electronics

radio, sound, communications and industrial applications of electron tubes ✦ ✦ ✦ design, engineering, manufacture

Selling tubes on consignment

✦

Dynamic loud-speaker design

✦

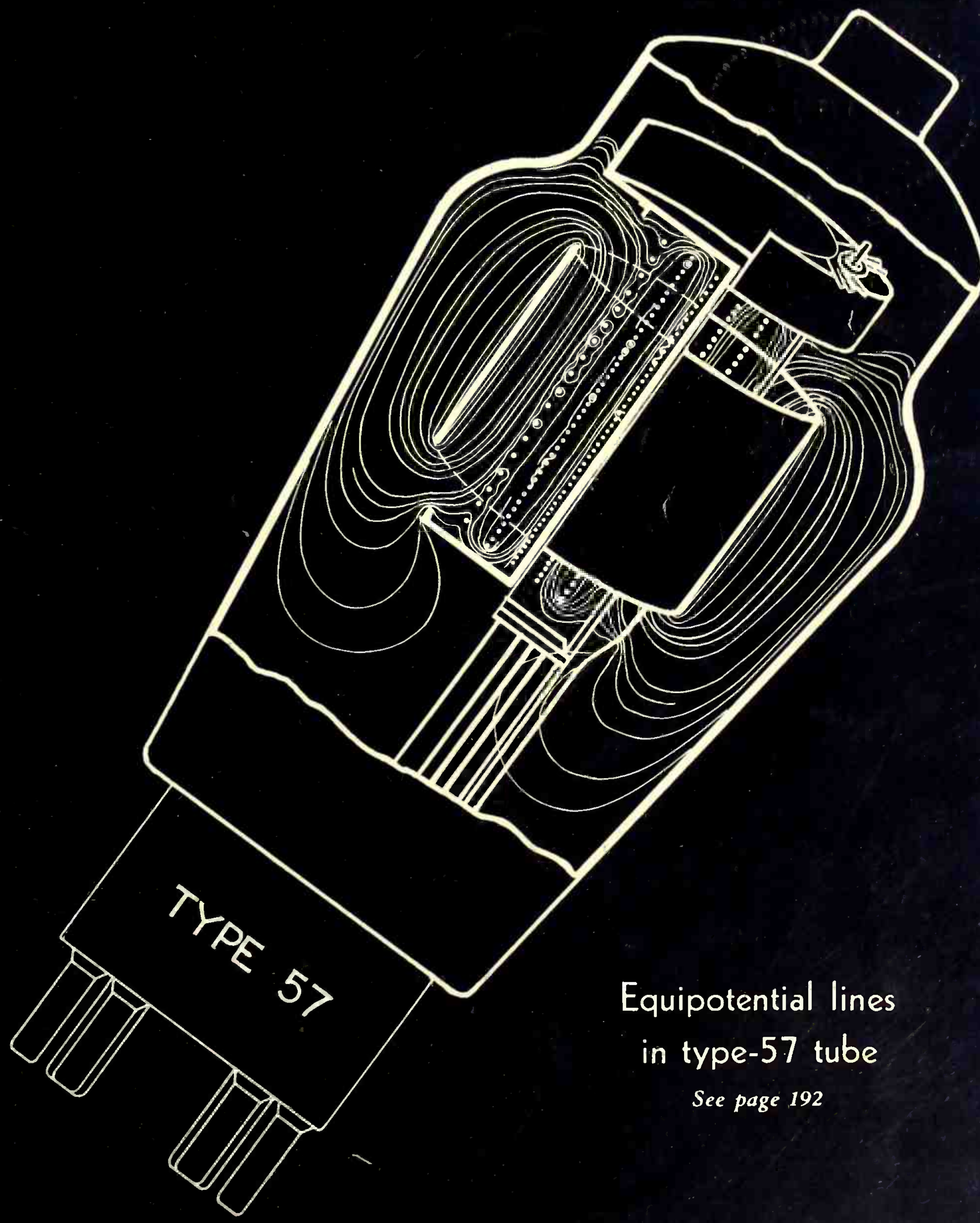
New tubes, sets and circuits

✦

Class B harmonic measurement

✦

Field plotting by vacuum tubes



Equipotential lines in type-57 tube

See page 192

McGRAW-HILL PUBLISHING COMPANY, INC.

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JUNE 1932

Characteristics of the
Wunderlich Tube

by

Frederick E. Terman, Sc.D.
Professor of Communication Engineering
Stanford University

"The Wunderlich tube can be thought of as a triode to which there has been added a second grid that is wound between the meshes of the usual grid. This tube has been developed for grid leak power detection purposes, and gives full wave grid rectification in a balanced circuit in which negligible radio frequency current flows in the plate circuit."

"When compared with the triode type of grid leak power detector, the Wunderlich power detector has about the same efficiency, introduces less distortion because the balanced input circuit prevents simultaneous grid and plate rectification, and develops approximately twice as much output voltage."

"When compared with the plate rectifier commonly employed in broadcast receivers, the Wunderlich detector has the advantage of a somewhat greater rectification efficiency, particularly when the signal voltage is in the order of several volts."

"The Wunderlich tube has ample power capacity to excite the power amplifier of any broadcast receiver now on the market, and also supplies a voltage which can be used directly for automatic volume control purposes."

Excerpt from technical paper by Prof. F.E. Terman. Complete paper will be sent upon request.

WUNDERLICH

The **BLUE TUBE** *with the* **RED BASE**

manufactured by **ARCTURUS RADIO TUBE CO., NEWARK, N.J.**

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electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, June, 1932

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Higher fidelity standards ARE HERE!

DAWN, under an open sky, is a striking phenomenon to watch.

First there is a faint flush in the East.

Then while you are still watching, suddenly you realize that *all parts* of the heavens have grown rapidly lighter. A few minutes later the whole sky is brightly aglow. And the new day is really under way.

▼

SOMETHING like this is taking place right now in the engineers' battle for greater tone fidelity. Suddenly, all along the whole line of electronic devices, this matter of tone fidelity becomes of first commercial importance. A new day is breaking for greater tone accuracy.

At the Radio Show at Chicago, the new models showed a much higher degree of fidelity, made possible by the new tubes and circuits and by the trend to double loud-speakers. In phonograph recording, accuracy in reproduction out to 9000 cycles is now achieved. The new films have sound tracks of remarkably full tone range. Last month a new theater opened at Providence, with recordings running from 40 to 8000 cycles with complete faithfulness of tone. And in 16-mm. home talkies the effort goes on to widen the range further and further. Already the broadcasters have driven their side-bands out beyond 7500 cycles.

Meanwhile that gifted prophet of new musical possibilities, Dr. Leopold Stokowski, cries aloud for even wider frequency reproduction, and even greater range in sound levels,—beyond anything we have today in mechanical or electronic reproduction. Not content with the progress made so far, he points the way to the greater beauties of melody and musical stimulation which will come with even higher standards of tone quality. Eventually even his high requirements will be generally met.

▼

BUT the new dawn of appreciation for tone is distinctly here. And like the real summer dawn, it has broken suddenly *in every quarter* of the heavens. All groups progress together in upholding the new standard.

It is fortunate that tone quality improvement has thus come simultaneously in all quarters. For each branch of the art thus stimulates and holds the advances of the others. Rapidly the public's tastes and demands are being raised to new levels of tonal excellence.

Let us hope that the gain thus registered will be held, and that through a new demand for higher quality of reproduction, an end can be put to the senseless quality-skimping practices of the recent past, which robbed purchaser, dealer and manufacturer of the very things each aimed to obtain.

SELLING TUBES

Industry again interested in policy which protects price and profit margin

SINCE the radio-tube business was built physically along the lines of incandescent-lamp production, it was inevitable that the consignment plan of selling would be early considered for radio tubes, just as consignment selling has for years dominated incandescent-lamp sales. Throughout the whole history of radio-tube selling the consignment method has been intermittently discussed, and on several occasions a general swing to the lamp plan seemed likely, but nothing came of it.

During the last thirty days, however, one tube company has adopted consignment selling for its entire output, and it is known that several other companies have employed the same principle recently for their sales in particular territories. These examples have revived interest in consignment selling, and have aroused speculation as to whether consignment merchandising might not soon be generally adopted in the industry. At the same time there have been many discussions as to the advantages and drawbacks of consignment selling under conditions now prevailing in tube distribution.

Arguments for the new policy

Under the consignment plan, title to the merchandise continues in the manufacturer, until the tubes have actually passed across the counter to the retail buyer. Under this plan, therefore, both distributor and dealer become merely the agents of the manufacturer in passing along the merchandise. The manufacturer owns the tubes and controls them in all respects, including price, up to the moment of actual retail sale.

From the standpoint of the retail dealer, advocates of consignment sales point out, there are a number of advantages in this plan. The dealer has no investment to make. He is assured of carrying an adequate stock, complete in all items, without any outlay on his part. On each sale, moreover, he is provided with his full compensation or "profit," since there is no price-cutting on such a line, closely held, and sold directly from manufacturer to retail buyer. Besides getting his full margin of profit, the retailer is also afforded full protection against losses from obsolescence and price decline. Such protection as to price and full profit-margin enables the dealer to carry on his business on sound principles, with adequate provision for local promotion and advertising.

For the jobber or distributor, consignment selling has all of the advantages above listed for the retailer, so far as assured profit, price protection, full stocks, and safeguarding against price declines are concerned. A consignment policy also gives the jobber better control of the defective-tube evil, since the matter of replacements falls directly back on the manufacturer. The fact that the retailer needs no investment, also makes the appointment of local outlets easier for the jobber.

The tube manufacturer who embarks on a consignment policy insures for himself and for his retailers and distributors a definite price and a definite profit margin on all the goods he sells. Control of prices all the way down to the retail "firing line" makes it possible to see that all sales are made at a profit, and that in the chain of distribution each link that performs a function gets paid for it. Moreover, the elaborate system of reports and records by which consignment sales are reported to the manufacturer, makes it possible for the latter to get in close touch with the movement of his product from month to month. In this way, the manufacturing department can control its output in accordance with the buying taking place. This is particularly important in preventing over-production of single items in the tube lines, and enables the factory output to be kept in close step with demand, preventing overstocks which may later have to be reabsorbed at a loss.

Advocates of the consignment policy point to its long and successful history in the incandescent-lamp field, where practically all lamps have been sold under the consigned plan, with fixed compensation to the retailer and jobber. This has resulted in keeping the lamp field largely free of price-cutting, until the present year, and has made it possible for that industry to absorb heavy development costs which have been almost as frequent and as far-reaching as those in the radio-tube field.

Critics of proposed policy cite troubles

Opponents of consignment selling applied to radio tubes call attention first of all to the heavy investment required of the manufacturer. The maker of the tubes is required to finance the whole selling operation, carrying all stocks as part of his own investment. This means a larger outlay and greater interest costs, and a differential taken from the dealer's compensation which must go to the manufacturer to meet these carrying charges on investment.

Operation of a consignment plan also involves an elaborate system of reports to be filled out monthly by retailer and jobber, giving full details of stocks on hand. While a consignment system may be well adapted to a lamp business carrying only six or eight principal items, the complexities become very great when the number of items runs up to 30 or 40, which represent the minimum number of tubes for an adequate stock today.

The whole financial burden of tube selling is thrown back on the manufacturer who enters into a consignment plan. Bad credits and collections for sales already made, become the manufacturer's direct loss, and usually at a time too late after the damage has been done, for the

ON CONSIGNMENT

Objection seen to manufacturer's investment involved, lack of dealer initiative

manufacturer to protect himself. Losses due to obsolescence and price changes also fall back on the manufacturer, and in the constantly shifting kaleidoscope of radio, this factor is far more important than it is in the relatively stable field of incandescent lamps.

But the chief charge against consignment selling raised by critics of the plan relates to the abuses which are open to dealers under such a plan. Overstocking is likely and customary, it is contended. Large unnecessary amounts of certain tube items are carried, because these can be stocked without any cost to the retailer "and somebody may buy 'em sometime." Incidentally, all initiative of the retailer to move this consignment merchandise is removed, since he is under no pressure to sell these items. At the same time he may have other tube stocks which represent "money tied up," and it is human nature, of course, to push these lines, while letting the consigned merchandise rest peacefully on the shelves.

The "ten-dollar dealer"—rackets

Another complication is introduced by the receiving-set manufacturers with their own demands to the dealer to sell replacement tubes of their special brands. Every dealer has at least three set-makers selling him regularly, many have still more. These receiver manufacturers insist that the dealer shall stock their own particular brands of tubes as being best adapted for the sets he is carrying. With the larger amounts involved in set sales, as compared with tubes, the dealer is bound to yield to these importunities. Then follows a condition with "direct-sale" tubes competing with consigned tubes in the dealer's own store. And with economic pressure of dollars tied up, being exerted on the side of the dealer's own actual investment, the consigned stock is placed at considerable disadvantage.

Radio tubes are sold through a very large number of outlets, and a considerable volume goes through stores handling other lines of merchandise. The radio-tube sales of these fringe outlets may be individually very small. The problem of handling consignment sales to these "ten-dollar dealers" has received particular study in both the lamp and radio fields. While cited by opponents of the plan, as showing the difficulty of handling small outlets on a consigned-sales plan, it has nevertheless been possible to work out methods of deferred payments or collections at intervals, with actual check-up of dealer's stocks less frequently than is required of the larger outlets.

At this point there is opportunity for the unprincipled agent to cheat his supplier, by incorrectly reporting stocks on hands, by deliberately mislisting items, by inserting customers' used tubes in manufacturer's carton, and even by reporting empty cartons. All of these rackets are prevalent, and eternal vigilance would seem to be the price of success if consignment selling is to receive widespread adoption in the tube field, especially in its outer fringes.

At the present time consignment selling is being introduced in a limited way, only one or two of the smaller tube producers applying the principle so far in a national way. But the policy has been considered for adoption throughout the whole industry, and only a few years ago it seemed likely that consignment selling might be universally adopted, with the largest producers as the leaders in the movement.

In the view of some tube merchandisers, a consignment policy can succeed only when the largest producers in the field are operating on such a policy, and practically all tubes are sold through consignment, as prevails in incandescent lamps.

On the other hand, tube producers who have not yet adopted the consignment policy, profess to see advantages to a single company handling its tubes on this plan, in the face of a general policy of "outright-sale," particularly in territories where the price-cutting situation has been bad, and the local trade is ready to turn to a line which carries an assured profit.

THE PROS AND CONS OF CONSIGNMENT PLAN

Advantages	*Difficulties*
Maintains retail price	**Heavy investment by manufacturer**
Protects profit margin	**Destroys dealer initiative**
Controls production	**Creates sluggish stocks**
Avoids dealer investment	**Encourages sales of other lines**
Insures full stock and items	**Involves elaborate accounting**
Protects against obsolescence	**Makes possible "rackets" and deception**

+ + TRADE SHOW SEES

MEMBERS of the Radio Manufacturers Association evidenced their confidence in the return of good times by displaying at the Eighth Annual Trade show in Chicago, May 23-26, new sets and tubes on which $200,000,000 will be risked within the next half year. This vast amount of money is to go for new dies, new machinery, retooling expense, raw materials, labor and overhead according to J. Clarke Coit, president. The fact that nearly four million sets and fifty million tubes were made in 1931, that there are several million obsolete sets in use and that there are still some thirteen million homes sans radio is cited as cause to believe a market will be found for the 1932 production.

While these new sets were being bragged up—rightfully, for they are far in advance of anything shown to the trade in the past—Radio Row in New York City was flooded with 1931 sets with as many "big names" as the movie, Grand Hotel.

Technical advances

Technical features of the new sets center around the new tubes, the 46 and the 50-series, (*Electronics,* April 1932, page 118) but more important to the listener will be invisible circuit details such as silent tuning, automatic tone correction regardless of volume (*Electronics,* August 1930, page 230) class B amplifiers (*Electronics,* March 1932, page 82) or twin speakers (*Electronics,* May 1932, page 154).

Introduction of the new tubes caused many headaches and some last minute changes but provided set makers with a better opportunity than has existed before to make "good little sets and better big ones." The 50-series of tubes provided some space saving, but, more important, they are better tubes than those used heretofore. Attempts to get the industry to concentrate on a 6-vol. series which could be used either on a.c. or d.c. with the idea of ridding the dealers' shelves of so many different kinds of tubes, seems to have resulted only in greater confusion.

The tube picture is still further complicated by a new detector (RCA 55) announced just as manufacturers left for Chicago. It is reported that the Harrison laboratory has still another tube well under way. This is a multi-grid tube for the output stage. These tubes are described below.

Outstanding among the technical advances made generally available this year are the noise suppression circuits which make tuning between stations a quiet operation and not filled with static and other noises. While delayed a.v.c. circuits have been in use in some receivers for a year or more, not much noise was made about them and the public generally did not realize the advantage.

Greater use of two speakers in a single set seems assured. Distortion to a very great figure exists in most sets of the present vintage due to loudspeaker overloading, i.e. non-linearity of excursion on strong signals. At the same time the distortion from overloaded speakers is decreased, an apparent binaural effect is attained. In addition there is much improvement in the transient effect preventing loudspeaker hangover thus giving cleaner reception.

