

Metal Tube Amplifier

MORLEN ELECTRIC COMPANY, INC., 100 Fifth Avenue, New York City, offers a new public address amplifier using all-metal tubes in all stages. This amplifier uses two 6F5 and two 6C5 triodes in the voltage amplifier, two 6F6 triodes as "power-drivers" and four 6F6 output tubes. The amplifier will

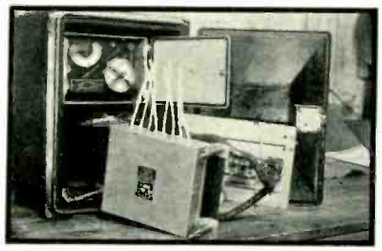


deliver 38 watts normal and 45 watts in heavy-duty speech service. It has a dual mixer input and dual output impedance. This new amplifier can be used in practically every class of P.A. service.

Oil Process Condensers

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

Use is made of a newly refined oil termed Micranol in the manufacturing process. These condensers are said to withstand peak surges of thousands of volts and will give long faithful service under hard-working conditions. They



are sealed against moisture absorption; housed in round aluminum containers with porcelain insulator supported terminals; and mount very easily by means of ring clamps.

The condensers have a working voltage of 2000 volts d.c., and are tested at 6000 volts d.c. The 1 μf size comes in a container $3\frac{3}{8}$"x$2\frac{1}{2}$" in diameter. The 2 μf unit is $3\frac{3}{8}$" high by $3\frac{1}{4}$" diameter.

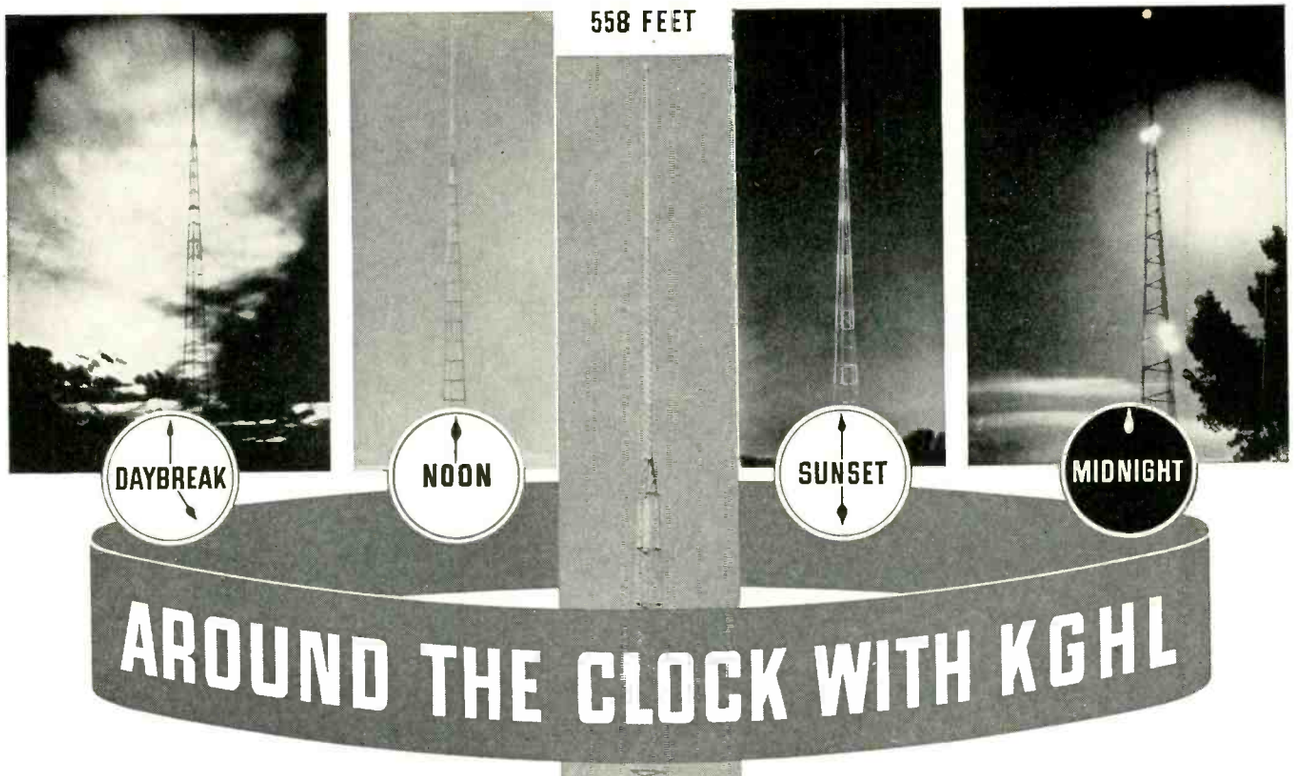
It is stated that a feature of these new condensers is their extremely low cost to the amateur or experimenter. A bulletin Form No. EC-1 describing them is sent free upon request.

Sound System

THE TURNER COMPANY, Cedar Rapids, Iowa, offers a general purpose sound system, designed to meet the need of hotels, lodges, churches, schools, etc. "Porti-Vox," as this system is named, consists of a speaker-amplifier unit, microphone and outlying speaker, and sells for $112.50 complete or $95.00 without the outlying speaker.

Battery Pentode

ERROR: Hygrade Sylvania pentode 1F4 is enclosed in an ST-14 bulb, instead of ST-12, as reported on page 54, Feb. *Electronics*.



AROUND THE CLOCK WITH KGHL

Daybreak . . . noon . . . evening or midnight, KGHL's Truscon self-supporting vertical radiator can utilize the station's assigned power with the maximum efficiency. Night fading is eliminated.

Truscon vertical radiators include the antenna itself, insulation, counter-poise system and bases. These economically-designed, self-supporting structures are mechanically sound, electrically efficient and are available in fractions up to five-eighths wave length for the complete range of broadcasting frequencies.

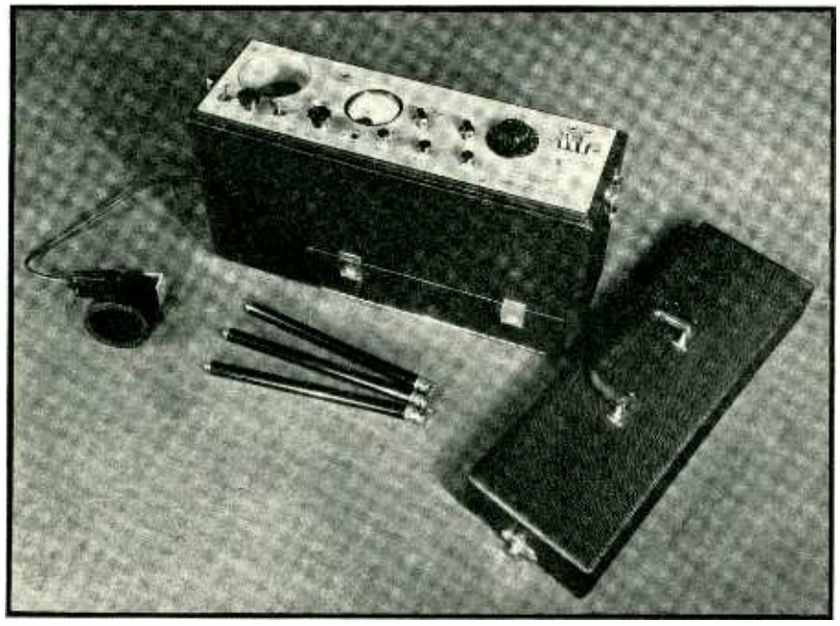
Another important feature is radical reduction in overturning moment at base (due to wind load on structure) in comparison with conventional tower design. Smaller mechanical load on the insulators permits narrow base with resultant minimum insulator and shunt capacity. Improved performance is insured.

Truscon offers expert cooperation to station executives, operators, radio consultants and engineers in determining the most efficient and economical design to meet *your* station's requirements.

TRUSCON VERTICAL RADIATORS

TRUSCON STEEL COMPANY • YOUNGSTOWN, OHIO

If you are unfamiliar with the location of the Truscon sales office in your vicinity, write direct to Truscon Steel Company, Youngstown, Ohio.



Erpi sound level noise meter

Noise Meter

ELECTRICAL RESEARCH PRODUCTS, INC., 250 West 57th St., New York City, has a new sound level meter, model RA-142 designed to meet the tentative standards of the American Standards Association.

Among the outstanding features of the equipment are the calibrating oscillator and receiver, permitting overall field calibration of microphone and amplifier; extreme compactness and light weight (34 lb. complete with batteries); high sensitivity (20 db. above the A.S.A. reference level).

This meter uses a Western Electric 618-A transmitter, standard studio-type moving coil microphone, and has provision for selection of either flat or ear response characteristic by the operation of a key.

Dielectric Tester

A NEW DIELECTRIC or breakdown tester manufactured by the Acme Electric & Mfg. Co. of Cleveland, Ohio, not only indicates shorts, opens, or grounds—but actually checks circuits at approved standard testing voltages. The manufacturer states that this unit is entirely different from insulation testers now in use—in that the Acme tester will permit actual application of the standard testing voltage of double the rated voltage plus 1000 to the appliance device or equipment under test and thus prove the dielectric strength of the insulation to meet standard safety limits. Any windings with rotted, old or defective insulation, below minimum safety standards would break down under test necessitating proper rewinding or repairing and thus preventing the usage of unsafe, electrical equipment.

The Acme Dielectric tester is a compact complete unit operating from 110 volts, 60 cycles. Secondary connections are supplied with four-foot high-voltage cable leads each equipped with test prong. The secondary test voltage is manually controlled by a tap-switch that provides any voltage; 500, 1000, 1250, 1500, 1750, 2000, or 2500 volts. The short circuit current is 1 amp. at 500 volts and 200 m.a. at 2500 volts. The 100% leakage type transformer used in this device permits short circuit without damage. This current limitation also eliminates burning of materials at point of breakdown of apparatus under test.

Acme engineers point out particularly the use of a second secondary winding on the same common core, but shielded from the high voltage secondary. This second secondary supplied 110 volts to a small indicating ruby lamp. Lamp is inset and shielded by metal mask. This lamp glows when the device is turned on—thus warning operator of live secondary leads. On partial breakdown the lamp dims and on complete breakdown goes out.

Universal Remote Control

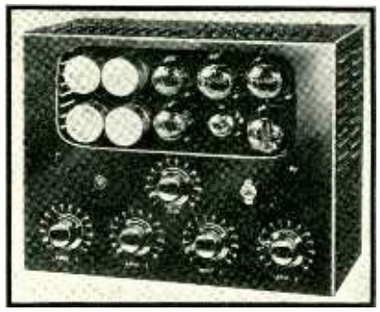
KAY PRODUCTS OF AMERICA, INC., 562 DeKalb Ave., Brooklyn, N. Y., presents a new modern auto-radio remote control unit embodying "wrist-watch" finger control, full airplane dial calibrated in kilocycles, escutcheons with chromium knobs harmonizing with all car interiors.

This new control permits easy custom-instrument panel installation of all makes and models of auto-sets without the necessity of cutting the dashboard or difficulties in fitting. There are no visible bolts or screws. Adapter couplings are supplied for all cables.

Kay controls are supplied in various gear ratios to fit any auto-radio receiver. Escutcheon plates supplied additionaly matching the dash finish of all 1935-1936 cars.

Crystal Microphone Mixer

WEBSTER ELECTRIC COMPANY announces model 4P-15 a mixer which will do the work of 4 preamplifiers. It uses four electronic mixers. Any of the four inputs can be used for phonograph pickup as well as crystal microphone. As in all Webster-Chicago models of this size it has tapped output to accommodate the various groups of speakers required. The undistorted output is 15 Watts.



Specifications of Model 4P-15

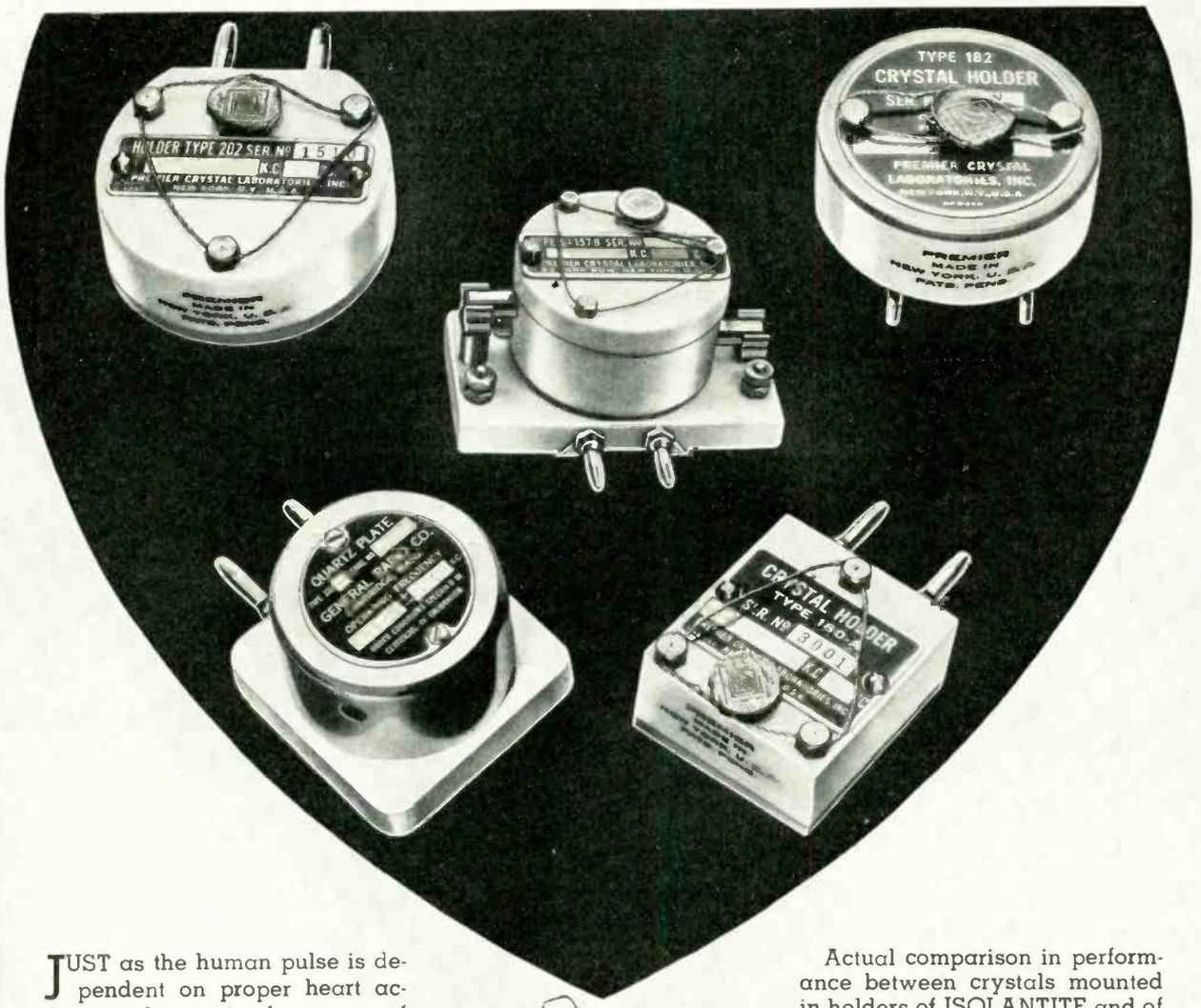
Number of stages 4, Tubes required 4-6C6, 2-6A6, 1-76, 2-2A3, 1-5Z3; Gain at 400 cycles 117 db.; Hum level 26 db below zero level; Power output 15 watts, Output impedance 2, 4, 6, 8, 16, 500 ohms.; Input Impedance for 4 crystal microphones; Speaker requirements a-c type; Power consumption 120 watts, Overall dimensions 7½"x10½"x 13½"; Net Weight, 30 pounds.

The Webster Electric Company, Racine, Wisconsin.