Use of Class B amplification will be found in at least one receiver from every manufacturer. Although confined to the higher price sets, a pair of 46's will provide a 10-20 watt output which is plenty of reserve power needed to negotiate the steep grades encountered in symphonies, operas and less often in other music. The average level of operation is probably in the neighborhood of 1 watt with peak power of present sets limited to 3 watts without too much distortion. Thus the new class B sets will have much more margin to give naturalness to good music.

Undoubtedly there will be many sets using the 46 tube (designed for class B amplification) in a class A circuit. The advertising can still claim the sets use "all the new tubes," there will not be the trouble of designing the more difficult new circuit, and better fidelity will result than by using pentodes. Thus the 46 either as class A or class B may hasten the demise of the pentode. The projected 3-grid tube described below will aid in this process. The 6-volt idea may grow so that another trade show may see a distinct trend toward this form of standardization, desirable from the trade standpoint at least.

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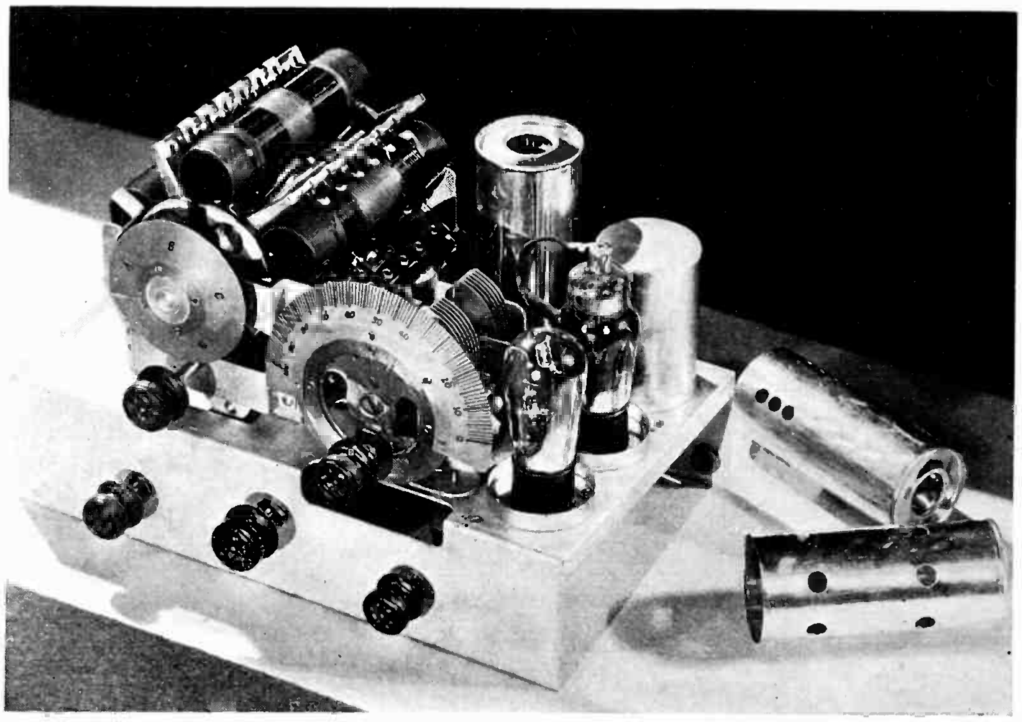
1932 SHORT-WAVE CONVERTER



Mechanical coil-changing system in short-wave converter used with new Kolster broadcast models showing modern method of tuning over wide frequency band

NEW SETS, CIRCUITS, TUBES

Automatic tone compensation designed to boost the bass at low volume level will give the user the feeling that the tonal range has been distinctly broadened. Coupled with actual betterment of the high and low registers and with plenty of reserve power, such compensation circuits will accomplish much to acquaint the public with the excellent music in the ether and waiting for someone to tap in on it. Other circuits automatically give better high frequence response on local stations.

Automatic volume control, of course, is gradually getting into the entire picture. Other functions to be taken out of the hands of the listener are tone control and noise control. The only thing which is not automatic is the sale of the set! But certainly never before has the trade so much to offer for so little money. Midgets in general have not decreased in price; many extremely valuable features are available in the $130-$150 class. And there will be many good $60 sets.

What final position short wave radio will take is still uncertain. Coil changes by hand are definitely out—this is another function to be performed automatically or mechanically, not manually. It is certain that short wave is on the up-and-up and if good foreign programs are regularly available the opening to the public of the entire radio frequency spectrum below 600 meters is but a matter of time. Those who declared American sets would never have two wave-length ranges (like the Europeans) are finding themselves forced to admit that the process of extending the frequency range of modern receivers is going on quietly and fairly painlessly.

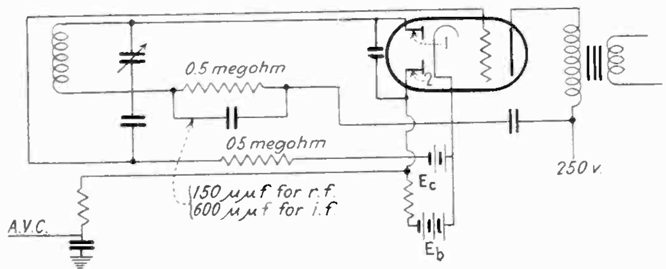
New tubes, new tubes, new tubes!

The new duplex-diode triode unipotential cathode detector tube (type-55) announced late in May is a double-barrel 10-gauge affair that can be used for more purposes than shooting ducks. It is a combined detector, amplifier and a.v.c. tube. There are two diodes and a triode in a single envelope. A single cathode has one emitting surface for the diodes and another for the triode. Each element has its own personality. The diodes can perform the detector and a.v.c. functions simultaneously with sensitivity control and time delay action confined to the a.v.c. circuit while the triode can be used as an amplifier with conditions properly adjusted for best results. The virtues of diode detection are well known; if the load resistance is sufficiently high compared to the tube resistance the dynamic characteristic becomes linear and distortion-free detection is possible. Since the resistance of a diode is low the proper load resistance is not difficult to attain.

The two diodes may be used for full wave rectification with circuit balanced for carrier input so that no carrier frequency filtering is theoretically necessary. The two diodes can be connected together with twice the output.

Introduction of such a tube was forecast by the interest shown in the Wunderlich tube. In no part of the radio receiving circuit has there been the need of research and new tubes as in the detector. Distortion and inefficiency have marked the demodulation process; cleaning up distortion in other places makes imperative the remodeling of this business of getting from the modulated carrier its information and entertainment.

Another trick tube with three grids is on the way to bring into play the utmost originality of circuit people. This pentode has its grids so proportioned and spaced that if the two grids nearest the plate are tied together a triode for class A operation results. If the grid nearest the plate is connected to the heater-type cathode a pentode results and if the two grids nearest the cathode are



Circuit where one diode of the 55 is a half-wave detector, the other acts as a.v.c. tube and the triode as a.f. amplifier

connected a tube suitable for class B amplification is available. An output of 2 to 3 watts will be possible. Just when this tube will be available is not known.

With mail order houses offering loft-made automobile radios at $60 and with the big manufacturers getting the prices down to the $50-$60 level, small auto-set makers will find the sledding tough. Lowering of price will undoubtedly widen the market, and so soon as the public finds out it cannot purchase unknown brands for the same price and get the same performance as from nationally advertised products, the auto radio sales should get off to a good start. The purchaser can easily tell the difference between a 5-10 microvolt set and one which requires several hundred microvolts. There will be plenty of 5-tube, $60 supers with a.v.c. and other trimmings for those who listen as they ride or park.

The new detector tubes, Wunderlich and RCA 55, will prove helpful in the auto set. The several functions which these tubes will perform, and all in one small envelope, will save space which is worth dollars and cents in this market.

RCA television demonstration

Prior to opening the Chicago display, licensees of the Radio Corporation of America were given opportunity to see a preliminary demonstration of cathode-ray television reception. The transmitter was in the Empire State building where Mr. Sarnoff addressed the assembled lookers-in on 24th street. While this apparatus represents the nearest approach to commercial models it is still far from the stage where it can be offered the public. Those who have played with television were favorably impressed with the quality of pictures received; those who had done nothing with such experiment thought the pictures needed to be vastly improved. It is fair to assume that much better equipment is in the Camden laboratory, but is a correspondingly farther away from production and sales.

[*Please turn to page 206*]

Dynamic speaker design—Part I

By A. R. BARFIELD

Chief Engineer,
Best Manufacturing Company

THE dynamic type of loudspeaker has remained far in the lead of all others because, aside from other considerations, it gives the best performance at a given cost. It also permits wide variation in performance so that it can be adapted to almost all conditions. During the recent and present price competition in the radio market, the dynamic loudspeaker has undergone drastic changes in design, with economy the dominant factor. As a result, the component parts have been reduced in size and cost as much as possible. The reduction in performance, however, has been by no means proportional to the economy realized. The small loudspeakers now being used are giving much better performance per unit of cost than the ones used up to two or three years ago. This is due in part to more efficient design and in part to the fact that small loudspeakers naturally have better performance per unit of cost than large ones.

The problem facing the design engineer is to produce a loudspeaker having a given performance at the least cost, or conversely, the best performance at a given cost. In either case, the best performance from a given amount of material is desired. For a given performance, the cost of the loudspeaker comprises certain fixed costs and a variable cost which depends on the design of the magnetic circuit. This analysis deals principally with the design of the magnetic circuit and the driving coil which is attached to the diaphragm.

The performance of a loudspeaker is concerned chiefly with the frequency-response characteristic and the sensitivity. The frequency-response characteristic for frequencies above about 250 cycles depends to the greater extent on the characteristics of the diaphragm and the mass of the driving coil. At frequencies below 250 cycles, the frequency-response characteristic depends on the density of the flux in which the driving coil is immersed in addition to the characteristics of the diaphragm and the mass of the driving coil. As will be shown later, the sensitivity of the loudspeaker at frequencies above 250 cycles and the sensitivity below 250 cycles are almost inversely proportional. The sensitivity above this point depends directly on the flux density about the driving coil and the sensitivity at certain frequencies below 250 cycles is almost inversely proportional to the flux density about the driving coil. With a given required average sensitivity, the designer of the magnetic circuit can do but little about the response below 250 cycles. It must be accomplished by the diaphragm design. A diaphragm which has a uniform frequency-response characteristic above 250 cycles requires that the driving coil have a certain mass, among other things. Likewise, the design of the magnetic circuit requires that the mass of the driving coil be within certain limits for maximum obtainable sensitivity, the mass of the diaphragm and the amount of material in the magnetic circuit being specified. If the two requirements are not the same, the diaphragm must be altered to conform to the requirements of the magnetic circuit design, if possible. Sometimes, it is necessary to reach a compromise between the two.

At frequencies between 250 and 500 cycles, the motion of an ordinary cone diaphragm is, in general, such that its entire mass can be considered as concentrated at the driving coil. In other words, all parts of the diaphragm are moving in phase. Therefore, the force applied to the driving coil end of the cone can be calculated from the force developed by the driving coil and the relative masses of the driving coil and the diaphragm, the acoustic reactance factor being included in the value for the diaphragm mass. The band of frequencies between 250 and 500 cycles per second will be called hereafter base frequencies for the sake of brevity. All calculations of sensitivity will be made for the base frequencies. The impedance of the driving coil is also fairly uniform for this band. It will be discussed later. The problem of obtaining the proper response at frequencies above and below the base frequencies relative to the response at the base frequencies is almost entirely a matter of diaphragm design. However, the electrical and magnetic design for maximum obtainable sensitivity, or maximum obtainable force applied to the cone diaphragm at the base frequencies, allows considerable latitude in the mass of the driving coil as will be shown later. The diameter and inductance of the driving coil are additional factors to be considered in the diaphragm design. This analysis is limited entirely to the problem of obtaining the greatest possible force applied to the diaphragm at the base frequencies. No doubt, many objections to this working basis will be raised on grounds that the uniformity of response at high frequencies depends very critically on the mass and diameter of the driving coil. However, it is possible to design a satisfactory diaphragm about a driving coil which can have a considerable variation in its mass, the diameter of the driving coil being also slightly variable. The diaphragm design depends on such a great number of factors, of which the mass and diameter of the driving coil are but two, that the effects of these two

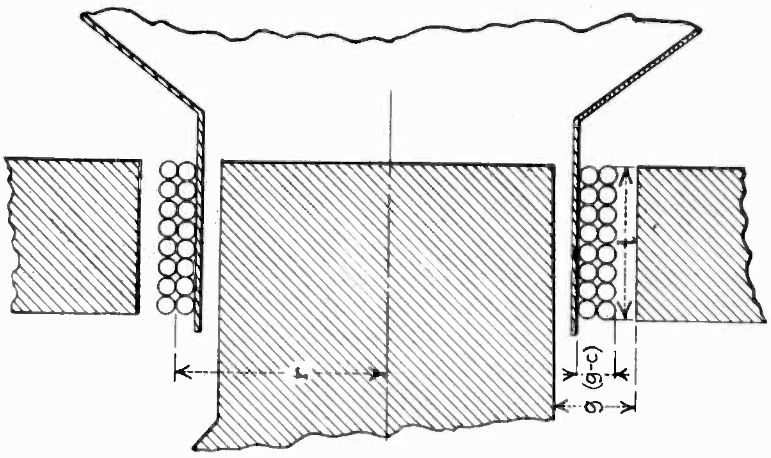


Fig. 1—Dynamic speaker driving coil

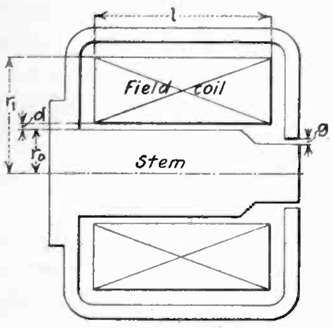


Fig. 2—Dimensions of the magnetic circuit

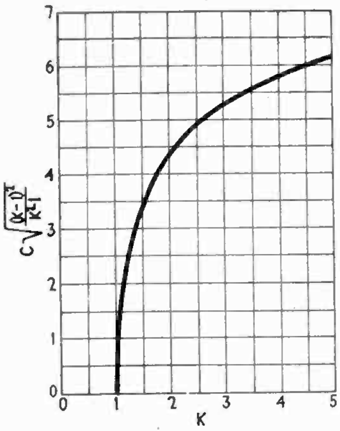


Fig. 3 — Relation between mmf. of field coil and its dimensions

in ordinary cases can be compensated by the proper proportioning of the other factors.

Now, to turn to the matter of obtaining the greatest force applied to the diaphragm at the base frequencies, the characteristics of the driving coil will be analysed.

The driving system

In Fig. 1 the driving coil is shown between the poles. The force developed by the coil is the product of the current in the conductor, the length of conductor, and the magnetic flux density in which the conductor is immersed. Or,

$$F_d = i\beta l.$$

If all of the turns in the coil were connected in parallel instead of in series, the current in each turn remaining the same, the force would obviously be unchanged and can be represented,

$$F_d = F_g \sqrt{\frac{2\pi K_c P r t (g-c)}{a \rho g^2}}, \quad (1)$$

where K_c is the ratio of total conductor cross section to the total cross section of the coil,

P is the total power in the coil, real and reactive,

ρ is the resistivity of the conductor,

a is the factor by which the d.c. resistance of the coil is multiplied to obtain the scalar impedance at the base frequencies,

F_g is the mmf. acting across the gap, g,

r, t, g, and c are as shown by Fig. 1.

a is not a constant, but it is nearly enough constant that it can be considered so for a design having a given amount of material. A comparison between a very small design and a very large design would have a slight error because a is slightly larger for the large design.

Some of the force developed by the driving coil is used to drive the coil itself. The remaining force applied to the diaphragm,

$$F = F_d \frac{M}{M+M_o}, \quad (2)$$

where M_o is the mass of the driving coil and

M is the mass of the remainder of the moving system, diaphragm, leads, centering devices, outside suspension, and the effective mass added by the acoustical reactance. The force applied to the diaphragm is, then,

$$F = F_g \sqrt{\frac{2\pi K_c P r t (g-c)}{a \rho g^2}} \times \frac{M}{M+M_o} \quad (3)$$

It would be of little value to interpret the meaning of (3) because F_g is a function of r, t, and g. However, if F_g were constant, g and the product, rt, would have values which would make F a maximum.

The field coil

The mmf. developed by the field coil of Fig. 2 is, of course, proportional to the product of the number of turns and the current. As in the case of the driving coil, if it is assumed that all of the turns are connected in parallel electrically, the current in each conductor remaining the same, the resulting mmf is the same, and equation (4) can be formed.

$$F_c = K_o \sqrt{\frac{K_f l P_f (r_1 - r_o)^2}{\rho (r_1^2 - r_o^2)}} \quad (4)$$

where K_o is a constant,

K_f is the ratio of conductor cross section to the total cross section of the coil,

P_f is the power dissipated in the coil,

ρ is the resistivity of the conductor material,

l, r_1, and r_o are as shown by Fig. 2.

If r_o in equation (4) is made equal to zero, r_1 also disappears from the equation, and

$$F_c = K_o \sqrt{\frac{K_f l P_f}{\rho}} \quad (5)$$

Therefore, if the inside radius or diameter of the coil is zero, the excitation set up by the coil is independent of the outside radius and the amount of material in the coil. However, the inside radius must be greater than zero in order to conduct the useful flux to the driving coil. An equation and graph to be given later will show how F_c varies with r_o.

If

$$r_1/r_o = K, \quad (6)$$

$$F_c = K_o \sqrt{\frac{K_f l P_f (K-1)^2}{\rho (K^2-1)}}, \quad (7)$$

or F_c is a function of the ratio of the outside radius to the inside radius and is independent of their actual values. Figure 3 shows how F_c varies with K, all other quantities held constant according to equation (8),

$$F_c = K_1 \sqrt{\frac{(K-1)^2}{(K^2-1)}}, \quad (8)$$

r_o can be expressed in terms of the total flux to be conducted through the coil and the flux density in the material conducting the flux.

$$r_o = \sqrt{\frac{\varphi}{\pi \beta_s}} + d. \quad (9)$$

where φ is the total flux,

β_s is the flux density in the flux conductor which will hereafter be called the stem, and

d is the difference between the radius of the stem and the inside radius of the field coil. For simplicity, d will be assumed either to be negligible or to be included in K_f or β_s.

φ is composed of two parts, the useful flux and the leakage flux. The useful flux is

$$\varphi_o = 2\pi r t F_g / g, \quad (10)$$

and the leakage flux

$$\varphi_e = F_g / R_e, \quad (11)$$

where F_g is the mmf. acting across the gap,

R_e is the leakage reluctance,

R_e is a function of r, g, l, and r_o. A very useful simplification can be made by assuming,

$$\varphi = m\varphi_o, \quad (12)$$

where m is the ratio of the total flux to the useful flux.

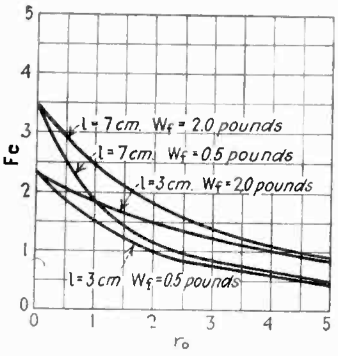


Fig. 4—Mmf. as a function of inside radius of coil

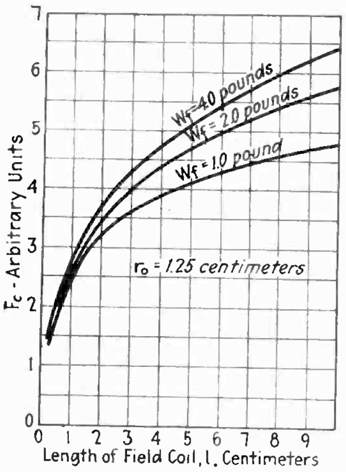


Fig. 5—Relation between mmf. and l

For a design having a given amount of material m is nearly enough constant to be considered so. However, it is variable with the size of the loudspeaker. If the designer assumes the wrong value of m, the error can be corrected by measurements on an experimental model. m varies from about 1.2 for very small loudspeakers to about 2.0 for very large ones.

Combining (9), (10), and (12),

$$r_o = \sqrt{\frac{2mrtF_o}{\beta_s g}} \qquad (13)$$

The weight of copper in the coil is

$$W_f = \pi (r_1^2 - r_o^2) l K_f \delta_c, \qquad (14)$$

where δ_c is the specific density of the conductor material. Therefore,

$$r_1 = \sqrt{\frac{W_f}{\pi l K_f \delta_c} + r_o^2}, \qquad (15)$$

and,

$$(r_1^2 - r_o^2) = W_f / \pi l K_f \delta_c. \qquad (16)$$

Combining (4), (15) and (16) gives

$$F_c = K_o \sqrt{\frac{K_f^2 l^2 P_f \delta_c}{\rho W_f} \left[\sqrt{\frac{W_f}{\pi l K_f \delta_c} + r_o^2} - r_o \right]^2} \qquad (17)$$

Figure 4 shows how F_c varies with r_o, constant values being assigned to all of the other factors.

(13) and (17) can be combined to give

$$F_c = K_o \sqrt{\frac{K_f^2 l^2 P_f \delta_c}{\rho W_f} \left[\sqrt{\frac{W_f}{\pi l K_f \delta_c} + \frac{2mrtF_o}{\beta_s g}} - \sqrt{\frac{2mrtF_o}{\beta_s g}} \right]^2} \qquad (18)$$

A part of the mmf. developed by the field coil is used to maintain the flux through the iron part of the magnetic circuit. The amount of the developed mmf. which is thus lost depends on several factors. In most cases, the part lost in the iron path should be about twenty to thirty per cent of the total developed by the coil. Then the part of the developed mmf. which is applied to the gap is seventy to eighty per cent of that developed by the coil.

$$F_g = b K_o \sqrt{\frac{K_f^2 l^2 P_f \delta_c}{W_f} \left[\sqrt{\frac{W_f}{\pi l K_f \delta_c} + \frac{2mrtF_g}{\beta_s g}} - \sqrt{\frac{2mrtF_g}{\beta_s g}} \right]^2} \qquad (19)$$

where F_g is the mmf. acting across the gap, and

b is the fractional part of F_c which acts across the gap.

Equation (19) expresses F_g in terms of all of the factors which affect it. It is seen that F_g appears on both sides of the equation. A solution of the equation to get it on one side would be impractical. The equation can be solved by assuming a value for F_g and then proving this value by substitution in the equation.

The purpose of equation (19) is to determine the values of F_g to be used in equation (3). With the value of W_f and the other factors given, g, and the product rt are the independent variables. The relation between F_g and the independent variables is determined by equation (19). Then the value of F is determined by substituting in equation (3) the chosen values of g, the product rt, and the corresponding value of F_g given by the solution of equation (19). By plotting a graph of F as a function of g and the product rt, the values of g and the product rt for maximum F are found.

In equation (19), it is interesting to note that F_g depends almost entirely on K_f, l, and P_f when W_f is large.

The value of β_s to be used in equation (19) can be determined by examination of the magnetization curves of the material of which the magnetic circuit is to be constructed. β_s should be chosen below the knee of the saturation curve but is not critical as will be seen later. The permeability and the flux carrying capacities are a maximum for flux densities just under the knee of the saturation curve.

Equation (3), giving the force applied to the diaphragm, is repeated.

$$F = F_g \sqrt{\frac{2\pi K_c Prt(g-c)}{apg^2}} \times \frac{M}{M+M_c}$$

These two equations, (3) and (19), need not be combined as they will be used separately. They cannot be solved directly for the values of the various factors to make F a maximum.

Equations (3) and (19) represent the relation between the force applied to the diaphragm at the base frequencies and all of the other factors affecting this force. The equations were derived with several slight approximations for the sake of simplification. They are not rigorous, but they do give a direct method of analysis of the problem of loudspeaker design. The error caused by the approximations is shown by experiment to be very small.

All of the dimensions in equations (3) and (19) have an optimum value except l. It is obvious that the excitation set up by the field coil increases as l increases. On the other hand, the part of the mmf. used in the stem varies directly as l, also. Again, if the mmf. developed by the field coil increases because of an increase in l, the radius of the stem must be increased in order to conduct the additional flux. A curve giving the relation between the mmf. developed by the field coil and l is shown by Fig. 5. The radius of the stem is constant for the curve. If the effect of the change of the radius of the stem and the mmf. lost in the stem were subtracted from the developed mmf. of the curve, the resulting value, which would be the mmf. acting across the gap would be almost independent of the length of the field coil between the values of six and nine centimeters. For the calculated graphs to follow, l is given the constant value of seven centimeters. By taking into account the permeability of the iron of which the stem is made and all of the other factors such as the weight of the field coil, the mass of the diaphragm, the power in the field coil, etc., an optimum value for l could be found. The increase in sensitivity brought about by using this correct value of l instead of seven centimeters would probably be only very slight. It is safe to say that l should be from one and a quarter to two times the diameter of the field coil, depending, in addition to other considerations, on the mechanical design problems.

NOTE—The concluding part of this article on loudspeaker design will appear in an early issue of *Electronics*.

A grid-glow micrometer

By ROBERT W. CARSON
Meter Engineer, Westinghouse E. & M. Co.
Newark, N. J.

In an investigation of the elastic hysteresis or retarded elastic deformation of material used for spiral instrument springs it was necessary to measure the change in the load deflection of a very thin ribbon of phosphor bronze. The ribbon was supported at the ends, and a small weight was attached midway between the supports. In tests using small stresses the load deflection of the ribbon was as small as 0.1 inch, and the accompanying elastic hysteresis effects were less than 0.001 inch.

To measure the progressive nature of this hysteresis effect at such small stresses with any degree of accuracy, it was necessary to use a measuring device that did not itself alter the deflection of the ribbon. The usual optical measuring devices of sufficient sensitivity did not have the range required, were difficult to keep in adjustment during tests which continued for several weeks, and vibration and temperature variations were extremely difficult to control.

A hand micrometer with an electrical means of indicating instant of contact between the micrometer and the center of the ribbon failed because even the slight contact pressure required to pass sufficient current to operate a sensitive galvanometer caused a change in the ribbon deflection. When a high voltage high resistance circuit was used electrostatic attraction pulled the ribbon against the contact point. Likewise, electrostatic effects introduced errors in the results obtained when the change in the ribbon deflection was indicated by a change in the capacity of a condenser, one plate of which was the ribbon.

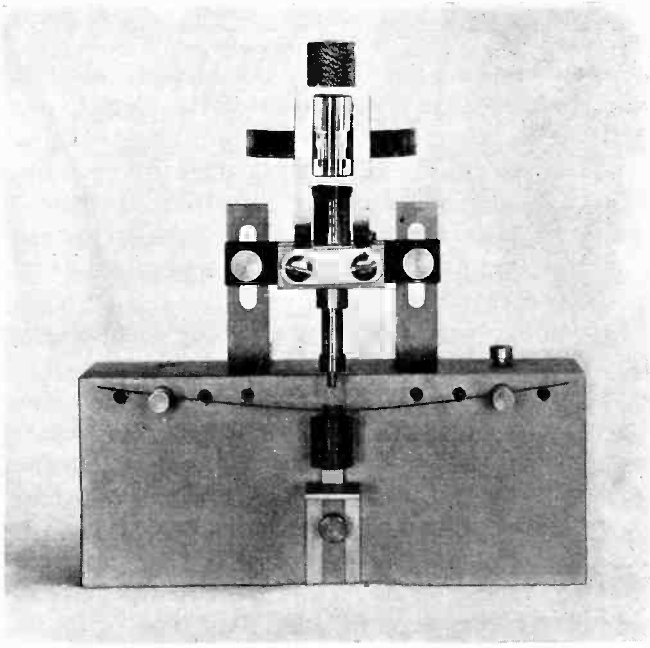
Use of grid-glow tube

Satisfactory measurements of the elastic hysteresis effects were finally made by using a grid-glow tube. The insulated micrometer was fitted with a needle point which made contact with the center of the ribbon as shown in the photograph. The contact between the needle point and the ribbon was arranged to close the control circuit of a relay using a Westinghouse DKU-612 grid-glow tube. It was found that at the instant of first metal to metal contact a small non-ohmic current would flow. Even with a control circuit resistance of two megohms this small current was sufficient to operate the relay.

After several refinements were made in the test equipment, the micrometer was found to be sensitive to displacements of 0.00001 inch. To attain this sensitivity a rigid mounting for the micrometer was required. The temperature of the test stand was held constant with a thermostat to eliminate variable expansion. A constant tension thread drive made it easier to set the micrometer to the exact point of first metal to metal contact, and prevented backlash in the micrometer threads. A large diameter drum was fitted to the micrometer barrel, and graduations on the face of the drum viewed through a magnifier made it possible to read the micrometer setting to one-fifth of one ten-thousandth of an inch.

During several months of use in the elastic hysteresis investigation the grid-glow micrometer maintained the original sensitivity with only occasional sharpening of the needle point. No arcing or pitting at the contact points was found, and with careful manipulation contact pressure was not in evidence. Slight vibrations of the ribbon which introduced errors in readings when an optical system was used, were stopped when the micrometer point came in contact with the ribbon.

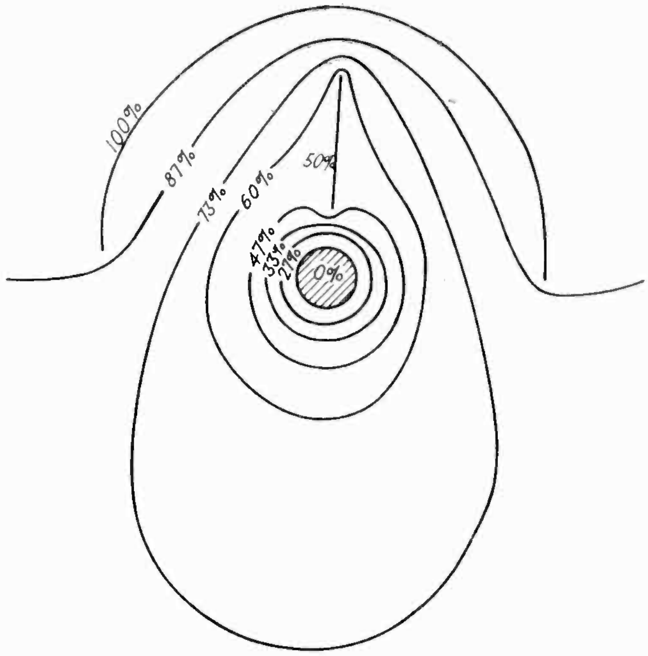
Other applications of the grid-glow micrometer readily suggest themselves. For instance when measuring the diameter of very small wire, or the dimensions of very ductile or plastic materials such as soft copper, rubber, or ceramic materials the work may be deformed between the anvils of a hand micrometer. The operator's sense of touch may not be sufficiently sensitive for exact readings of the micrometer because the material being measured must build up resistance to the micrometer screws, and the compression of the micrometer jaws may alter the dimension being measured. With the grid-glow micrometer no contact pressure is required, and the grid glow tube is far more sensitive than any operator's sense of touch.



Electronic micrometer that will indicate displacements of one hundred-thousandth inch

Also, when it is necessary to measure small dimensions of a few thousandths of an inch with precision the grid-glow micrometer offers an inexpensive method whose operation is already familiar to the mechanic. As an inspection device the use of the grid-glow micrometer would eliminate the personal error in setting and reading a hand micrometer. The grid-glow micrometer is an extremely sensitive yet inexpensive direct reading measuring device, requiring no standardizing or adjustment of levers or lenses, and is equally sensitive over its entire range. (The circuit used appears on page 204, this issue).

Determining field distribution by electronic methods



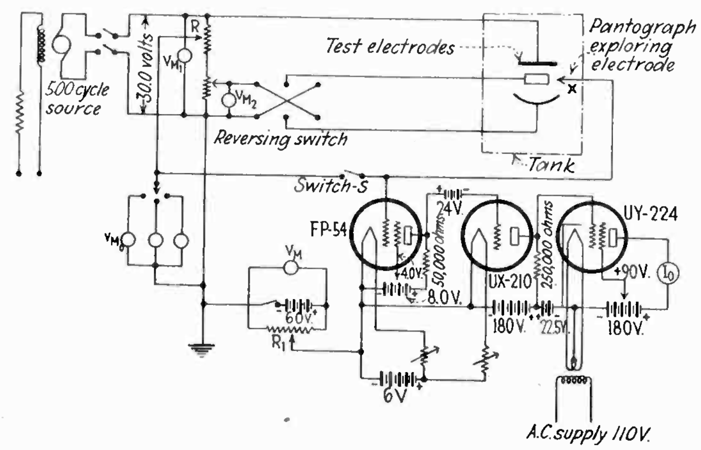
Typical field diagram determined by the immersed model system

By E. D. McARTHUR
Vacuum Tube Engineering Dept.
General Electric Company

IN MANY lines of work, particularly electrical, a knowledge of the distribution of the electric or magnetic fields about a set of objects is of great practical and theoretical value. The application of vacuum tube technique to determine the distribution of these fields has resulted in easier manipulation, increased sensitivity and greater stability compared to apparatus developed up to the present time.

This type of problem is found, for example, in the study and design of high voltage equipment, such as cables, insulators, etc., magnetic flux paths in rotating machinery, and in numerous other cases. The device to be described is capable of experimentally determining the distribution of "fields" which ordinarily necessitate the solution of a partial differential equation in some form.

In other cases, a useful solution mathematically is nearly impossible. It is in this latter type of work that the system to be described finds its greatest usefulness. Consider the electric field distribution between two plane parallel plates of finite dimensions. A calculation of the potential distribution between these two plates is very simple if we consider them to be of infinite extent. This, however, is an assumption which prevents the prediction of anything about the distribution of potential near the ends or corners of a pair of plates having finite dimensions. In this case, a solution is available[1] but in many other cases of this nature an exact mathematical solution is laborious and not always possible.