All-Wave Antenna

RCA MANUFACTURING COMPANY, INC., Camden, New Jersey, offers a new all-wave antenna, consisting of a special doublet, a transposed transmission line, an antenna junction box and a receiver coupling unit. The antenna acts as a pick-up medium, giving high signal strength over an extremely wide frequency range. The transmission line conveys this energy from the antenna to the receiver, and the receiver coupling unit matches the transmission line to the input receiver circuits.

Is your pulse strong and steady?



JUST as the human pulse is dependent on proper heart action, so the carrier frequency of your transmitter is dependent on the proper functioning of its crystal.

Crystals mounted in holders made of ISOLANTITE generate frequencies of greater amplitude and precision than where other insulating materials are employed.

Actual comparison in performance between crystals mounted in holders of ISOLANTITE and of organic materials has shown more than 75% increase in transmitter output where ISOLANTITE was employed.

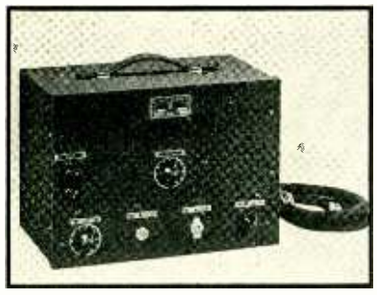
Avoid frequency drift and assure increased output by insisting on ISOLANTITE crystal mountings. Isolantite, Inc., 233 Broadway, New York, N. Y. Factory at Belleville, N. J.

Isolantite
CERAMIC INSULATORS

Converters

THE MODEL 81 frequency modulator unit recently announced by the Clough Brengle Co., 1134 W. Austin Ave., Chicago, Ill., converts any standard oscillator into a frequency modulated unit for cathode ray oscillographs.

This device employs the fixed-sweep principle introduced by this company, producing a selectivity curve accurately calibrated in frequency widths. The



output of the oscillator is connected to the input of the model 81 whose frequency modulated output is in turn connected to the receiver under test. This eliminates the necessity of installing a jack or other alterations which may destroy the instrument's accuracy of calibration. Net price of this device complete with tubes and built-in sweep motor is $34.25.

High Wattage Attenuators

FOR CONTROLLING the volume of high powered amplifiers and public address systems, the Ohmite Manufacturing Company, 4835 W. Flournoy Street, Chicago, has recently brought out a new line of high wattage T-pads and L-pads. These units offer almost stepless control of high power amplifiers. The resistance elements used in these pads are Ohmite, all-porcelain, vitreous enameled rheostats which are not affected by weather or temperature conditions. There are two lines, rated at 25 watts and 50 watts. Because the contacts ride directly upon the resistance elements, constant, smooth graduation is obtained. These attenuators were designed to control the volume of individual speakers or groups of speakers, and are connected between the speakers and amplifier. Units are enclosed in black metal housings and are furnished complete with molded knobs and etched dial plates. Attenuators to match all standard line impedances are carried in stock.

Alloy

KOVAR, A PATENTED ALLOY developed in the Research Laboratories of Westinghouse Electric & Manufacturing Company, is one of the developments important in perfecting metal tubes. This alloy has the same coefficient of expansion as certain glass, and wets the glass when heat is applied, a perfect seal can be made between the two materials. Kovar is used in metal tubes in the form of eyelets welded to the steel header, and into which leads are sealed with hard glass. Distributed by Stupakoff Laboratories, Inc., Pittsburgh, Pennsylvania.

Sight-light Indicator

A COMPACT PHOTOELECTRIC illumination meter recently introduced is expected to add new impetus to the "Better Light-Better Sight" movement by increasing the simplicity and effectiveness of room illumination tests. A product of the Weston Electrical Instrument Corporation, the new unit is of vest-pocket size, yet covers a wider range of illumination values on a single scale than any previous type.

Illumination values as high as 250 foot-candles are read directly from the scale. The scale is so spaced that low

illumination levels are fully and legibly indicated. The scale is divided into five "seeing task" zones, set off by colored divisions. The back of the indicator contains an embossed metal plate classifying specific seeing tasks so completely that no assumptions need be made by the user.

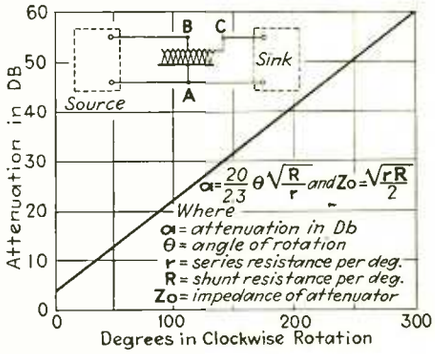
Measuring $2\frac{3}{8}$x$2\frac{3}{4}$ inches, the unit is truly of vest-pocket size, and rounded corners add to its convenience from this standpoint. Retail price of the new Sight-Light Indicator is $12.50 throughout the United States.

Aluminum Record Blanks

UNIVERSAL MICROPHONE COMPANY, Inglewood, California, has developed a line of blanks made of a composition coating of special alloy aluminum material, that is not subject to deterioration from age. Speech, music and other programs or messages can be placed in storage and kept for long periods without frequency loss or the accumulation of background noise.

Attenuators

ELECTRAD, INC., 173 Varick St., New York City, announces a new development in attenuators, involving a new principle in design, making it possible to obtain a substantially constant impedance unit whose attenuation is linear in db and continuously variable over the entire range.



To accomplish this attenuation a variable ladder network consisting of a series element on which the contact rids, and which has a shunt element connected to it along its entire length, is used.

The BN attenuators are available in line impedances varying from 15 ohms to 10,000 ohms, listing at $3.00.

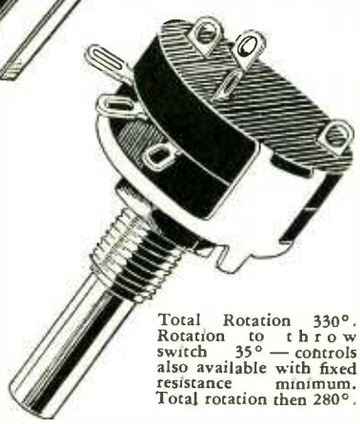
Velocity Microphone

THE NEWEST microphone offered by Amperite Corp., 561 Broadway, New York City, operates directly into the grid of the tube eliminating the input transformer and inherent noises. This microphone is capable of high fidelity reproduction at minus 45 db. It has a gradual rising characteristic (7,000 to 11,000 cycles per second) which results in a desirable brilliancy of reproduction.

Auto Antenna

NORWEST RADIO LABORATORIES, Shelby, Montana, has a new auto antenna designed principally for all steel, turret top cars and for use in isolated districts where signal strength is low. Will perform equally well on fabric topped cars and will add to the streamline appearance of any car. Mounted on rubber vacuum cup standoffs with aluminum tubing for high conduction. No holes to drill in top—increased pickup because of less absorption—low motor noise level obtained by shielding effect of car top—not affected by wet weather—will not short from ice, water or mud. Lists at $7.50 for coaches and sedans; $6.50 for coupes.

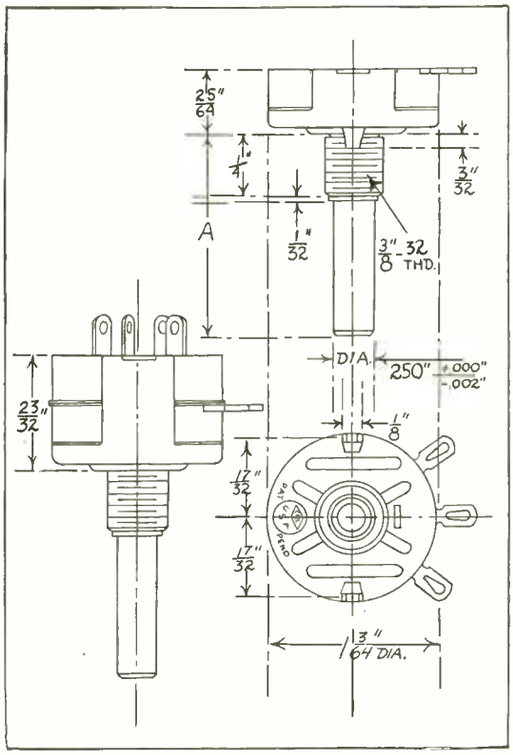
the New MIDGET Radiohm



Total Rotation 330°. Rotation to throw switch 35° — controls also available with fixed resistance minimum. Total rotation then 280°.