Circuit diagram of the complete equipment

An experimental method of determining these fields is made possible because the distribution in any homogeneous medium is controlled by the same law and is given by the same equation, provided there are no charges in the medium. This medium may be air, glass, water, or any one of various other substances.

Experimentally, the problem is solved by using for a medium distilled water and exploring this medium with a metering system which requires so little energy for its operation that the field distribution is not disturbed to any large extent.

The device consists of a tank in which are placed models of the electrode structure to be studied and at the edge of the tank a pantograph which carries a small exploring electrode made of .007 in. copper wire sealed into a glass tube. The other end of the pantograph, which extends out over a drawing board placed adjacent to the tank, carries a marking device such as a sharp prick punch or a pencil. The tank is about 2 ft. wide, 3 ft. long and 8 in. deep. In operation a picture of the model is made on drawing paper and the paper attached to the drawing board in such a position that the pantograph will trace the picture if the exploring electrode be moved along the model. Obviously, then any point in the tank can be located, with respect to the electrodes in the tank, by means of the exploring electrode and this position transferred accurately to the drawing board. The potential of the exploring electrode is determined by the potential distribution in the tank and is measured by a vacuum tube voltmeter system. The set is supplied with alternating voltage from a 500-cycle alternator. It has been found that the use of a 500-cycle supply is necessary to reduce the migration of ions in the fluid between the electrodes. If these ions are permitted to accumulate in large numbers at the surface of the electrodes, they will disturb the voltage distribution and the system will give results which are inaccurate. The

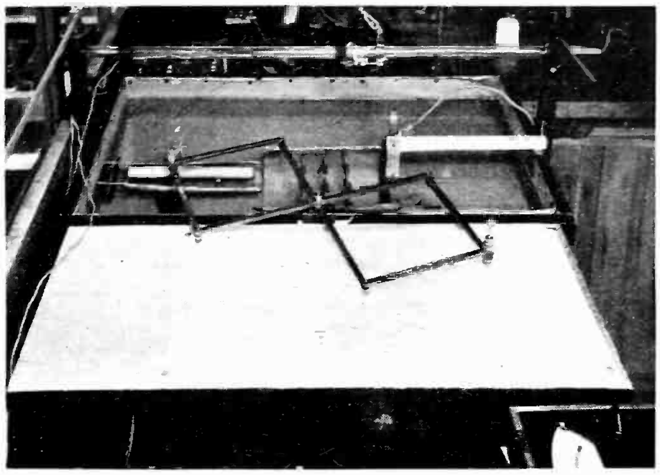
[1] Electricity and Magnetism. J. H. Jeans. 5th Edition, p. 274. Fortescue and Farnsworth. A.I.E.E., Vol. 32, Part I, p. 893, 1913.

error due to these ions is about 5 per cent to 10 per cent. It is for this reason also that distilled water is used. Distilled water has a sufficiently high resistivity so that the amount of conductance current flowing from one electrode to the other is kept at a minimum. This helps to reduce the number of ions formed and makes the power requirements of the whole device less. Other solutions, of course, may be used such as a copper sulphate solution used in conjunction with copper models of the electrodes to be studied.

Operation of the equipment

The diagram shows the electrical connections for three electrodes; that is, two independent voltages. Any number of electrodes can be used, of course, by providing the necessary voltage sources for them. The operation of the system is as follows: Suppose, for example, that we wished to find the potential distribution in a plane normal section of two parallel plates. The plates would be prepared and suspended in the tank so that the upper edge projected out of the water and the lower edge extended about four inches under water. The spacing, of course, is fixed at this time also. The voltage between the two plates is fixed at 30 volts by the alternator field. With the switch S closed a potential of 10 volts is applied to the grid of the first tube by means of the variable contact R and the meters V_m. The bias resistor R_1 is then changed until the plate current reading, I_o, of the last tube (UY-224) is adjusted to some conveniently read value of current, such as 0.1 m.a. Now the switch S is opened and the value of I_o is changed to some value depending upon the potential of the exploring electrode X. The exploring electrode is now moved in the tank until the current I_o returns to its original setting. The electrode X is then at a position in the medium where the potential is 10 volts with respect to the grounded electrode. This position is recorded on the drawing by pricking a small hole in the paper. By repeating the process, a number of such points, all having a potential of 10 volts, may be found. A curve drawn through all of these points then is the 10 volts equipotential curve of the system. Similarly, any number of equipotential curves may be plotted. If it is

[2]C. W. Rice, A.I.E.E., Vol. 36, p. 777, 1917.

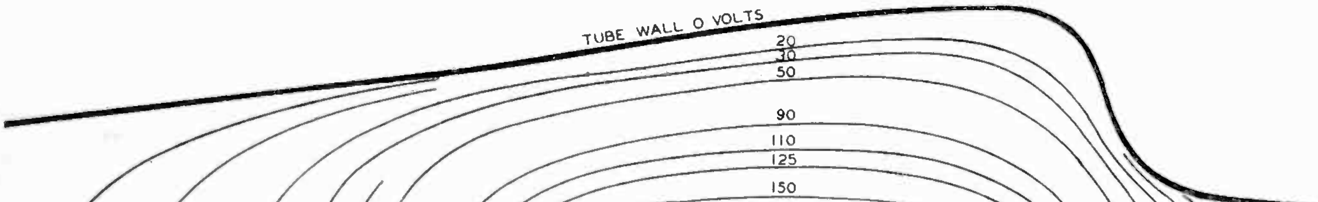


Physical apparatus used for plotting fields, the pantograph being clearly shown

desired, the lines of force may now be drawn on the picture by a number of different methods (see reference 2). The equipotentials may now be marked in per cent of the total, in which case, one plate is 0 per cent, the other 100 per cent and the lines between hold for any applied voltage, excepting when the presence of corona or some similar disturbance vitiates the results. Any number of electrodes of any shape may be used and their potentials may be made to represent positive or negative charges, depending upon whether their voltages are in or out of phase (180°) with the main supply voltage. This is accomplished conveniently for a three electrode system by the reversing switch.

If the device to be studied has an axis of symmetry, the field measurements are made in a normal plane to this axis; that is, the electrodes must be arranged in the tank so that a plane which cuts this axis of symmetry is coincident with the surface of the water. The exploring electrode then penetrates the surface of the water about $\frac{1}{16}$ in. to $\frac{1}{8}$ in.

If the structure has no axis of symmetry, the whole structure must be covered with water and means provided for extending the exploring electrode into the region to be studied. In this case the exploring electrode is a fine wire sealed into the end of a glass tube and ground off flush with the glass.



Equipotential lines in RCA-57 tube measured with apparatus, similar to that described here, in use in the RCA-Radiotron laboratories. Since electrons tend to cross such lines at right angles, much can be learned about tube construction and operation from the chart

The sensitivity of the device is sufficient to permit the location of equipotentials of about 0.1 volt when the total applied voltage is 30 volts.

The accuracy of the system depends on the accuracy of the meters V_{mo} and upon the quality of the pantograph. It is not difficult to obtain measurements of complicated electrode systems which will locate the position of any equipotential with a maximum error of 1 per cent.

There are a few precautions which must be observed. Needless to say, the various voltages must be kept constant throughout the course of any series of measurements. It is essential that the surfaces of the electrodes, including the probe electrode, be kept clean and free from grease spots, oxides, or any other contamination which might tend to prevent a good connection between the metal surface and the water.

The system may also be operated with the order of operations reversed and the potential variations at points of interest may be studied. This is accomplished by setting the pantograph at the point of interest and changing the potentiometer R until a potential indicated by V_{mo} is found which gives the same reading of I_o that is given by the potential of the exploring electrode. In this way, the change in field at certain points may be studied, using the geometry of the electrode system or the potential of one or more electrodes as variables.

The device described should be of use not only to determine unknown field distributions but to check the correctness of a mathematical analysis. The data found by this means may also be used to establish empirical relations to express algebraically the effect of variable dimensions or variable voltages. It cannot be used to represent the voltage distribution in a system in which there is a space charge other than zero unless the distribution of this space charge is known.

Briefly, the system described is capable of rapidly determining the electric or magnetic field distribution about complicated structures with good accuracy in those cases where Laplace's equation applies.

▼ ▼ ▼

An improved 120-volt d.c. audio amplifier

By CHARLES F. STROMEYER

Cable Radio Tube Corporation, Brooklyn, New York

THE results given in this paper are the summation of many months of development towards an improved audio system operating from a 120-volt d.c. line. It is the author's belief that the results will be better appreciated if viewed from a practical angle, rather than from a theoretical angle.

The power tube plate will receive 120 volts minus the sum of its bias voltage and the d.c. drop in the output transformer primary in the usual case where its set is to be operated from a d.c. house lighting circuit. The voltage of such circuits in New York city, a typical locality, averages about 120 volts. This is not a high voltage and it is difficult to secure sufficient loud speaker power output.

Power obtainable from Class A (single, push-pull, or parallel) triode or pentode amplification, when operating at this requisite low voltage, is seriously limited due to the negative bias restricting the plate current, and the small negative region of the $e_g - i_p$ characteristic. The power may be somewhat increased over ordinary push-pull by operating at reduced bias and allowing some grid-current flow, but the distortion becomes quite intolerable. Furthermore, the input transformer's secondary must have a relatively low resistance which limits its turn ratio; and as the power sensitivity of the tubes is already low, the problem of obtaining the necessary high input voltage offers a serious obstacle, for either a single or multiple first audio stage is unavoidable. These objections are also true of Class B amplification.

For these reasons a special tube (Triple Twin type 291) was designed for d.c. line operation.

The tube comprises two special triodes in one envelope. The cathode of the input section is directly connected to the grid of the output. A high input impedance is maintained. The plate characteristics of the input section are designed to supply the power for the grid of the output at a negligible distortion.

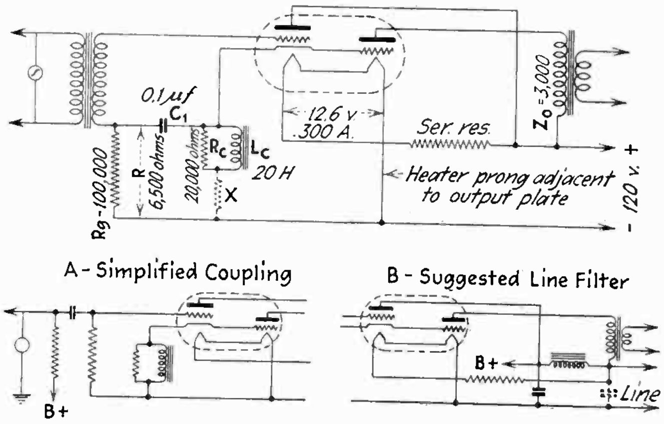


Fig. 1—Circuit diagram with constants for 120-volt circuit

The 291 is provided with an indirect heater type input section in series with a filament type output, having a 300 ma. current rating, which is the same as the automobile series (236, 237, et cetera.) This heater-filament arrangement is efficient and simplifies the bias problem. In Fig. 1, the d.c. drop between cathode and ground is the bias for the input grid and also establishes a positive voltage of equal magnitude on the output grid. The d.c. component of the output grid current opposes the plate current in the cathode circuit. Therefore, the input plate current's true reading must be measured between the plate and $B+$. The resultant d.c. cathode current averages 1.7 ma.; and for an 11-volt bias, the cathode should be off ground by approximately 6,500 ohms d.c. resistance. As the two currents are a function of the bias voltage, and as these currents oppose in a common resistor, they have a pronounced stabilizing effect on the self-biasing. The output grid return

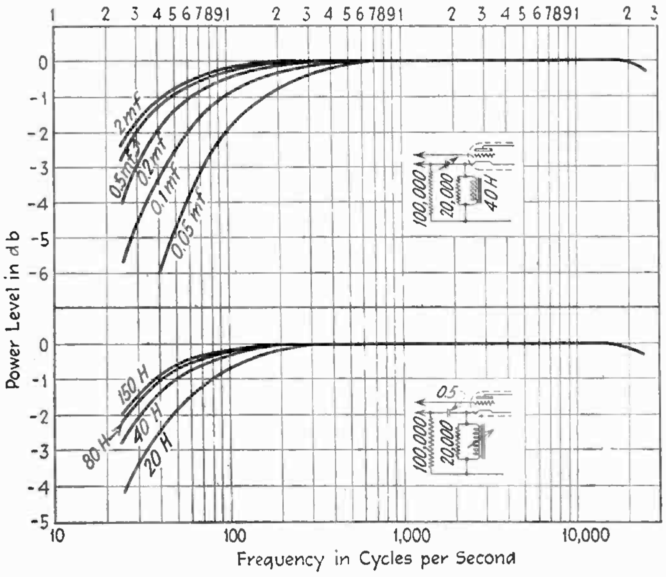


Fig. 2—Fidelity curves for various values of inductances and capacity

terminates at the filament leg and, therefore, the filament base prongs must be wired correctly, in relation to the filament series order. R_c limits the impedance variations of L_c. The signal from the input transformer is above ground by the signal developed between cathode and ground. The input section d.c. grid return is through R_g and its signal path through C_1.

A signal of 6.0 r.m.s. volts produces the rated power of 1.25 watts. Power above 1.45 watts is limited by grid current of the input section. The power varies perfectly as the square of the signal up to 0.8 watts. From this value there is a slight divergence from the square law relation, representing a power loss of only 0.7 db. Although 7.5 per cent total distortion is higher than the usual arbitrary triode ratings, it is similar to the pentodes 238 and 233. Cancellation of even harmonics will be advantageously realized in a push-pull combination. Distortion at low power is much less than might be expected. This is partially due to operating the output grid at a positive voltage.

Low power loss with varying load

The power loss of varying the load is small, even over wide variations, compared to a triode or pentode. It is only 1.5 db. down at three times the rated load. This means that the average speaker, whose impedance varies considerably with frequency, will receive a practically constant power regardless of the signal frequency. The speaker, therefore, does not have to be designed for any special frequency compensation, and should be designed with a flat frequency response, except where compensation is necessary for losses elsewhere. The distortion rises gradually with increasing load. This oddity is caused by the positive grid and grid emission during excitation with their consequent effect on the curvature of the output plate characteristics. The second harmonic predominates. Although the distortion rises, it is not over-emphasized, as the power is not increasing as in pentodes; and therefore, a speaker filter system is usually unnecessary. The power distortion curves at a low input selected from a family of curves demonstrate that the curvatures remain normal, regardless of whether the input is large or small.

The value for R_c is a compromise between power and distortion, as both decrease with lower resistance. At 10,000 ohms the distortion is down to a total of 5 per cent, and the power is down 15 per cent. The power does not drop very rapidly with line voltage. At 115 volts it is down 6 per cent; and at 110, down 12 per cent.

The selection of the coupling choke L_c and condenser C_1 depends upon the desired low frequency response. The family of fidelity curves given in Fig. 2 is helpful in selecting the values. Both sets were taken with a constant signal that produced rated power at 1,000 cycles. The signal was fed directly so as not to introduce characteristics of the input transformer. The output load was pure resistance. 0.1 mfd. is sufficient for midget receivers, as the level is only 2 db. down at 60 cycles, and only 1 db. at 100. Little improvement in fidelity is realized by increasing C_1 beyond 0.5 mfd. The lower curves represent the effect of varying the inductance. The 0.5 mfd. condenser was used. As the d.c. current passing through the choke is only a few ma., the unit can be small and inexpensive. A choke with a $\frac{5}{8}$-in. by $1\frac{7}{8}$-in. core stack and resistance of 9,600 ohms, which, when in shunt with R_c, produces the bias value, had an inductance of over 150 henries. Of course a much smaller inductance and resistance is entirely satisfactory, but the saving in choke winding will probably be offset by the addition of a series resistance to make up the bias value.

Special circuit arrangements

It has been pointed out that the input signal is above ground. This offers no difficulty if an input transformer is used as its secondary can be isolated. In ordinary resistance coupling, one side of the developed voltage is at ground potential. The latter type of coupling can be used but the gain of the Triple Twin's input section is sacrificed.

An inexpensive and effective line filter is suggested in Fig. 1-B. The output plate is not filtered. The input plate and, of course, the remaining tubes are filtered. Consequently the choke carries a relatively small current.

When more power is required, the 291 can be used in push-pull. The system produces results comparable with high-grade a.c. amplifiers. An output of 3 watts or better is obtainable.

COMPARISON OF TUBES OPERATED AT 120 VOLTS

Type	E_c	Z_o	Signal e_g (rms)	P_o	Power sensitivity $P_s = \frac{\sqrt{P_o}}{e_g\ (rms)}$
Triode 171A...	—18.5	3200	13.0	.150	.030
Pentode					
238 (Cathode)	—10.5	8500	7.5	.210	.061
233 (Filament)	—10.5	8000	7.5	.350	.079
Triple-Twin					
291	∓11.0	3000	6.0	1.250	.186

Measurement of Class B amplifier distortion

By CLYDE L. FARRAR
University of Oklahoma

In the past, audio amplifiers have been operated as so-called Class A amplifiers. This method of operation is inefficient but is relatively easy to design for low distortion. Because of their low efficiency, Class A amplifiers have been very expensive for high outputs. In order to increase this efficiency the so called Class B amplifier has been developed.