● **Centralab climaxes 13 years of variable resistor production with a control styled and engineered for modern, sensitive radio circuits.**

Built to supply a low noise level variable resistance in smallest practical diameter. The long resistor on the inner circumference, (long a Centralab Radiohm feature) is particularly advantageous in small diameter controls.



The MIDGET RADIOHM provides volume or tone control in single, twin or triple assemblies, as rheostat, potentiometer or with 1, 2, or 3 taps on resistance at choice of six different degrees of rotation. All assemblies available with or without Switch.

Switch Data: S.P.S.T.; D.P.S.T.; S.P.D.T.; four point. S.P.S.T. switches also available with dead lug. S.P.S.T. switch rating: 3 amps. 125 volts; 1 amp. 250 volts; 10 amps. 12 volts.

CENTRALAB *Div. of Globe Union Mfg. Co.*
MILWAUKEE, WIS.

Centralab
CRL

VOLUME CONTROLS
FIXED RESISTORS
SOUND PROJECTION CONTROLS
WAVE CHANGE SWITCHES

NEW BOOKS

Phenomena in High Frequency Systems

By AUGUST HUND. *McGraw-Hill Book Company, New York, 1936. (Price $6.00, 642 pages.)*

IN 1933 DR. HUND'S first book in English appeared. "High Frequency Measurements" has enjoyed a wide sale in the three years it has been available. This new volume, a companion to the first in many ways, has been placed with the other in the International Series in Physics, editor by F. K. Richtmyer. That is an endorsement that should mean a great deal to those students who are familiar with the series dealing with fundamental physical phenomena. But those who own only the Hund first volume in the Series will have a good sample by which to judge the present volume.

The book is a thorough survey of the field its title covers. The author is thoroughly familiar with classical experience and theory; and he draws upon the technical literature of the world in giving the reader a complete picture of the various phenomena with which the communication art deals. Dr. Hund follows the excellent style used in his earlier volume in not only giving a good exposition of the theory but of following this theory with circuit values as may be found in practice, thus furnishing a newcomer to some particular phase of the subject with all the equipment he needs to thoroughly understand the phenomenon.

There are long chapters on high frequency generators, voltage and current changers, frequency changers, rectification and inversion, amplifiers, electrostriction, electromagnetic theory, antennas and long and short lines, directive systems, recurrent networks.

The book is strongly recommended.—K. H.

Electrical Measurements in Principle and Practice

By H. COBDEN TURNER and E. H. W. BANNER. *The Instruments Publishing Company, Pittsburgh, Pa. (380 p., 219 fig.; Price $4.50.)*

THIS BOOK, one of several English works made available in this country by the same publisher, is intended as a guide for engineers and others who do not intend to specialize in electrical measurement practice, but who are interested in supplying measurement technique to their own practical problems. The authors have been successful in creating a practical book, avoiding the mathematical treatises characteristic of many books on the subject. Information on electrical units and standards is combined with detailed descriptions of measuring instruments, followed by sections on their uses in the fields of measuring electrical quantity, characteristics and properties of apparatus, and indirect electrical measurements. Although written from the British point of view, and concerned primarily with British standards and apparatus, the work is readly adaptable to American practice.

Atomic Physics

By MAX BORN. *Authorized translation from the German by John Dougall. G. E. Stechert Company, New York, 1936. (352 pages, illustrated. Price $4.75.)*

DR. BORN'S authority in modern physics theory and experiment is sufficient to direct attention to this book under any circumstances. The excellent arrangement of the book and its careful rendering in English by the translator has added to its value, particularly for those readers whose mathematical training does not extend beyond elementary calculus. Writers in the field of modern physics, especially when they concern themselves with such subjects as quantum statistics, must always make use of mathematical concepts not readily grasped by even the most intelligent and careful reader unless he has had formal training in higher mathematics. This difficulty has been circumvented in the present work by the ingenious method of compiling all the mathematical denominations in a series of 31 appendices, which occupy nearly 100 of the book's 350 pages. As a result the main body of the text contains only those mathematical expressions which are necessary to carry the train of thought describing the processes and theories of the atomic world. For this reason the book can be read by anyone who has had a year of calculus without skipping any of the mathematical demonstrations. For those who require a more thorough treatment, the appendices give rigorous, if concise, proofs of all results stated in the text proper. Cross references between the appendices and the text are complete.

The book is divided into eight chapter headings as follows: Kinetic Theory of Gases, Elementary Particles, The Nuclear Atom, Wave-Corpuscles, Atomic Structure and Spectral Lines, The Spin of the Electron, Quantum Statistics, and Molecular Structure.

The book is well illustrated with line diagrams and half tones, it is well written, and as thoroughly practical as the subject allows. An interesting feature is the inclusion of the name of the discoverer and the date of discovery with each reference to new ideas and experiments in the progress of physics. The book is highly recommended to all those engaged in electronic work because it presents the latest advances in the subject in a manner which is both accurate and as easy to comprehend as is possible, considering the fundamental necessity of mathematical formulation.

N.A.B. Engineering Handbook

THE NATIONAL ASSOCIATION OF BROADCASTERS has just prepared for its member stations an Engineering Handbook in loose leaf form which is a compilation of theoretical and empirical data in form for easy application to the problems of broadcasting. About half of the book is devoted to wave propagation and a quarter to directive antennas. The book is divided into the following sections.

WAVE PROPAGATION. C. C. I. R. Curves. The definitions, constants, and equations of ground and sky wave are summarized, and nine pages of curves are given which permit quick determination of daytime, median nighttime, or quasi-maximum nighttime field strength as a function of transmitter power, distance, frequency, and soil conductivity.

WAVE PROPAGATION. Rolph's Graphs for Ground-Wave Propagation. Another twenty-five pages are devoted to graphs of field strength, calculated from Sommerfeld's formula.

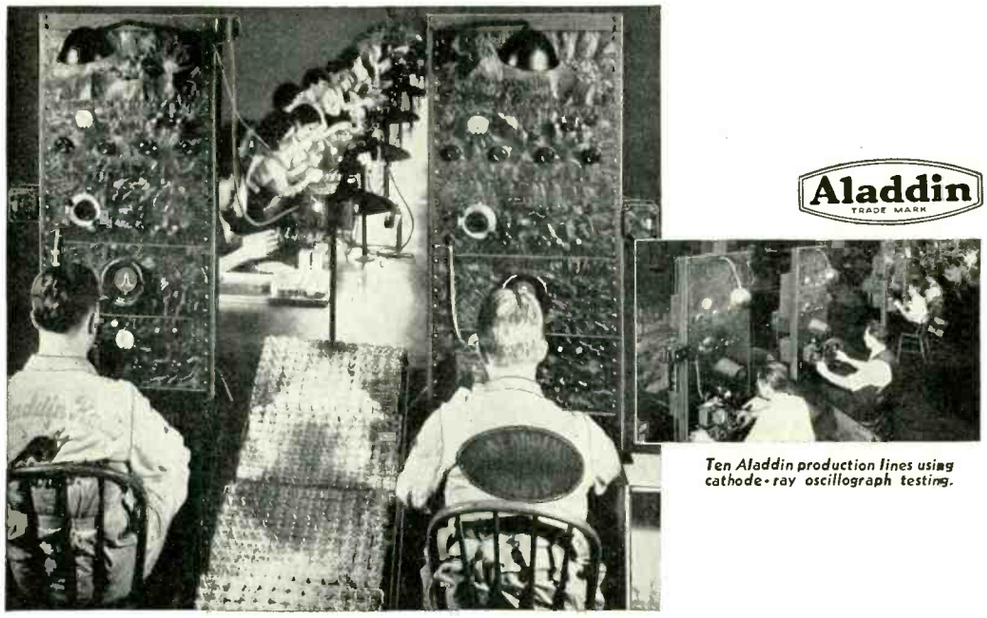
Shorter sections are devoted to sky wave, radiation and electrical performance of vertical antennas, and transmission line characteristics.