For a vacuum tube to have a high efficiency the load impedance or resistance must be large in comparison to that of the tube, and for the losses of the tube to be small, the applied voltage must be low when the current is high and correspondingly the current low when the voltage is high. Since a power vacuum tube in general has its rating determined by the plate loss, it should be operated at maximum efficiency and under conditions which give

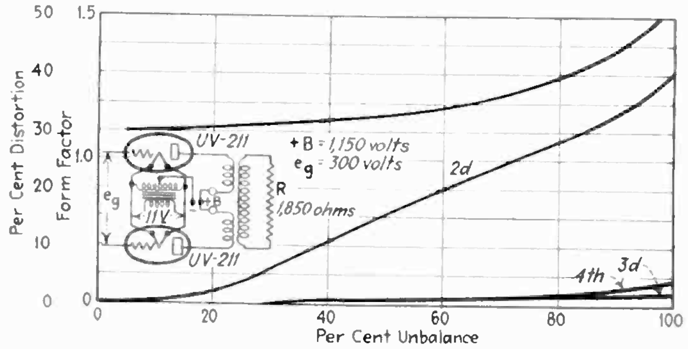


Fig. 1—Distortion due to unbalanced plate currents. The upper curve gives the form factor

minimum losses. For the purpose of this article the tube resistance will be considered as the plate loss divided by the square of the direct current to the plate while the impedance will be considered as the plate loss divided by the square of the alternating current to the plate. Class B operation is ideally suited for this type of operation since, with proper grid excitation, the plate loss is 21.5 per cent of the direct current plate input power. Analysis shows that for those conditions in which e_b is not equal to zero that the plate loss may be higher at less than full load although i_p is smaller. It can be shown that if two properly balanced amplifier tubes are operated in a push-pull circuit, the output of such an amplifier will be free from all even harmonics of the fundamental providing a pure wave is applied to the input. The output of a Class B amplifier consists essentially of a fundamental and a series of even harmonics, principally second, and if two Class B amplifiers are properly balanced and operated in a push-pull circuit, the output will be free from second harmonic distortion.

The plate input of a Class B push-pull amplifier will then be a series of pulses of d.c. current, each pulse will be a half sine wave if a sine wave of voltage is applied to the grid and the plate current is a linear function of the grid excitation. However, an a.c. ammeter of the electrodynamometer or thermo-couple type will give the same reading as if it were connected to an ordinary a.c.

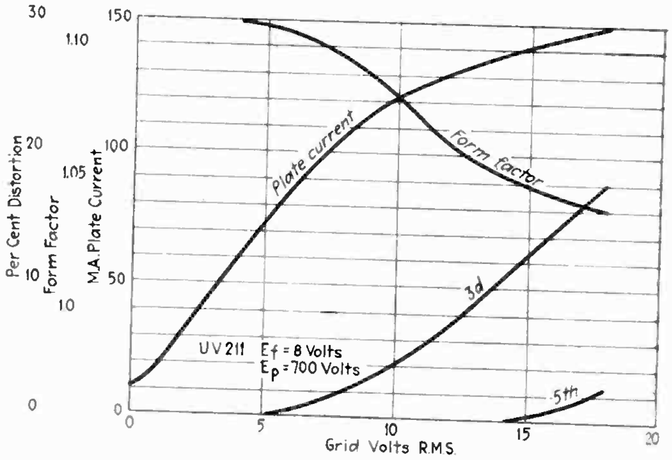


Fig. 2—Distortion due to plate saturation showing relation to form factor

circuit and hence will read effective value of current. On the other hand, a d.c. ammeter will read average value of current. By dividing the effective alternating current as read by the a.c. ammeter by the average current as read by the d.c. ammeter, the form factor is obtained and if this is equal to 1.11 the output wave is a pure sine wave. If this factor is other than 1.11, $\left(\frac{\pi}{2\sqrt{2}}\right)$, the output wave is not a pure sine wave, and hence the output wave is a distorted reproduction of the input wave, considering a pure sine wave as being applied to the tube.

To determine percentage distortion

This at once suggests a method of determining the per-cent distortion in a Class B amplifier. Results of a series of tests are shown by means of Figs. 1 and 2. In Fig. 1, the plate currents were unbalanced which resulted in the negative half of the output wave being different from the positive resulting in the generation of even harmonics. In performing this test the plate currents were unbalanced by lowering the filament temperature of one tube. This resulted in some third or odd harmonic generation as the output of this tube was not a half sine wave, due to plate saturation, the ultimate form factor being 1.5 instead of 1.57 or $\frac{\pi}{2}$. However, no practical amplifier would ever be operated at this value of unbalance. Figure 2 was obtained at low filament and plate voltage in order to obtain plate saturation without excessive heating of the plate. The form factor thus varied from 1.11 to 1.05, the theoretical minimum value of it being 1, which, of course, could not be reached as this would be a square wave. The plate currents were adjusted each time to be equal. An examination of these curves shows that the conditions for low value of distortion are not difficult to obtain.

From Fig. 1 it can be seen that the form factor does not change rapidly in the lower range of distortion, and in this case, ratio of direct current plate currents can be resorted to as this change is large in the lower percentages of distortion. An approximate unbalance of 27 per cent will give only 5 per cent second harmonics. If a constant alternating current is applied to the grid the plate current of each tube can be read and the percentage plate unbalance could be determined. It would be possible to build an ammeter with two elements connected to the same shaft, and if one element was connected so as to oppose the other the percentage unbalance could be determined under pulsating load.

Form factor as indicator of distortion

In Fig. 2 the form factor changes quite rapidly for low values of distortion and hence will give quite an accurate indication of the amount of distortion. In making these tests a constant applied alternating current is applied to the grid and all meters are read for various values of load. The maximum undistorted output can then be determined by obtaining the form factor and the plate unbalance. Unlike the Class A amplifier where the second harmonic distortion is most troublesome, the Class B amplifier is limited in general by the third harmonic distortion.

A series of load tests was made to test the output, efficiency, etc., of the a pair of UV-211 tubes operated as Class B amplifiers. These tubes were operated at normal rating except the plate voltage was 1,150 volts. The effective tube load was 1,700 ohms. In dealing with a Class B amplifier it is generally easier to speak of the two tubes as a single tube whose operating point is in the mid point of the two tube characteristic curves plotted as shown by Fig. 3. In this case the tube is taking no plate current when no signal is impressed upon the grid. The primary of the coupling transformer is then one half the actual transformer. The tube resistance will then be the total plate loss divided by the square of the plate current. Since the maximum efficiency for undistorted output is 78.5 per cent, the tube resistance will always adjust itself, depending upon the grid excitation, to a certain proportion of the plate load resistance, hence there is an optimum plate resistance for maximum efficiency and at the same time maximum power or minimum tube heating. However, this is not at all a critical adjustment.

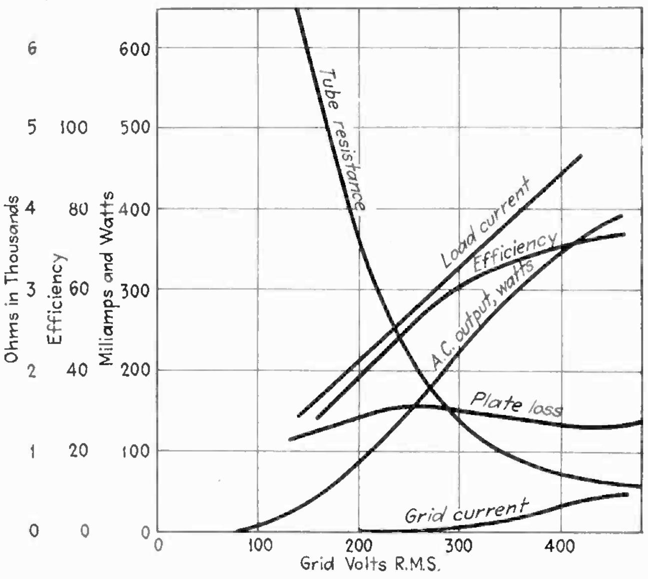


Fig. 4—Power output, efficiency and other characteristics of Class B amplifiers

This plate resistance of the tube as given by e_p/i_p will then vary under Class B operation from zero to infinity, hence the use of the tube resistance as equal to tube loss divided by the square of the current. The amplification of the tube has in general nothing to do with the actual resistance, therefore the output will be the same for any type of tube of a given rating, each type of tube requiring a different grid excitation to produce this output.

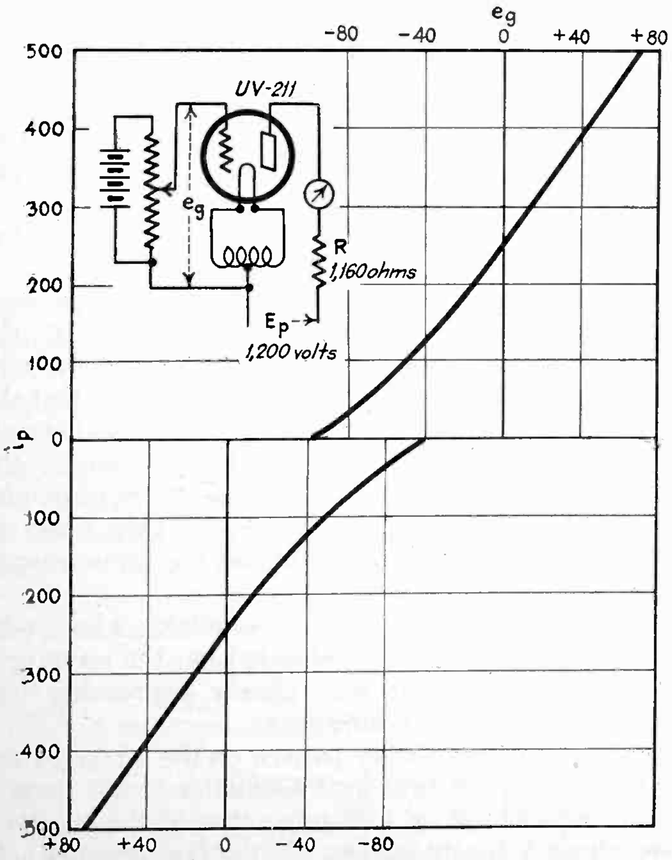


Fig. 3—Characteristics of UV211 power tubes used as Class B amplifiers

Experimental data

Curves 4 and 5 show the results of a series of tests on two UV-211 tubes. For the higher loads part of the third harmonic distortion is caused in the amplifier feeding the grid circuit of Class B amplifier. This effect is only noticeable at the high outputs in the region of about 300 watts. Since the grids of the Class B amplifier are driven quite positive as shown by Fig. 4, it is obvious that grid power is required. This grid power must come from the amplifier, feeding the Class B amplifier, and in this case at the higher loads the exciting amplifier was unable to supply the peak grid currents, which are probably equal to six or eight times the average current, without a change in form factor. This lowering of peak grid voltage gave the same effect as plate saturation and hence contributed somewhat to the third harmonic distortion. Some tubes were found to have a negative slope for part of the grid voltage characteristic curve. Under certain conditions this resulted in oscillations not related to the generation of harmonics of the frequency under test. In general, this effect resulted only under rather heavy overloads, accompanied at the same time by abrupt changes in plate current divisions between the two tubes. This phenomenon has not been completely investigated to the writer's knowledge.

An examination of Fig. 4 shows the relation between the applied grid voltage, the grid current, the plate alternating current output, the tube plate loss, the tube efficiency and tube resistance as defined above. It is interesting to note that the maximum plate loss (161 watts) occurred at an efficiency of approximately 50 per cent and from that point decreased until with a tube output of 382 watts the plate loss being 138 watts. It should be remembered in an actual amplifier each tube will dissipate one half the above loss.

The disadvantage of a low amplification tube is shown by the grid current curve, the grid current reaching the high value of 44 ma. for an output of 382 watts. Although the per cent of third distortion was 27 per cent and 7th was 3.7 per cent, for reasons stated above, the actual distortion due to the use of Class B amplifier was considerably less than this value due to the distortion of the exciter amplifier, which was unable to deliver the peak grid current corresponding to an average grid current of 44 ma.

Later tests made on the exciter amplifier show that the maximum distortion should be approximately 20 per cent for the Class B amplifier alone.

Curve 5 shows the per cent distortion, the form factor, the applied voltage e_b to the tube, plotted against grid excitation. The applied plate voltage e_b is numerically equal to $E_p - i_p R$ where R is the equivalent load resistance reflected through the transformer. E_p the plate voltage minus the e_b is equal to the peak value of the alternating current voltage. For a distortion of approximately 5 per cent e_b is then approximately 20 per cent of the plate voltage. Hence, there is available a peak value of 80 per cent of the d.c. plate voltage for the alternating load. Thus if a definite a.c. voltage in the load is known the required coupling transformer can be designed according to the same procedure as used for a power transformer. The r.m.s. value of the a.c. voltage being then $0.80 \times 0.707 E_p$ or approximately $0.56 E_p$, where E_p is the d.c. plate voltage.

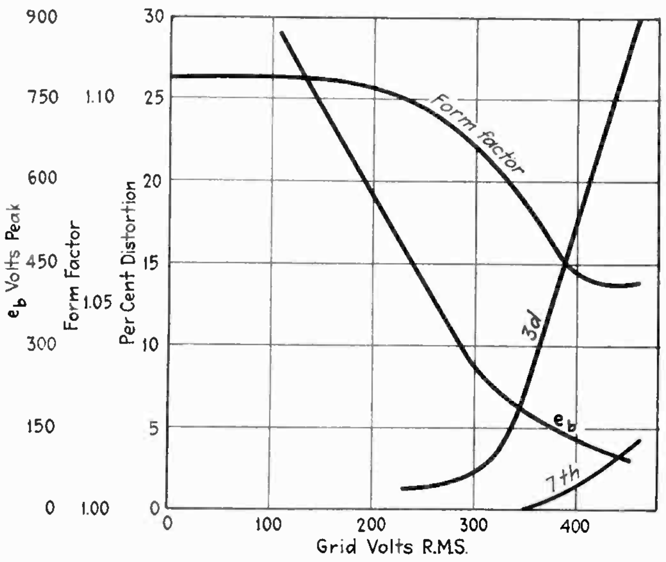


Fig. 5—Distortion characteristics showing relation of form factor

Thyratron linear time axis for cathode-ray oscillograph

By H. NEUSTADT

In using a cathode-ray tube as an oscillograph, the most conveniently read results are obtained by applying on one pair of the deflecting plates a voltage which increases linearly with time to its maximum value and then snaps back to zero as quickly as possible. This voltage will then supply a linear time axis for the pattern on the screen, and the result will be a curve which shows directly how the voltage under observation is varying with time.

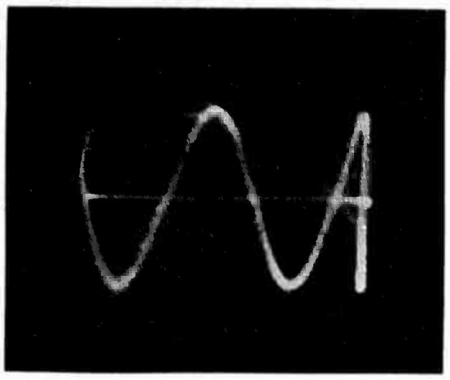
The circuit shown supplies a linear time axis in the following manner.

The plate and filament voltages of the kenotron are adjusted so that it is running at a plate voltage well above the value giving saturation current. The result is that the current through the tube is practically constant, regardless of variations in voltage across it caused by the charging of the condenser, C.

This constant current will feed charges on to the condenser plates at a uniform rate and since $V = Q/C$, the voltage across the condenser will build up linearly with respect to time. It will finally reach such a value that the thyratron breaks down and discharges the condenser almost instantaneously. When this has happened, the voltage across the thyratron is zero, so it deionizes and stops passing current. The condenser is then ready to charge up again at a constant rate and the same process is repeated.

The circuit can be considered an oscillator whose output (the voltage across the condenser) has the waveform shown in Fig. 2, which very closely approaches one ideally suited for use as a time axis.

To get a simple, stationary pattern on the screen of the cathode-ray tube, the time axis oscillations must have a frequency equal to N or $1/N$ times that of the observed voltage where N is any integer. If the frequency is $1/N$ times, then the pattern will be made up of N full cycles. If N times, then the pattern will be one *Nth* of a cycle. But if the frequency of the time axis is equal to that of



Oscillogram of 10,000-cycle wave

the observed voltage ($N = 1$), then the pattern will be one full cycle. This last condition is usually the one desired in practice so some means must be provided to adjust the frequency of the time axis to equal that of the observed voltage. It is also usually desirable, for the sake of detail, to get as large a pattern as screen space allows, so some means must be provided to control the time axis amplitude.

Adjustment of these two factors can be obtained in this circuit by varying the filament current of the kenotron and the grid bias of the thyratron.