Directional Antenna Arrays. This is a long section filled with equations, tables, and calculated patterns useful in designing the types of directive antennas which are used by broadcast stations to reduce radiation toward a distant station or increase radiation in the direction of the most important audience.

Other sections deal with the design of various pads and attenuators, with the empirical standards and rules of the Federal Communications Commission, and with the calibration of field strength measuring equipment.

Non members of N.A.B. can obtain copies of this excellent handbook from headquarters in the National Press Building, Washington, D. C., at a price of $10 per copy.—V. J. A.

Precision production of Polyiron Core Coils on one of Aladdin's ten assembly lines. Every stage of production is carefully checked and each coil must pass rigid tests on the cathode-ray oscillograph before being packed for shipment to manufacturers.



Aladdin
TRADE MARK

Ten Aladdin production lines using cathode-ray oscillograph testing.

Are You Letting a Few Cents Stand between These Results?

Good Reception

Perfect Reception

Today all recognized quality radio receivers are superbly engineered—a tribute to the study, skill, and tireless effort of the oft unappreciated radio engineering profession. These experts are agreed that few receivers, however, are or can be graded higher than the component parts of which they are made.

Efficiency in radio receivers depends so very largely upon the quality of the r-f and i-f transformers that no engineer who seeks perfection in reception can afford to use any others than those bearing the name *Aladdin Polyiron.*

Aladdin transformers cost more than most because they're worth more. Every penny invested in their vastly better performance and the greater ease in assembly is returned in dollars in larger sales volume and lower labor costs. Radio engineers who would enhance their reputations, Sales Managers who seek consumer preference, and Purchasing Agents who realize that a lower price means lower quality would, we feel sure, if their own best collective interests were understood, specify, talk, and buy only Aladdin Polyiron Inductances — the surest, safest, and most economical way to radio receiver supremacy.

Aladdin transformer construction and performance characteristics are outstanding. These are facts we'll be glad to prove to you or let you prove for yourself.

Aladdin's recommendations for four tube battery receiver:—Unshielded antenna coupler, Type 2287, Range 535 to 1750 kc. For 250 uuf antenna to 6D6 tube.

Gain	Frequency	Band width at 10x
21.2	550	32 kc
20	1000	58 kc
15	1400	122 kc
16.5	1750	178 kc

Send for complete details and recommendations.

Aladdin

Aladdin Radio Industries, Inc. 466 West Superior Street Chicago, Illinois

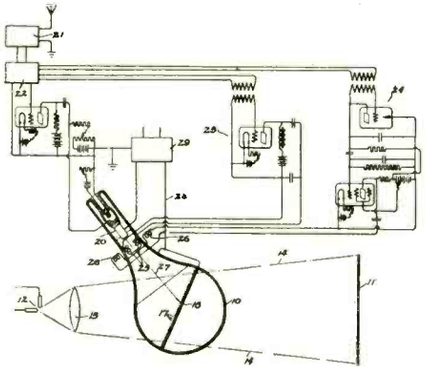
Licenced under Johnson Laboratories, Inc. These devices are manufactured under one or more of the following U. S. Letters Patents: 1887380, 1978599, 1982690, 1940228, 1978600, 1997453, 1978568, 1982689, 2005203, 2002500, 2018626. Other patents pending.

PATENTS REVIEW

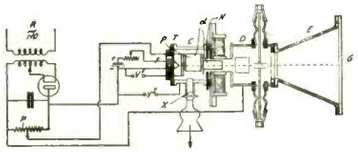
PATENTS indicate trends. Next year's radio circuits, applications of electron tubes for non-communication purposes, new tube types, new materials, may be discovered by following United States and British inventions.

Television

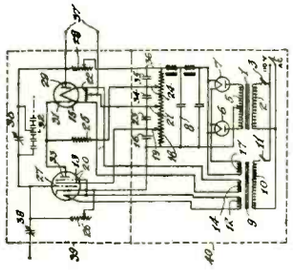
Cathode ray apparatus. The following patents involve circuits, kinescopes, control equipment, etc. No. 2,024,979 to G. F. Metcalf, G.E. Co. No. 2,025,-143, V. K. Zworykin, RCA. Also No.



2,025,143



2,021,253



2,025,208

2,022,450 to Zworykin. No. 2,006,063, A. W. Vance, RCA. No. 2,007,380, W. J. Morlock, RCA. No. 2,017,127, Fritz Michelssen, Telefunken. No. 2,011,260, Dietrich Prinz, Telefunken. No. 2,014,-532, W. R. Koch, RCA. No. 2,013,162, H. J. McCreary, Associated Electric Laboratories, Inc., and No. 2,021,252 and 2,021,253 to P. E. L. Chevalier, RCA. No. 2,025,208, timing axis, to P. L. Hoover, Endowment Foundation, New Brunswick, N. J.

Electronic Tube Applications

Engraving system. A light sensitive scanner, amplifier, graver, etc., for the purpose of making photo-electric intaglio and relief engravings. Walter Howey, New York, N. Y. No. 2,029,-103.

Braking system. A regenerative braking system for a motor using a thermionic valve. Hermann Hermle, G. E. Co. No. 2,027,865.

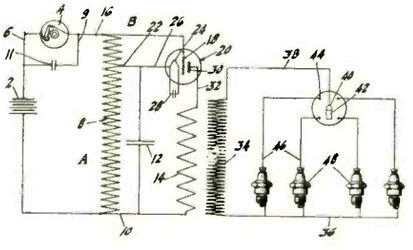
Oil testing. Photoelectric apparatus for testing the transparency of oil. Mead Cornell and C. C. Curtis, San Francisco. No. 2,027,518.

Temperature control. A three-element tube with a means for varying the vapor pressure in the container as a function of temperature. L. Smede, WE&M Co. No. 2,027,405.

Electrostatic treating. Process of treating plant products by passing them on a conveyor, subjecting them to an electrostatic field having a frequency preferably not less than 1,000,-000 cycles, and a voltage of the order of 4,000 volts per linear inch, the speed of movement through the field being such that the plant products treated are not injured, while the insects infesting said products are killed. Thomas J. Headlee, New Brunswick, N. J., Endowment Foundation. No. 2,027,976.

Electric meter. A variable gain vacuum tube a-c voltmeter. E. L. Bowles, Wellsley Farms, Mass. No. 2,029,355.

Ignition circuit. Use of a three element tube in automobile ignition sys-



tem. D. W. Randolph, General Motors Corp. No. 2,027,617.

Razor blade testing. Method of detecting variations in the sharpness of blade edges by directing a beam of light successively along the edges and measuring variations in the intensity of the light. Max Knobel and L. H. Young, Gilette Safety Razor Co. No. 2,027,595. Patent applied for March 19, 1931, 43 claims.

Electric timing. Circuit utilizing a glow tube having three elements, condenser, etc. F. G. Kelly, Engineering & Research Corp., New Haven, Conn. No. 2,029,622.

Recording Apparatus

Film recorder. Method of recording and reproducing sound by means of a transparent film having an opaque layer by tracing a reproduction of the vibrations of sounds in the opaque layer to form a transparent sinuous band of constant width. R. L. A. Nublat, Le Parc Saint-Maur, France. No. 2,025,608.

Phototelegraphy. Method of producing from a single source of electrical energy in a single electric circuit currents of different frequencies, the magnitude of the current varying with variations in source and method of producing in an output circuit a current which varies in accordance with the ratio of the currents of the frequencies. H. G. Bartholomew and J. W. Dalton, London. No. 2,021,474.

Compensation circuit. Method of compensating for velocity variations in the movement of a sound record film past a translating point. No. 2,024,-608; to E. H. Smythe, B.T.L., Inc.

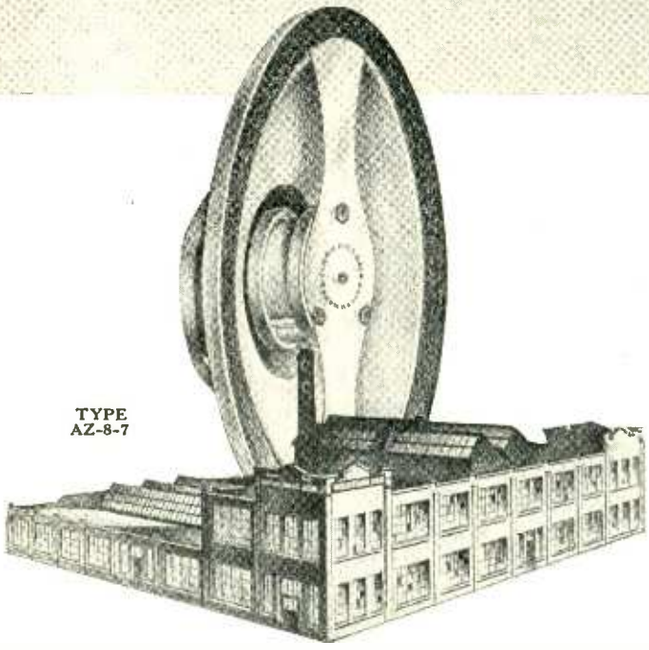
Light source. Method of using a cathode ray tube as a light source for recording sound on film. S. C. Whitman, Whitman Sound Systems, Ltd. No. 2,024,080.

Silent system. Device for recording modulated currents on a photo sensitive material with means for rendering the device inoperative in the absence of modulated currents. H. C. Silent, E.R.P., Inc. No. 2,022,983.

Binaural system. Method of producing variations in light intensity as a function of changes in the relative location of the sources of sound. W. S. Halstead, White Plains, N. Y. No. 2,022,665.

Rerecording method. Raising the sound impulse level during the rerecording of predetermined sections of a record, shading the normally clear portion of the sections to reduce the ground noise impulses. J. V. Maresca, R-K-O Corp. No. 2,022,473.

The CINAUDAGRAPH Speaker



TYPE
AZ-8-7

DESTINED TO REVOLUTIONIZE CONVENTIONAL SPEAKER CONCEPTS

Engineers listened. They were a hard-bitten gang as they sat within the sound-proof Cinaudagraph Laboratories . . . all fellows who had long since begun to take "New Developments" for granted.

Now they listened with open mouths. The new Cinaudagraph Speaker was performing. They heard a miracle in sound: they saw speaker history in the making.

Within our walls we have kept our secret. Our personnel has had strict orders not to "spill" this thing that has been brewing in our laboratories until tests proved the product was finished.

Now we are ready! This laboratory demonstration before a group of leading engineers and writers dramatizes the fact that the Cinaudagraph Speaker is "going places"! A new era in sound has begun.

In every detail of its design, its construction, its materials, the Cinaudagraph Speaker *is new.*

- *It's New in* Cone Construction

A new polyfibrous material is used in the construction of the Cinaudagraph cone. This material is presented for the first time in the Cinaudagraph Speaker and was developed exclusively by our engineers. It is so constructed as to present a varying density of composition which allows for the transmission of voice coil oscillations with a fidelity heretofore found impossible. The extreme flexibility of the polyfibrous composition makes possible the production of speakers to individual frequency requirements.

- *It's New in* Magnetic Material

"Nipermag"—a permanent magnet alloy presented for the first time in American speakers by Cinaudagraph engineers, has been and is being used extensively with great success in Europe. "Nipermag" is controlled exclusively by the Cinaudagraph Corporation. *(It should not be confused with other magnet alloys now available on the American market.)*

- *It's New in* Voice Coil Construction

A core of quartz silicate, a non-elastic, extremely dense mineral, is used in the construction of the voice coil. The advantages of this Cinaudagraph voice coil are its ability to transmit frequencies without losses or deviations and its ability to operate under adverse climatic and temperature conditions.

- *It's New in* Spider Construction

A centering device, consisting of an interlaced net, is an exclusive Cinaudagraph development whose extreme axial flexibility makes a really low note obtainable.

- *It's New in* Baffle Construction

The "Infinite Baffle" developed and constructed by Cinaudagraph engineers absorbs rear radiation and allows only the true undistorted tonal frequencies to emanate from the front of the speaker.

These five major engineering improvements contribute largely to the attainment of an extraordinarily flat frequency response of from 30 to 15,000 cycles per second. This Speaker is available in 8, 10, 12 and 18 inch sizes. All parts required in its assembly are manufactured under the supervision and control of the Cinaudagraph personnel.

This is our announcement to you. Other genuine engineering features of the new Cinaudagraph Speaker, too numerous to mention, will be gladly furnished on request.

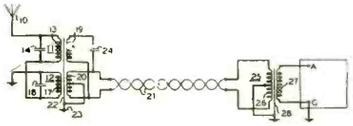
CINAUDAGRAPH CORPORATION

SPEAKER DIVISION
STAMFORD, CONN., U. S. A.
Dep't. S.

Trouble recording. Combination in one track of two independent recordings of the same sound picked up at different positions. H. A. Henning, B.T.L., Inc. No. 2,025,388.

Sound localizing method. Method of securing correspondence between the apparent location of a source of sound and the quality of the sound by altering the relative loudness of the component frequencies so that for a close-up the high and low frequencies predominate while for long shots the middle frequencies predominate. L. G. Bostwick, B.T.L. No. 2,025,374.

Antenna system. Method of coupling an antenna to a receiver by means of a transmission line. W. W. Macalpine,



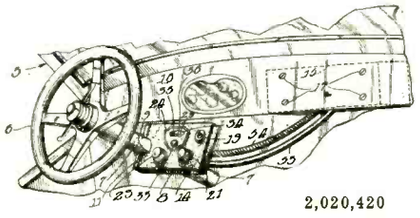
International Communications Labs. No. 2,021,734.

Radioanalyzer. Testing equipment, plugs, meters, jumpers, etc. R. N. Auble, Weston Electrical Corp. No. 2,023,947.

Fading regulation. Two patents assigned to RCA, No. 2,011,930 to H. J. de Bellescize, and No. 2,027,022 to J. W. Conklin.

Feed-back circuit. H. A. Wheeler, Hazeltine Corp. No. 2,022,067.

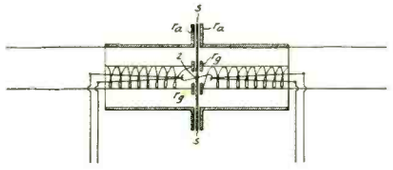
Remote control system. No. 2,019,-316 to Leonard Morey, New Rochelle, N. Y. No. 2,025,218 to L. W. Reinken, Federal Tel. Co. No. 2,025,783 to C. M. Sinnett and M. E. Karns, RCA. No.



2,020,420

2,020,420 on automobile radio control to W. P. Lear, Galvin Mfg. Corp.

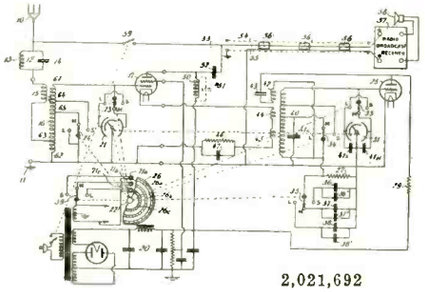
Ultra short wave receiver. A double tube comprising duplicate sets of elements, all within a single envelope, anodes and grids coupled together capacitively, the anodes mounted co-



axially with respect to each other. H. E. Hollmann, Telefunken. No. 2,021,891.

Superregenerative circuits. Two patents. No. 2,008,261, W. v B. Roberts, RCA, and No. 2,010,978, Arthur Clausing, Siemens & Halske, Germany.

Multi band circuits. No. 2,022,805, P. O. Farnham, RCA. No. 2,023,439 to



2,021,692

Rudolf Rechnitzer, Telefunken. No. 2,021,692 to H. M. Lewis, Hazeltine.

Tone control. An audio frequency regenerative system. L. F. Willging, Crosley Radio Corp. No. 2,024,321.

Volume Control. Use of silicon carbide crystals and a binder material for varying the load impedance of the space discharge tubes to control volume. D. H. Ring, B.T.L., Inc. No. 2,025,400.