The grid bias, since it controls the breakdown voltage of the thyratron, will affect both frequency and amplitude of the time axis. The breakdown point limits the maximum possible voltage to which the condenser can charge

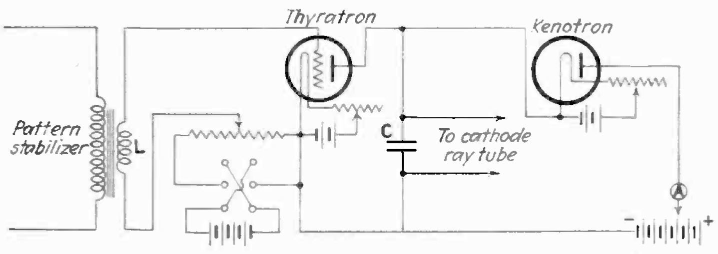


Fig. 1—Circuit for the thyratron controlled time axis

and so determines the amplitude. But by so doing, it also determines the time during which the condenser can build up charge before dscharging to zero; so it affects the frequency besides. The whole action is shown in Fig. 3, where the thyratron is shown breaking down at two different voltages corresponding to different values of grid bias.

Varying the kenotron filament temperature will affect the frequency alone. Since it controls the saturation current of the tube, it will determine the rate at which charges flow into the condenser. Since again, $V = Q/C$, it will determine the rate at which V builds up to the breakdown voltage of the thyratron. The action is shown in Fig. 4, where V builds up at two different rates, as determined by the flow of charge allowed by the kenotron filament temperature.

Obviously the same effect can be obtained by varying the capacitance of the condenser, for that will vary C in the above equation and so change the rate of increase of V. But instead of using a simple, inexpensive fixed condenser, a variable condenser would be necessary.

Circuit adjustment

From the above, it will be seen that the way to adjust the circuit is to vary the grid bias until the time axis has the desired length on the screen. Then the kenotron filament rheostat is set so that the time axis has a frequency in step with the observed oscillations, which condition is shown by a stationary pattern on the screen. Once the two frequencies are in step, they are kept that way by the coupling coil L in the thyratron grid circuit. It applies a small part of the observed voltage on the grid and helps to trip the thyratron every time the observed oscillations reach a peak with the result that the thyratron breaks down each time at the same point in the cycle of the voltage being examined. This feature prevents the pattern on the screen from drifting.

In actual practice, using an FG-17 thyratron, a tungsten filament kenotron (a coated filament is not used because it does not saturate well) and a $\frac{1}{2}$ μf condenser it has been found easy to run the circuit at frequencies up to 1500 cycles per second, and possible but difficult to run it up to 4000.

Upper frequency limit due to thyratron

At frequencies in the upper portion of the working range, there come into prominence two factors in the circuit's operation which have not been emphasized before. These are the definite length of time required for the thyratron to discharge the condenser, and the time required for the thyratron to deionize. The effect of these two time lags is clearly shown in the above oscillogram of a 10,000 cycle wave taken while the time axis circuit was operating at a frequency one-third that.

Were it not for the lags mentioned this would have been three full cycles of a sine wave. But it will be seen that, while the thyratron was deionizing, the condenser, being shorted, could not charge up again. So there was no horizintal motion of the light spot and part of the first cycle is distorted into a vertical line. Also part of the third cycle is distorted because the discharge time is not short enough to swing the spot back to origin abruptly but instead swings it back in a loop.

However the middle portion of the oscillogram, the second cycle, represents a portion of the spot's path where there were no such distorting influences and so gives a very fair picture of the 10,000 cycle wave. This indicates how, by getting a few cycles on the screen and disregarding the end ones, it is possible to study frequencies much higher than 10,000 cycles.

The circuit has recently found application in an investigation* on the time necessary to start conduction in an FG-17 thyratron by W. B. Nottingham to whom most of the information in this article is due.

*Journal of the Franklin Institute, Vol. 211, No. 6. June 1931.

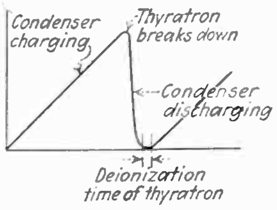


Fig. 2—Wave form of thyratron-condenser circuit

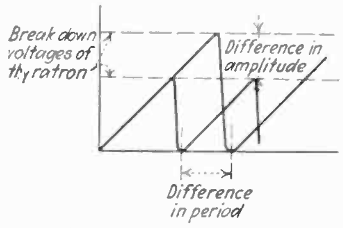


Fig. 3—Effect of grid bias timing on frequency

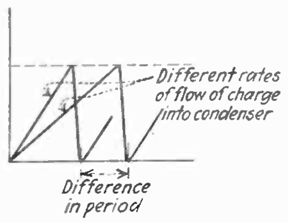


Fig. 4—Effect of kenotron temperature on frequency

HIGH LIGHTS ON ELECTRONIC

Photoelectric eye operates spray priming lumber

PRIMING COATS OF PAINT can now be applied to lumber with the help of the photoelectric eye, thus protecting the lumber from change in moisture content, infection by fungus growth, etc. The DeVilbiss Company of Toledo, Ohio, with the assistance of the General Electric Company, has designed a spray priming equipment using aluminum paint for this purpose.

The new equipment operates at a speed of from 60 to 200 lineal feet or more per minute, depending on the speeds of the conveyors feeding lumber to and taking it from the priming machine. The operation is entirely automatic.

The priming equipment is in the form of a spray painting booth with apertures through which lumber enters and leaves. Two sets of spray guns operate inside the booth. As the lumber enters the booth it trips a small "flag" which intercepts a beam of light falling on one of two photoelectric tubes. The impulse set up in the tube causes the first set of spray guns to operate, coating the face, one edge and one end of the board as it passes through the booth. When the board reaches the exit side of the booth, it actuates a second photoelectric relay in the same manner, causing a second set of spray guns to spray the back edge, other side and other end of the board as it leaves the booth. Thus a uniform priming coat is applied to all surfaces of the lumber at one operation. As the lumber leaves the booth, the "flags" are released, allowing the light beams to shine on the photoelectric tubes once more, and stopping the spray until the next board arrives.

According to the DeVilbiss Company, the cost of such overall priming ranges from $8 to $10 per thousand board feet. While aluminum paint has much popularity as a primer, other materials such as lead, paint, oil, etc., can be used readily with the equipment.

✦

Loudspeaker opportunities in legitimate theaters

IN THE NEW 3,000-seat Earl Carroll Theater in New York City, the largest house in the country for "legitimate" stage productions exclusively, the complete system of loudspeakers includes six speakers in the auditorium itself, and twenty in other parts of the building.

Among the features possible because of this innovation are:

(1) A general reinforcement of all music and voice from the stage;

(2) A disappearing orchestra working on an elevator platform so that after the orchestra has descended to the basement, the platform can be replaced and used for the stage production while the orchestra's music is still audible to the audience;

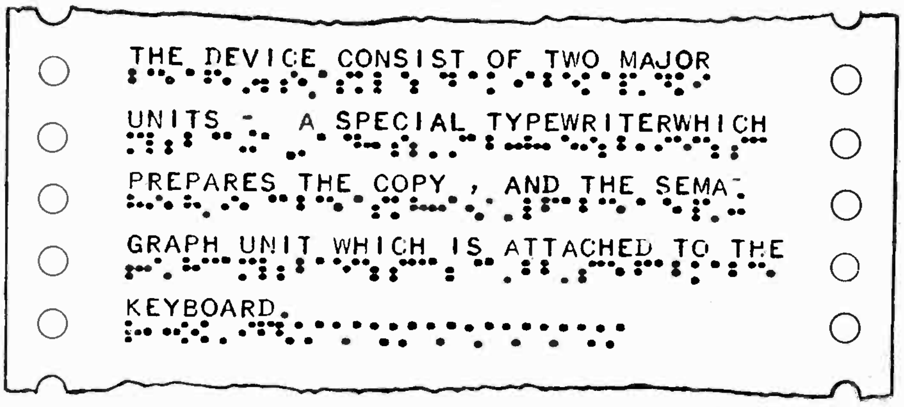
(3) The use of special phonograph records to reproduce off-stage sound effects.

In the lobby a loudspeaker makes possible the "curtain" announcement for the beginning of each act.

The loudspeakers in the dressing rooms enable members of the cast to hear a continuous reproduction of the performance on the stage and also make it possible for the stage manager sitting in the wings to keep the players in their dressing rooms advised of the play's progress and of their cues, eliminating the call boy's nightly rounds.

✦ ✦ ✦

TYPEWRITER COPY OPERATES LINOTYPE



With this new invention of Buford L. Green, Charlotte, N. C., typewritten matter fed to linotype is scanned by a photocell which controls the type matrices

"Electric eyes" for engineering contractors

ONE OF THE FIRST "electric eyes" used on construction operations is the one which operates the scales automatically at the N. Ryan Co.'s ready-mixed concrete plant in Brooklyn, N. Y. The scale beam is set for the weight desired. A light source is set directly back of the beam and the photo-electric relay is 6 ft. in front of it. Cement is fed into the hopper and when the proper weight is reached, the beam rises, exposing the light source and energizing the photo-electric relay. This opens the control circuit to the cement feed motor and automatically shuts off the supply.

A photo-electric cell installation on the Koon Dam, Evitts Creek, Bedford County, Pa., construction not only measures but records the content and weight of each batch of concrete. This photo-electric cell attachment cuts off the motors when scale indicator reaches zero on dial. A paddle-shaped tip on indicator interrupts the light beam and actuates electric relay which stops motor. Behind the scale dial is a graphical recording apparatus which records weight of sand, weight of rock, weight of cement, weight of water, and time of mix.

✦

Adjusting illumination in tunnels and movie houses

A VEHICLE TUNNEL in Paris makes use of photo-cells to control the light intensity inside to correspond with the natural lighting outside, and in this way, call for less ocular adjustment on the part of drivers entering and leaving the underground stretch. This use of the photo-cell suggests a similar need in the case of motion-picture theaters, where the general lighting might well be arranged to follow roughly the outside intensity, so that persons entering from the brighly lighted street would find the interior more quickly comfortable.

The Paris tunnel is 800 ft. long. At first it was thought that on dark days and at night, the greatest inside intensity would be needed. But tests showed exactly the opposite to be the case.

On sunny days all the lights are on. If the day is gray, every other bulb is glowing, and on dark days one light in four is used. At night every eighth lamp is turned on.

A tunnel brightly lighted at all hours of the day and night confuses the vision

DEVICES IN INDUSTRY + +

of the driver on entering and leaving. The purpose of the system used in this Paris tunnel is to keep the intensity of illumination about the same inside and on the streets, so that no sudden adjustment of sight is required. A photoelectric cell at one entrance controls the system, automatically turning lights on or off as the light outside becomes dim or bright.

✦

Tubes in scientific crime detection

The Scientific Crime Detection Laboratory of Northwestern University, which is located at 469 East Ohio St., Chicago, is carrying out tests of a new device to be added to the present "lie detector" or polygraph, as an additional means of studying emotional disturbances. This new apparatus, according to Charles Wilson, research engineer for the laboratory, will employ three and four-element tubes as part of the equipment.

Use has also been made of photocells in connection with color phenomena in the fluorescence and phosphorescence of substances when excited by ultraviolet radiation. Many stains otherwise indistinguishable can be readily detected or identified by exposing them to ultraviolet. The use of fluorescent substances in ink and papers as identifying media has also been proposed, to avoid possibility of counterfeiting.

Photo-cell inspector detects flaws, has "memory"

Professor Floyd Firestone of the University of Michigan, Ann Arbor, has employed photocells in a new inspection device for revealing flaws less than one ten-thousandth of an inch in size.

The object to be examined, any piece of metal shiny enough to reflect light well, is held in a clamp and revolved. As it revolves it also passes under the lens of a microscope, the light from the metal surface passing through the microscope to a photo-electric or selenium cell. If a flaw or crack appears on the product being viewed, it at once alters the quantity of light from this area, and this is noted by the photo-electric cell, which shows a change in the current passing through it.

The cell will react to a change in one ten-thousandth of a second, but this is too short to operate relay switches to turn the faulty material into discard, so a "memory" had to be devised. This took the form of a gas-filled radio tube which came into action when the fluctuating current from the photo-electric cell was amplified and passed through it. Current from this tube actuates a magnet, which sets the apparatus for automatic discard. The discharge in gas-filled tube continues, once started, thus remembering the flaw by keeping the discard path open. Once the inspection of the whole piece is completed, it is shunted aside and the memory tube reset automatically for the coming of the next piece.

Although the new inspecting device is especially rapid in examination of round objects, such as automobile pistons, which can be revolved and moved forward at the same time, it can also be used on any object with a light-reflecting surface, such as sheet tin.

✦

Sun behind clouds, infra-red rays work new sextant

For four and a half days of thick, cloudy weather, during a recent voyage, the Mauretania was navigated by observations of the invisible sun taken with the new MacNeil infra-red sextant. The inventor is Paul Humphrey MacNeil, of Huntington, Long Island, N. Y. His sextant employs a thermocouple as the radiation-sensitive element, but uses photocells and thermionic tubes to amplify the energy obtained from the thermocouple.

The complete instrument consists of two devices—the sextant proper, which is a hand instrument, and an amplifier connected with it by two small, flexible, rubber-covered cables. The amplifier is portable and of light weight for use in airplanes. It is being produced at Delft, Holland, while Henry Hughes & Son of London, well-known makers of navigating instruments, are now manufacturing the sextant. Mr. MacNeil expects later to have the instruments turned out both in England and the United States.

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PHOTOCELL WATCHES FREIGHT-CAR POSITIONS FOR OPERATOR

In this car-dumping installation at Waukegan, Ill., as the empty car travels down the return track, it cuts off a beam of light, causing the relay to ring the bell in the operator's cab. The bell warns him that the car has reached the predetermined point and that the car-retarding mechanism should be operated

electronics

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O. H. CALDWELL, *Editor*

Volume IV — JUNE, 1932 — Number 6

"Clear channels" for rural broadcast service being whittled away

STEP by step the "cleared channels" set up for the service of the rural population and farmers, are being destroyed. Two of the original forty were already no longer exclusive, as the result of other stations being authorized to operate on them and create heterodynes. And now it is proposed to put Canadian 5000-watt stations on the WPG-WLWL and the Hollywood channels, thus limiting these wavelengths to local usefulness.

The population of Canada certainly should have its share of the facilities of the North American Continent. Canada has about the same population as California or New York City. But already Canada had three times the radio wavelengths assigned to those equivalent populations.

Under the increase just assented to by the United States Government, Canada, in addition to spoiling the above two clear channels with 5000-watt stations, will continue to use her present six exclusive channels and also the additional exclusive wavelength (outside the broadcast band) at 540 kilocycles which has been preempted for use opposite Detroit.

Canada also has served notice that eventually she intends to use twenty present American regional channels for similar stations in Canada, thus destroying their availability also for American use near the Canadian border.

Altogether, under the new set-up, Canadian stations will be using some twenty-nine wavelengths, or four times as many per capita as will be available to serve American listeners.

Gyps in the radio business

MANY of radio's present ills may be traced to past excesses of production. Uncontrolled optimism—or ambition—followed by open or surreptitious dumping made possible large scale operations by hundreds of loft artists contributing nothing to the betterment of radio.

Each succeeding drop in price made more remote the legitimate manufacturer's chance of profit, and so increased in direct ratio the opportunity for the gyp manufacturer. Each wave of advertising stressing low prices, educated the public to believe cheapness was more important than fidelity, long life, or freedom from service cost.

There are more than a half hundred of this opportunist gentry operating in New York City. Their overhead is nil, their technical equipment consists in soldering irons, they contribute nothing to research, spend no money for local or national advertising. They buy and sell for cash, making about two dollars on each set sold on Radio Row or in department stores. Annually this parasite takes from legitimate manufacturers the profits from a half million sets.

Tubes by other names—

FOR many years, sporadic and unsuccessful attempts have been made to standardize nomenclature and numbering of vacuum tubes. Such attempts if successful would be specially apropos at the present time with every man, woman, and child of the radio and electronic industry bringing out a new tube. The manner in which tubes have gotten the numbers by which they became known has always been a mystery.

Is there any reason, even a poor reason, why a 224 should be a screen-grid tetrode while a 227, brought out long before the 224, is a general purpose triode? Or what about a 235 makes it variable-mu? Or why an RCA 57 is an r.f. pentode designed for radio receivers while an FG 57 is a thyratron, an 857 is a mercury vapor rectifier handling 20,000 volts and 20 amperes, and the FP 57 is a tetrode corresponding to RCA 850?

Since a tube would oscillate just as hard, or whatever it is supposed to do, just as well under any other name, would it not be wise to get some system into this madness so that by its very name one could tell what the tube is for?

New horizons in music

UNDER this title, Dr. Leopold Stokowski gave free rein to his imagination before the Acoustical Society at New York, pointing out some of the new possibilities which must follow the wider use of electronic devices.

New melodic systems, new dramatic possibilities, new scales, new intensities, were among the pictures he rapidly sketched. An orchestra at six times normal level is more compelling a creator of musical emotion than ever. Combinations of unequal beats give new rhythmic quality to music. Wider ranges of volume, wider ranges of frequency, must come in our reproducing systems. All of these will be possible, Dr. Stokowski believes, as electronic devices afford new delicacy of control.

It is fortunate that the outstanding musical figure today is an artist who can think clearly as an engineer and thoroughly understands how to create the effects his musical spirit calls for.

Phonograph-record progress "toward reality"

LEON SCOTT in 1857 is credited with the construction of the first instrument for making a graphical record of a sound wave. The stylus used by Scott made a lateral cut in the surface of the cylinder. In 1877 Edison brought out a machine similar to Scott's phonautograph but instead of making a lateral-cut record his stylus traced an impression of variable depth in the tin-foil cylinder. The next important advance was the electric recording stylus developed by the Bell Laboratories which extended the frequency range to 5000 cycles. This stylus while fundamentally different from Scott's did use the lateral cut principle.

During the past few months we have seen a further great advance in the art of phonograph recording as developed by these same laboratories in which the "hill-and-dale" or vertical-cut grove has again come into favor. While using Edison's original method, the new records far transcend what has gone before. The frequency range has been extended to 10,000 cycles and the volume range increased from 30 to 50 decibels. Music reproduced with the new records gives one a sense of actual presence during the original rendition.

A radio substitute for traffic signs and billboards

THE radio set on the modern family automobile is a great joy, but the idea might be carried further, to give speeding motorists roadway instructions, traffic cautions, and even advertising reminders, suggests W. C. White of Schenectady.

If automobile radio sets were tuned to a fixed short-wave, then all along the roadway, local antennas could be used to deliver appropriate messages to motor-car drivers, Mr. White enthusiastically proposes. For example, upon approaching a dangerous curve, the car would pass through a zone of ether vibrations counselling in clear ringing tones: "Slow down for bad curves ahead."

The motorist peering ahead for a gas station sign would be happily rewarded by hearing—"Al's Service Station, only one mile away. Goozle's Gasoline," and thus would be forewarned long before the red tanks hove into sight. And at the end of a dusty 400-mile drive, think of the delicious satisfaction of hearing the rise of a still small voice—"Chicken dinner, with ice cream, two miles ahead."

Transmitters little larger than an ordinary radio set would serve to energize these roadside antennas, whose range of action would be limited to a few thousand feet away from the antenna.

MODULATING A MOONBEAM

Marking the opening of the 67-story Doherty building in New York, May 13, L. W. Chubb and Phillipps Thomas, Westinghouse research experts, arranged a light-gate to modulate a concentrated beam of the moon's rays, over which Mr. Doherty addressed a nation-wide radio hook-up

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Barrier layer photocells in photometry

[A. DRESLER] The sensitivity of the Siemens and Halske cuprous-oxide front wall cell which has an active surface of 3 sq.cm. varies with the wavelength in about the same way as that of the human eye, but the response in the blue varies from cell to cell by as much as 30 or even 60 per cent. The temperature coefficient is 1 per cent per deg. C., temperatures above 70 deg. C. injure the cell. The resistance of the cell decreases when light falls upon it, an effect which can be used for amplifying the current in a bridge circuit.—*Elektrotechn. Zeitschrift, April, 1932.*

✦

The world's largest ultra-short-wave transmitter

BRIEF DESCRIPTION of the new Berlin station now completed by Telefunken to replace the present 1½ kw. set, which, though sufficient for music, has proved too weak for television where the use of regeneration would too greatly narrow the received frequency-band. Special tubes have been developed, watercooled, working on 6,000 volts plate, and oscillating down to 6 meters. Seven stages are employed, a crystal on 56 meters being followed by two frequency-doubling stages, one amplifying stage putting up the power from 4 to 70 watts, another frequency-doubling stage giving the final wavelength of 7 meters and also increasing the power to 150 watts, and two final amplifying stages, the last using two tubes to develop 15 kw. Modulation is on the grid of the penultimate stage; for broadcast purposes the modulation amplifier is partly resistance and partly transformer-coupled (30 to 10,000 cycles) but purely resistance-coupled for television (up to 30,000 cycles). The sender can be tuned from 6 to 8 meters without change of condensers or coils.—*Funk, Berlin, April 15, 1932* (and various other papers subsequently).

✦

Steel tape as disc

[NOACK] Stille is now producing records on his steel tape in disc form, so as to be playable from normal turntables. The tape is tightly rolled into disc form, each turn having a groove cut in its edge in which a special needle runs. Playing-duration is that of a normal disc, but without needle-scratch noises or wear.—*Radio B.F.f.A., Stuttgart, May, 1932.*

✦

Resistance-coupled r.f. amplifiers

[P. KAPTEYN] Loewe Radio Lab. Tubes with high mutual conductance, small capacity between the electrodes (screened electrodes) and small mu are desirable. The highest possible amplification is equal to 2 E/T, where E is the plate potential, T a constant governing the emission of the filament at low temperatures where the current is proportional to exponential E/T. With multiple commercial tubes containing constant high resistors an amplification of 10 per stage may be obtained; with special tubes, in which the electrodes are suitably spaced and screened the amplification rose to 200 or 300 per stage at 200 meters, as against a computed value of over 600.—*Hochfrequenztechnik. February-March, 1932.*

✦

New scanning method

[TOULON] Development of that described in these Digests for March 1, in which the surface to be scanned can be regarded as divided into a series of squares, each in turn divided into elements in the usual way. Instead, however, of scanning line by line as in the normal system, or by lines taken in irregular order as previously described, a certain element in the first square is followed by the similarly placed element in each successive square, and so on with another element in each square: and the relative position of the elements is so chosen as to cover the whole square roughly as soon as possible (e.g. not "1, 2, 3, 4,......" but say "1, 12, 9, 23, 20, 2,...." for a square of 25 elements). The mechanical means for attaining this is fully described.—*La T.S.F.p.T. (supplement La Télévision), Paris, March, 1932.*

✦

Mechanical music

[LEBEDE] Interesting reminder that Haydn some 150 years ago wrote 30 short pieces for a mechanical organ on the same principle as the old musical boxes (revolving cylinder with steel bristles), that Mozart even earlier had written three pieces for such instruments, and that Beethoven's "Vittoria" (Op. 91, 1813) was not originally scored for full orchestra with two auxiliary military bands as now performed, but for the "Panharmonikon," a similar instrument. Mention is also made of Hindemith's works for mechanical piano and organ, and of the use of the new Nernst-Bechstein piano (electronically amplified string vibrations) in Weill's latest opera, "Die Bürgschaft." This in connection with the tendency among some musicians to despise "canned music" of all types. (The writer might have added that Honegger personally supervised the recording of his "Pacific 231" for player-piano).—*Radio B.F.f.A., Stuttgart, May, 1932.*

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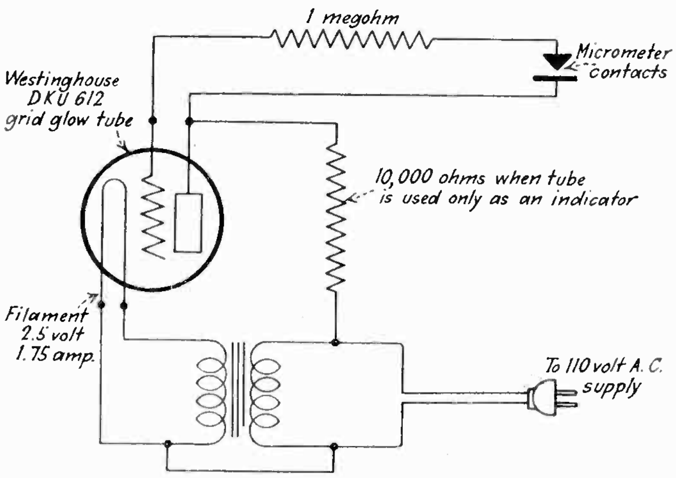
ELECTRONIC MICROMETER



Circuit used by Carson for measuring displacements of the order of a hundred-thousandth inch

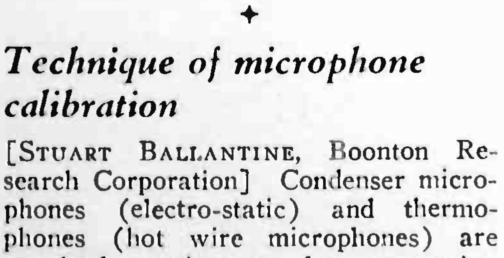
Improved radio-frequency measurements

[WIGAND] Full description of the new series of apparatus developed by Siemens for measurements from 100 to 1,500 kilocycles. These include a test transmitter of very constant frequency and which can be modulated up to 80 per cent, notable specially for its output transformer from which the oscillations are fed to the apparatus under test, in which a core of a newly-developed material has allowed of practically constant output throughout the frequency-range mentioned. A bridge-type tube voltmeter especially designed to measure the effective voltage of non-sinusoidal forms, an aperiodic four-tube radio-frequency amplifier in which a combination of resistance and transformer couplings is used to obtain a straight-line frequency characteristic; an inductance meter in which the coil to be tested is placed with a parallel standard variable condenser in the plate circuit of a crystal-controlled tube and the value of the parallel capacity at resonance taken, a repetition with another crystal allowing also the self-capacity of the coil to be ascertained; a meter for condenser-losses by comparison with a standard (amber insulated) condenser in the anode circuit of a dynatron, etc. A brief description of the methods used in testing a broadcast receiver with this apparatus is also given.—*Funk, Berlin, April 8, 1932.*

✦

Differential regeneration

[SCHR] German patent 528681. The fixed resistance of about 1,000 ohms allows the corresponding part of the differential regeneration condenser to be reduced in size that with decrease of regeneration no noticeable weakening of the higher audio frequencies occurs. —*Funk, Berlin, April 15, 1932.*



Regenerative circuit described in German patent

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Technique of microphone calibration

[STUART BALLANTINE, Boonton Research Corporation] Condenser microphones (electro-static) and thermophones (hot wire microphones) are standard equipment for measuring sound intensities. Electro-dynamic receivers are too liable to give resonance effects. Until recently microphone calibrations were performed by applying known alternating pressures to the diaphragm: at low frequencies by means of a reciprocating piston operated by a motor and at higher frequencies with the aid of the hot wire or thermophonic method. In view of diffraction effects and cavity resonance in the recess in front of the diaphragm it is desirable to supplement the usual calibration of the microphone in terms of pressures applied to the diaphragm by means of electrostatic forces applied between the diaphragm and a grille-shaped electrode mounted in front of it at one mm. distance.

For higher frequencies one or more fine wires or thin metal strips are mounted on a small hydrogen-filled enclosure of which one wall is formed by the microphone diaphragm. The strip carries a steady current, and by adding alternating current, temperature and pressure cycles are produced of the same frequency as the alternating current. The peak values of the pressure developed in the enclosure are given by an improved complicated formula.

The direct pressure calibrations thus obtained ought to be supplemented by calibrations in plane sound waves using the well-known Rayleigh disk for comparison. The pressure at the diaphragm may not be the same as the undisturbed pressure in the sound field. It is known that a small receiver absorbs energy from an area of the wavefront which may be several times greater than the actual area exposed to the waves, in which the energy passing per second through unit area normal to the direction of propagation (intensity of sound) is given by $P^2/2cs$ (P being the pressure amplitude, s the density, and c the velocity of sound in air). If the dimension of the receiving surface is of the order of several wave-lengths, the effective area is equal to the actual area. In practice this condition cannot be fulfilled for a broad range of wavelengths. But the corrections (diffraction and directional effects) can be expressed in simple Bessel functions when spherical microphone surfaces are used. Results obtained with ordinary microphones must be corrected for cavity resonance.—*Journal Acoustical Society, January, 1932.*

✦

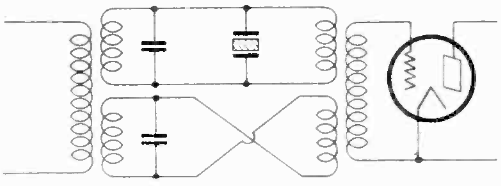
Radio interference and law

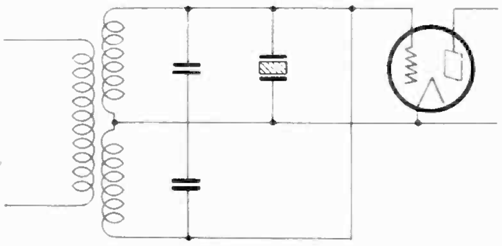
[W. VOGELSANG] Whereas in the United States the power-companies remove disturbances of their own accord, laws against persons operating devices which interfere with radio reception have been adopted in Denmark, Yougoslavia and Switzerland.

The suggestion is made that the show window of the radio dealer be used more often for calling attention to the milder cases which may not be objectionable individually, but represent a considerable factor owing to their large number.—*Radio-Helios, February, 1932.*

Piezoelectrical arrangement for receiver

[SCHR] French patent 698769 for the use of a crystal in the intermediate-frequency amplifier of a superheterodyne to increase selectivity (as in Robinson's Stenode system). The circuit without crystal passes on all the existing fre-





quencies, that containing the crysal suppresses the definite frequency chosen, to which the crystal is tuned. All therefore except the chosen frequency cancel each other out. The second arrangement uses direct coupling, but is otherwise similar.—*Funk, Berlin, May 6, 1932.*

✦

Extension of loudspeaker frequency range

[TOULON] Details of a system used commercially in France (Charlin) in which two, three, or four types of electro-dynamic loudspeakers are used in conjunction, together with a system of filters preceding the power-amplifiers, and therefore using a separate power-amplifier for each frequency-band, corresponding to one type of loudspeaker. The relative placement of the bass, medium, and high-note speakers is fully discussed.—*L'Onde Electrique, Paris, March (published April, 23), 1932.*

✦

Heterogenia

THE "DISC WAR" is ended, the gramophone industry agreeing to provide free discs as previously for the [German] transmitters, but one month only after their appearance on the general market, and with the proviso that not more than 60 hours per station per month are to be given up to disc concerts. [Quoted to illustrate German programme difficulties during the crises]—A recent concert in Lübeck used discs to provide the orchestral accompaniment to a singer and a violinist, this is said to be a revival of a pre-war idea. [Compare the suggestions of Professor Karapetoff in Electronics for April]—*Radio B.F.f.A., Stuttgart, May, 1932.*

Trade show sees new sets, circuits, tubes

[*Continued from page 206*]

Prior to the Trade Show a new circuit was demonstrated at Fordham University. This circuit prevents regeneration by a combination of electrostatic and electromagnetic coupling of such a nature that not only are the noises incidental to uncontrolled regeneration eliminated but by a dial the operator can narrow or widen the band of frequencies accepted by his set. As many as six or more stages may be cascaded without danger of oscillation, according to the sponsor, Research Products Corporation, Boston, Mass.

In demonstration against a number of models of present day receivers, the new circuit is said to have equal fidelity and volume but to be quieter than conventional receivers.

Another radio using very small tubes ($2\frac{1}{2}$ in. long by $\frac{3}{4}$ in. in diameter) has been developed. Overall it is no larger than the average mantle-electric clock. The set is to sell in the neighborhood of $15, has six tubes, uses the Rochelle salt loudspeaker (*Electronics*, May, 1932, page 166). The tubes are the developed by J. V. Capicotto; the set is sponsored by Radio Products Corporation.

Still another rumor is the perennial tubeless radio. Newspapers throughout the country a month or so ago ran boiler-plate articles about such a set that claims to do all present day sets do and besides has no tubes to wear. In the publicity much was made of McGraw-Hill figures showing that in 1931 the American public spent $68,000,000 for tubes. Engineers no longer claim anything to be impossible, but considering the vast sums of money spent by the telephone company to develop amplifiers, before the tube came along, many fingers are crossed with regard to the new set. Without a doubt a tubeless radio would attract much attention and if comparable in price, and performance would gather to itself its share of the annual 3-4 million set market.

There is more fact than rumor in the results secured by a prominent set manufacturer in selling expensive remote control radios. The hoped-for quota of $50,000 for 1932 has not only been attained already but at present rate the year's sales of $300 radios of this type will mount up to the imposing sum of $200,000 or more. Thus one of those things which "can't be done" is being accomplished with considerable success.

▼ ▼ ▼

NEW BOOKS ON ELECTRONICS SUBJECTS

Quartz resonators and oscillators

By P. Vigoureux, (1931), His Majesty's Stationery Office, London. 215 pages. Price, 7s. 6d. ($2.50).

THIS MONOGRAPH PREPARED under the auspices of the Radio Research Board (Great Britain) gathers together a considerable part of the literature on quartz crystal apparatus, on their applications, and on the theories pertaining thereto.

The general physical properties of quartz are briefly dealt with as also the cutting and the mounting of the plates. As the action of the direct and the converse piezo-electric effects is dependent on mechanical vibration the mathematical outline of the elastic theory of vibration in solids is discussed, and from this groundwork the development of circuit theory proceeds. The latter part of the book is devoted to the various theories of the internal structure of quartz, an aspect of the subject which presents many unsettled points.

The non-mathematically minded reader will find a great deal of interest in a perusal of the imposing list of applications which have been found for crystal apparatus. Aside from the extremely important use of resonators and oscillators as frequency controls, monitors, and standards in commercial radio practice, the list is a long one, ranging from high pressure measuring devices applicable to ballistic studies, and to the study of vibrations in heavy machinery, to extremely responsive optical arrangements important to the physicist and offering another line of attack on the optical problems of television. Piezo-electric devices are emulating the vacuum tube in versatility; together they command a most dominant place in the future of radio and television.