Adjudicated Patents

(C. C. A. N. Y.) De Forest patent, No. 1,507,016, for radiosignaling system, claims 24 to 28 *Held* not infringed. *Radio Corporation of America* v. *Andrea*, 79 F. (2d) 626.

(C. C. A. N. Y.) De Forest patent, No. 1,507,017, for wireless telegraph and telephone system, claims 15 and 17 to 21 *Held* not infringed. *Id.*

Patent Suits

1,756,000, J. M. Miller, Piezo-electric oscillation generator, filed Nov. 25, 1935, D. C., S. D. N. Y., Doc. E 81/370, *J. M. Miller* v. *Western Electric Co., Inc.*

1,707,545, E. C. Wente, Acoustic device, appeal filed Nov. 21, 1935, C. C. A., 8th Cir. (St. Louis), Doc. 10347, *Western Electric Co., Inc., et al* v. *Cinema Supplies, Inc.* Dismissed Nov. 21, 1935.

1,297,188, I. Langmuir; 1,573,374, P. A. Chamberlain; 1,618,017, F. Lowenstein; 1,702,833; W. S. Lemmon; 1,811,095, H. J. Round; filed Nov. 25, 1935, D. C., S. D. N. Y., Doc. E 81/368, *Radio Corp. of America et al* v. *E. Dane et al.*

1,329,283, 1,398,665, H. D. Arnold; 1,349,252, same, 1,403,475, same, 1,465,-332, same, 1,448,550, same, 1,520,994, same, Electron discharge amplifier; 1,-453,982, B. W. Kendall, Electrical receiving or repeating apparatus and the method of operating same; 1,493,595, D. G. Blattner, Amplifying with vacuum tubes; 1,544,921, R. C. Mathes, Amplifier circuit, C. C. A., 8th Cir. (St. Louis), Doc. 10,345, *Western Electric Co., Inc., et al* v. *Cinema Supplies, Inc., et al.* Decree reversed Nov. 21, 1935.

1,350,752, H. J. van der Bijl, High frequency signaling; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,448,550, same, Thermionic amplifier circuit; 1,507,016, L. de Forest, Radio signaling system; 1,507,017, same, Wireless telegraph and telephone system; 1,531,805, R. C. Mathes, Oscillation generator; 1,592,934, R. V. Hartley, Means for modulating high frequency oscillations; 1,596,198, S. Loewe, System for generating oscillations; 1,823,322, R. A. Heising, Wave transmitting and amplifying; 1,966,065, R. Gunn, Modulation system; Re. 17,245, Re. 17,247, W. G. Cady, Method of maintaining electric currents of constant frequency; Re. 17,355, same, Piezo-electric resonator, filed Oct. 31, 1935, D. C., N. D. Calif. (San Francisco), Doc. E 3946-L, *Radio Corp. of America et al* v. *Heintz & Kaufman, Ltd.*

1,356,763, R. V. Hartley, Oscillation generator; 1,403,932, R. H. Wilson, Electron discharge device; 1,447,773, Espenschied & Brown, Radio transmission control system; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,-520,994, same, Electron discharge; 1,-507,016, L. de Forest, Radio signaling system; 1,507,017, same, Wireless telegraph and telephone system; 1,544,081, F. K. Vreeland, Transmitting intelligence by radiant energy; 1,869,323, P. H. Evans, Communication system; 1,890,302, W. Runge, Arrangement for oscillation circuits; 1,896,780, F. B. Llewellyn, Modulating device; 1,936,-162, R. A. Heising, Transmission system; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation; Re. 18,916, J. G. Aceves, Supply circuit for radio sets, filed Oct. 31, 1935, D. C., N. D. Calif. (San Francisco), Doc. E 3945-L, *Radio Corp. of America et al.* v. *Heintz & Kaufman, Ltd.*

Re. 18,579, Ballantine & Hull, 1,-297,188, I. Langmuir, 1,573,374, P. A. Chamberlain, 1,618,017, F. Lowenstein, 1,707,617, 1,795,214, E. W. Kellogg, 1,-894,197, Rice & Kellogg, D. C., S. D. N. Y., Doc. E 81/289, *Radio Corp. of America et al*, v. *H. & B. Radio Corp. et al.* Consent decree for plaintiff (notice Dec. 7, 1935).

1,573,374, P. A. Chamberlain; 1,618,-017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull; 1,403,932, R. H. Wilson; 1,465,332, H. D. Arnold, filed Oct. 17, 1935, D. C., E. D. N. Y., Doc. E 7779, *Radio Corp. of America et al.* v. *A. Levine et al.*

1,855,168, C. L. Farrand, Loudspeaker, D. C., S. D. N. Y., Doc. E 71/302, *Utah Radio Products Co. et al.* v. *John Wanamaker, N. Y., Inc.* Consent and order of discontinuance without prejudice (notice Oct. 29, 1935). Doc. E 71/305, *Utah Radio Products Co. et al.* v. *Bloomingdale Bros., Inc.* Decree as above. Doc. E 72/10, *Utah Radio Products Co. et al.* v. *H. & B. Radio Corp.* Decree as above.

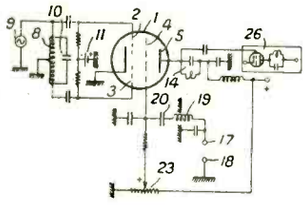
British Patents

Radio Circuits

Permeability tuning. An inductance coil having two or more concentric windings connected to the wave-change switch so that on short wave work the windings not in use are disconnected without being short-circuited, a common magnetic core being employed for two wave ranges. Oliver Pell Control, Ltd. No. 435,255.

Gain control. The gain of a carrier frequency amplifier is controlled by the amplitude of a harmonic of the carrier. Ericsson, Stockholm. No. 435,528.

Frequency doubler. A frequency-doubling tube has a fundamental wave from a source applied in push-pull to two input grids of equal control on the electron stream, thus creating a wave of double frequency in the plate circuit.



Modulating voltage is applied to an outer or screening grid. Radio Akt.-Ges. No. 435,561.

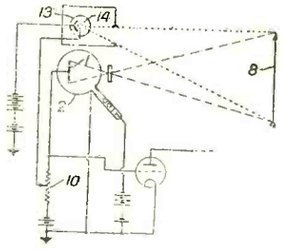
Modulation system. Prior to modulation, the carrier-wave level is varied in accordance with signal volume by means of a variable-mu tube the bias of which is dependent on the rectified strength of signals which have previously been distorted in amplitude by a second variable-mu tube. The object is to maintain strict linearity between carrier level and signal volume. Marconi Co. No. 435,565.

Hum elimination. Hum due to energizing tubes from rectified a-c supply is compensated by a series of filters responsive respectively to the fundamental hum frequency and several harmonics, the phase and amplitude of the filter outputs being adjusted and combined, then applied to the tube circuit in such a manner as to balance out the disturbing elements. L. E. Barton, Marconi Co. No. 435,733.

Television

Color television. A cathode-ray tube comprises a screen provided with several series of streaks, each series consisting of two or more adjacent and parallel streaks of materials fluorescing in different colors. Fernseh Akt.-Ges., Berlin. No. 434,868. See also No. 434,873 to Fernseh on a film for television which is exposed with the light sensitive layer in a coagulated condition without being completely dried. The thickness of this layer is of the order of the dimensions of a picture point. The emulsion contains a larger silver salt content and a smaller colloid content than normal, the variation being proportional to the ratio of the thickness of the light sensitive layer when completely dried to the thickness of the layer of a normal film.

Compensating system. The reverse signal current effects due to sudden changes in general brightness of an object projected on a photo-sensitive



screen scanned by a cathode-ray beam are compensated by the provision of an auxiliary photo cell receiving light from the whole of the object. A. D. Blumlein, London. No. 434,876.

Synchronizing system. The line-synchronizing signal is suppressed at the transmitter at least once per image and at the receiver the grid-controlled gas-discharge tube discharging at the image frequency is controlled by the action of this suppression on a tube discharging at the line-scanning frequency. Owing to the suppression of the synchronizing signal a condenser is charged to an abnormally high voltage and its discharge produces an impulse in an inductively coupled winding sufficiently strong to overcome a grid-bias and cause a tube to discharge. No. 432,783.

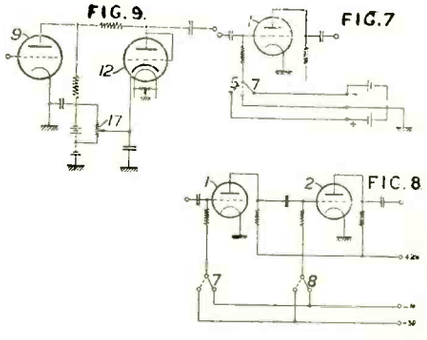
Color television. Several complete images are formed by a single cathode-ray on a screen or screens within a single tube by causing the images to overlap in effective superposition as regards an observer. The fluorescent substances, for example, calcium tungstate, zinc silicate, zinc phosphate, may be provided on separate screens or on adjacent areas on the same screen. Fernseh Akt.-Ges., Berlin. No. 432,989. See also No. 432,992, to Fernseh.

Synchronizing. Synchronizing impulses intercalated between successive lines of the picture comprise changes in one direction from the mean picture signal level, while image synchronizing signals comprise changes in the other direction. Preferably the line synchronizing signals are in the black direction and reduce the carrier to zero, while the picture synchronizing impulses are in the white direction. No. 433,552. No. 433,720 on a fixed aperture scanning system; No. 433,853 on televising continuously moving photographic film; No. 433,935 on an intermediate-film system in which the film is illuminated continuously. All to J. L. Baird.

Scanning system. A beam of light is given one component of scanning in the direction of smaller "light grasp," this movement is changed into one in the direction of larger "light grasp" and the beam is then given the other component of scanning. The "light grasp" in any direction is defined as the angle of divergence (or convergence) of the beam in that direction multiplied by the width of the entrance (or exit) pupil in that direction. Scophony, Ltd., Soho, London. No. 433,945.

Cathode-ray circuit. The intensity of a cathode-ray is modulated by modulating the anode voltage of the tube, and the forces deflecting the ray to scan a predetermined area are simultaneously varied in dependence on the modulating-potentials to compensate variation in the speed of scanning resulting from modulation of the anode voltage. Marconi Co. No. 434,199.

Film transmission. Means for intensifying the contrast in parts of the film wherein the details of the greater portion of the picture are insufficiently contrasted to result in satisfactory reproduction; for example, the details are included in a limited range of the tone scale. Where the pictures mainly comprise black subjects with a dark gray foreground the contrast in the dark zone of the tone scale is amplified with consequent disegard of the reproduction of the correct relative contrast of the details occurring in the light portion of the pictures. The control of the correcting arrangement may be effected manually, automatically or semi-automatically. In the latter case a tape is punched during visual examination of the film and the position of



the perforation controls the application of the appropriate correction. D. S. Loewe, Berlin. No. 434,274. See also No. 434,278 to Loewe on a synchronizing method.

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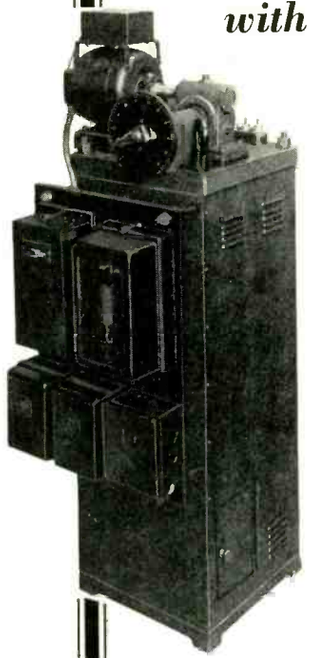

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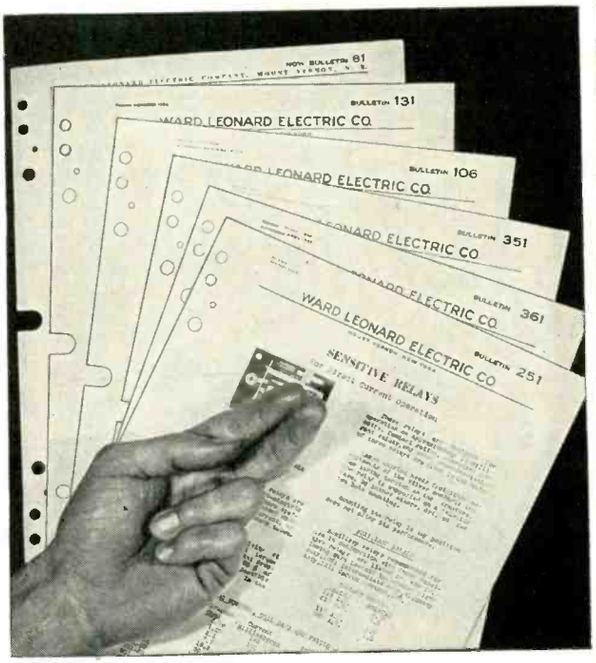

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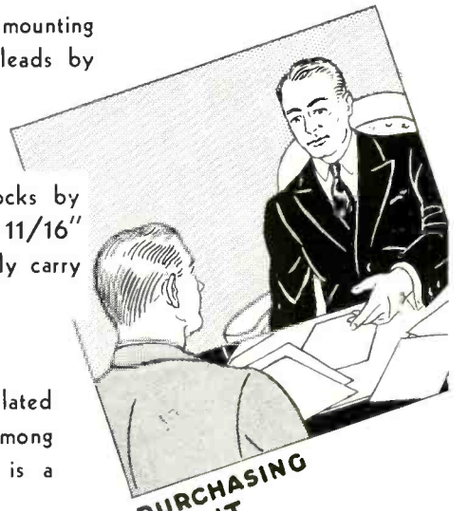

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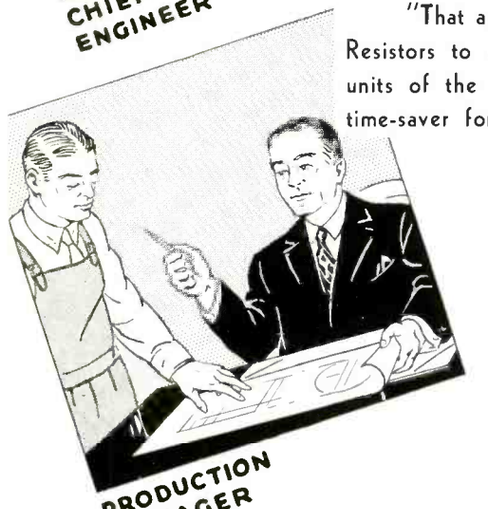

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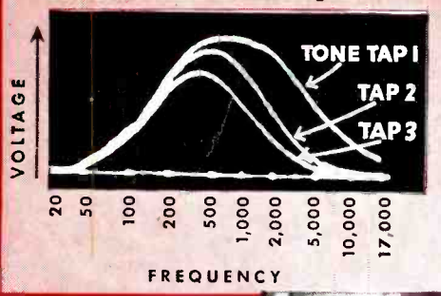

RCA-909. Cathode-Ray Tube, electrostatic deflection, 5-inch screen. The screen material, due to its long persistence characteristic, is capable of glowing for several minutes after excitation. Price $49.00

•

RCA-910 is similar, but has a 3-inch screen. Price $21.25

RCA-911. Cathode-Ray Tube, electrostatic deflection, 3-inch screen, features an electron gun constructed of material that is unusually non-magnetic. Useful in applications where spot deflection due to magnetization of tube parts must be kept very small. Price $22.50

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The oscillogram illustrates the use of the RCA-909 in tracing and recording the fidelity characteristics of an audio amplifier. Change of frequency was made manually. The three curves show the effect of tone control. The screen persistence of the RCA-909, as well as that of the RCA-910, permits viewing all three conditions simultaneously. Many other uses will suggest themselves.

RCA-911 is a new 3-inch cathode-ray tube having an electron gun unusually free from magnetization effects. Thus, RCA continues its development program of cathode-ray tubes for oscillographic applications.

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