Photographs illustrate the various modes of vibration of different sizes and shapes of plates (luminous resonator crystals); many other illustrations, response curves, and circuit diagrams are valuable. The index could stand a much more through treatment.

It is to be hoped that at some future time the author will extend the material of the present book into a more detailed treatment; admittedly, covering in comprehensive detail the ground marked out will involve no mean task but the rapidly devolping importance of the subject will soon justify such an effort.

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Die lichtelectrische zelle und ihre herstellung

By Richard Fleischer and Horst Teichmann, Theodor Steinkopf, Dresden, 1932. Price, 12 r.m. ($3).

THIS BOOK ON light-sensitive cells and circuits is a study of the various photo-electric effects and processing methods. These effects are classified into five distinct groups—the light-electric effects caused by outside influences, the light-sensitive effects caused by inside influences, the Becquerel effect, the Sperrschichtphoto effect and the crystal effect. Messrs. Fleischer and Teichmann give the theoretical explanation for the practicality of filling of alkali cathodes with gas and a treatise on the different gases, as hydrogen, the rare gases, the halogens, oxygen group, the nitrogen group in inorganic and organic links. Detailed production processes are explained such as the pouring, the distillation, the electrolytic, the reduction processing outside and inside of the cells. The various sensitizing methods are also detailed. Types of cells used for laboratory or for industrial purposes are described. In this connection the types manufactured by German, French, Dutch, Hungarian, English and American concerns are listed and valuable technical details as to construction, design and characteristics of these types are published.

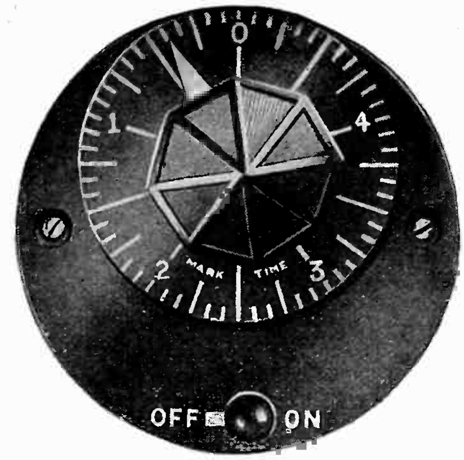
A chapter is devoted to the selenium and thalofide cells. Finally the crystal-photo effect, developed by Professor H. Dember of Germany, to which in scientific circles a great hope was attached, is described. The material used by Professor Dember is cuprons oxide, crystallized mostly in octahedron or rhomboidal forms. It is about 10 to 14 mm. thick and the direction of the generated emf. depends upon the direction of the light ray.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Time-switch for radio sets

M. H. Rhodes, American Industrial Building, Hartford, Conn., has developed a special "mark-time" switch to



meet the requirements of the radio set manufacturers.

The mechanism consists of a main spring, gear train, and simplified escapement, all fully enclosed in a bakelite housing $2\frac{7}{16}$ in. in diameter and $\frac{7}{8}$ in. deep. A conventional knob and pointer is fitted to the main shaft. The switching mechanism, insulated completely from the timing mechanism is available in two forms—one a positive snap action and the other a slow break suitable for 115 volts a.c. circuit.

In application the cabinet manufacturer provides a recess in the front wall of the cabinet, at the back, to accommodate the switch housing. A hole $1\frac{7}{8}$ in. in diameter, concentric with the main shaft carrying knob and pointer, is drilled to admit the dial section of the bakelite housing. Directly beneath, a slot $\frac{1}{2}$ in. by $\frac{1}{8}$ in. is cut to admit the switch lever.—*Electronics, June, 1932.*

+

New tone control for microphone

A form control recently developed by the Universal Microphone Company of Inglewood, Calif., may be connected across the buttons of any microphone. Its action is such that tone may be altered as desired, regardless of adverse conditions.

For example, shrill high-pitched voices may be toned down to normal, whereas gruff, deep voices may be tuned to more pleasing positions in the range of voice freqencies.

The new Universal tone-control also permits an adjustment in public-address installations for eliminating the "feedback" resonance or ringing echo following the pronunciation of certain words. Where the group address system is installed in a building having poor acoustics, this new tone control provides a flexible adjustable element, capable of overcoming many acoustical defects.—*Electronics, June, 1932.*

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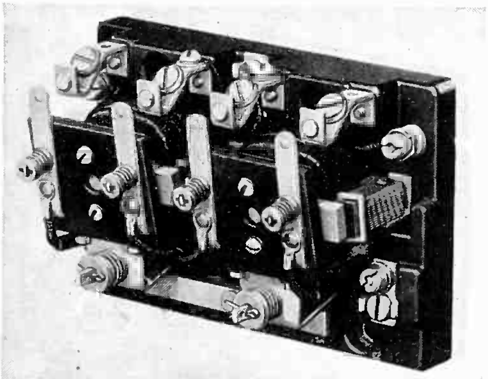
A.C. reversing contactor

The Square D Company, Industrial Controller Division, Milwaukee, Wis., has brought out a new a.c. reversing contactor designated as Class 8711, Type K, of small dimensions and particularly adapted to small hoist, dumb waiter, window and door control. Contactors are mounted on a porcelain base, are mechanically interlocked, and have silver-to-silver con-



tacts. The maximum rating is $\frac{3}{4}$ hp., single or 3-phase. The dimensions are only 6 in. wide by 4 in. high by $3\frac{1}{4}$ in. deep.—*Electronics, June, 1932.*

+

Four-channel mixer

The Gates Radio & Supply Company, of Quincy, Ill., has developed a Type 96A mixer, designed primarily for a 19-in. relay rack. It measures 19 in. by 12 in. by 6 in. in size and is finished in satin. It uses a standard four-channel parallel mixing circuit incorporating modified T mixing controls, microphone current control for carbon-type microphones, carbon microphone test jacks and current switch, as well as individual channel selector.

The entire assembly is standardized at a 200-ohm input and output impedance and is designed for operation with broadcast-station, public-address and recording amplifying systems. Price complete is $135.00.—*Electronics, June, 1932.*

Bulletin on radio interference

A valuable contribution to the increasing literature on man-made static and methods of alleviating troubles caused by such unwanted noises is Bulletin No. 2, Radio Inductive Interference by H. O. Merriman, engineer in charge, Interference Section, of the Radio Branch of the Department of Marine, Dominion of Canada. This bulletin (35 cents) published in 1932 is the result of investigations on some 30,000 cases of radio interference due to power lines and apparatus. Methods of locating trouble and of correcting it are well described.—*Electronics, June, 1932.*

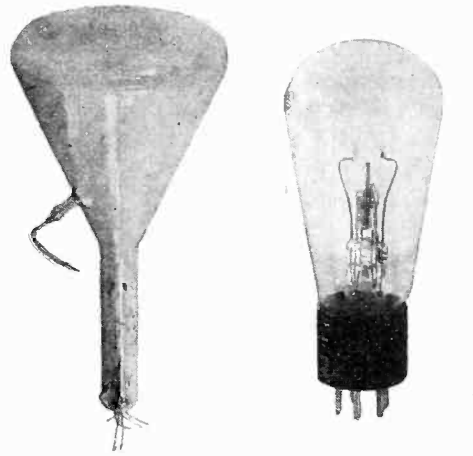
+

Cathode-ray tubes

A line of cathode-ray tubes of different types and sizes, suitable for a wide range of experimental and laboratory applications, is announced by the Globe Television & Phone Corporation, Starrett-Lehigh Bldg., New York City.

The lowest-priced tube of the line is the S-14 cathode-ray tube, contained in a glass envelope similar to the usual —45 power tube and provided with a five-prong base. Fitted with a single set of deflector plates, this tube may be employed as a voltmeter, ammeter or resonance indicator, as well as to demonstrate the basic principles of the cathode ray.

The line includes two sizes of cathode-



ray tube with silver anode, namely, the 5-inch and the 9-inch. This type is designed to be operated with deflecting coils on the outside of the bulb, instead of making use of deflecting plates inside the bulb.

There are three sizes of cathode-ray tube with deflecting plates, namely, 3-inch, 5-inch and 9-inch. This type has two sets of deflecting plates—*Electronics, June, 1932.*

A microphone to be worn on the lapel

Measuring less than $1\frac{1}{4}$ in. in diameter by $\frac{1}{4}$ in. thick, and provided with a handy clip, the "Lapel Mike," manufactured by Radio Television Industries Corporation, Reading, Mass., is worn by speakers and singers for complete freedom of action.

This carbon-granule microphone with stretched gold-plated duralumin diaphragm, incorporates unique constructional features making for maximum sensitivity and fidelity. A special method of stretching the diaphragm permits of vibrating the full area for maximum response. The carbon granules are subjected to vacuum treatment at high temperature for the removal of volatile matter, as well as to a washing in U.S.P. grade ether acetone, and zylol to remove every trace of grease. The microphone is exceptionally free from hiss and crackling.—*Electronics, June, 1932.*

✦

Refractory protected mercury switch

The Westinghouse Lamp Company announces a new refractory protected mercury switch. To protect the glass walls of this switch a refractory block is placed within the switch providing a chamber to confine the arc caused by the opening and closing of circuits having surge characteristics. The refractory protecting chamber is so designed as to insure a positive, safe and dependable impact contact, between two pools of chemically pure mercury. A few of the many uses of this switch are temperature regulators, motor controls, sign flashers, lighting controls, time clocks, heating controls, signals, gasoline pumps and spraying equipment.—*Electronics, June, 1932.*

✦

Super-sensitive relay

Controlling a current of 6 amperes at 220 volts by means of the minute flow of one one-millionth (0.000001) of an ampere is the achievement of the Burgess micro relay, product of the C. F. Burgess Laboratories, Inc., 202 E. 44th St., New York City.

This relay thus transforms normally indistinguishable contacts into readily distinguishable, powerful, useful forces. In this characteristic lies its greatest value for temperature-control work, go and no-go, and maximum and minimum control settings on sensitive indicating meters and other apparatus. It fulfills a function heretofore held uncertain because of the lack of a relay mechanism capable for such a wide spread between controlled and controlling energies. This device is particularly recommended wherever it is desired to provide indication or control at some predetermined value as shown by any indicating instrument, such as voltmeter, ammeter, pressure gauge, thermometer, etc., or in industrial equipment wherein positive action must be obtained by the closing of a circuit through very slight pressure. —*Electronics, June, 1932.*

✦

Portable automatic phonograph unit

A portable automatic phonograph unit for use with sound distributing systems has just been announced by the Operadio Manufacturing Company, St. Charles, Ill.

An automatic record changer, playing ten records on both sides continuously

without attention, is incorporated in an attractive crystalline finished metal carrying case. All hardware is heavily nickel-plated.

The unit is available in several models adapted to various types of service. A bulletin has just been issued completely describing these models— —*Electronics, June, 1932.*

✦

For calibrating signal generators

The RCA Victor Company, Inc., Camden, N. J., announces its standard microvolter Type TMV-47A for the checking and calibration of signal generator equipment. In addition, the standard microvolter may be used as a signal generator, provided the voltage required is within its range.

The unit requires a driving oscillator whose frequency is half the output frequency of the microvolter. This oscillator may either be a signal generator or a simple oscillator, and may be modulated if so desired. Since only the value of r.f. voltage required for the measurement is generated, no errors are introduced from leakage and the accuracy of the instrument when properly operated over the broadcast band depends upon the accuracy of the direct-current meter used to read the output, as no thermo couples are used. The output range is 1—10,000 microvolts.—*Electronics, June, 1932.*

✦

Magnet-controlled mercury switch

The Providence Electric Controls, Inc., 763 Allens Avenue, Providence, R. I., has announced a full line of improved mercury switches, ranging in capacity from 1 to 100 amperes. In types having a rating up to 5 amperes special heat-resisting contacts are used. In the larger switches arcing takes place over a ceramic surface eliminating the danger of tube breakage.

A new feature is the "Magnetrole" mercury switch which operates entirely by magnetic control. A gas-filled tube containing two mercury pools and a floating displacement member is placed within the field of an electrical coil. When the coil is energized, the floating piece within the tube is drawn down displacing a certain amount of mercury. This causes a rise in the level of one of the mercury pools with a consequent merging of contacts.—*Electronics, June, 1932.*

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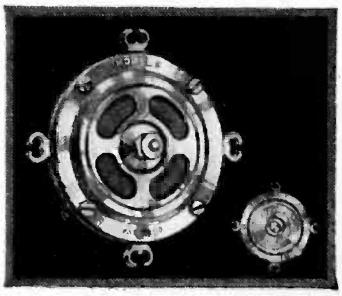
Microphone for voice

The Shure Brothers Company, 337 West Madison St., Chicago, has developed a new two-button microphone of the non-stretched diaphragm type. Through its special construction the diaphragm is damped to eliminate the

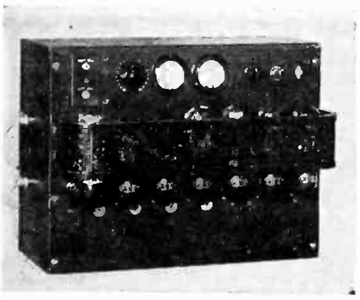


chatter of noisy vibration. This gives clearness of reproduction to the speaking voice. By the use of two buttons "push-pull" microphonic action is secured. The buttons have highly polished gold surfaces. Model 5-N is especially recommended for public address systems.—*Electronics, June, 1932.*

Theater amplifier

The Webster Electric Company, Racine, Wis., offers a new line of completely a.c.-operated four-stage theater amplifiers (Models 6048-R and 6049-R) with a number of new features including exceptional tone quality and volume, realistic reproduction, silent operation, compactness of design and simplicity of operation.

Extreme care has been exercised in the design of this amplifier to give fidelity of tone from film or disk—



realistic reproduction is obtained which retains the natural timbre of voice or music. The volume control is so designed as not to cause any frequency discrimination at any volume setting. Therefore, no tone compensators are required.

Great simplicity has been achieved in operation. The only operating control is the specially designed unit combining a single action volume control and silent fade-over from one projector to the other. A snap switch is provided for the power line.—*Electronics, June, 1932.*

✦

Transformers for radio receivers

The Kenyon Transformer Company, 122 Cypress Ave., New York City, is putting on the market a complete line of radio transformers and chokes, transmitting equipment, and step-down transformers. Special stress is laid on the care taken in design and production, and on the fact that every unit leaving the plant receives a full test in successive and final operations.—*Electronics, June 1932.*

✦

Socket with "floating contacts"

A new departure in radio socket design has just been introduced by the Cinch Manufacturing Corporation, Chicago. Scientifically designed, with floating contacts, all strain on the bakelite is eliminated, preventing warping and loss of tension after the tube is inserted. The floating principle employed, makes the contacts self-aligning assuring a rigid contact on each tube-prong at all times. This construction eliminates all holes generally used for riveting contacts to bakelite. Thus a considerably stronger socket is provided. A special lip on the contact simplifies the soldering operation.

The new Cinch radio sockets are made for four-, five- and six-prong tubes with $1\frac{27}{32}$ in., $1\frac{11}{16}$ in. and $1\frac{1}{2}$ in. mounting centers.—*Electronics, June, 1932.*

✦

Radio-phonograph combination

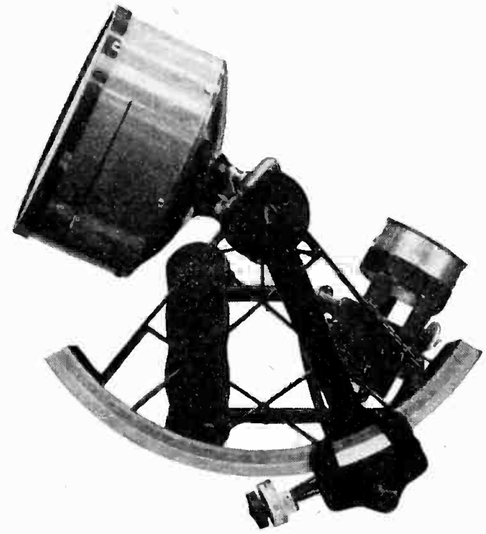
The "Combinaire," a 10-tube superheterodyne radio and Capehart automatic record-changing phonograph, is the product of the Capehart Corporation of Fort Wayne, Indiana, Ind. This unit covers both broadcast and short-wave bands and includes 12-inch dynamic speaker, push-pull pentodes, automatic volume control, vernier tuning and other refinements. The changer includes a device for playing encores and rejecting any record and an unloading lever. Upper doors make the record changer easily accessible for loading. It is not necessary to remove vases or statuary to raise a lid.—*Electronics, June, 1932.*

✦

Infra-red sextant

Macneil Instrument Corporation, 25 Broad St., New York City, has acquired exclusive license to make and sell the Macneil "all-weather sextant" under patents pending and issued to Paul H. Macneil, the inventor.

Accurate observations may be taken



with this sextant at any time during the solar day when either or both the sun and the natural horizon are obscured by fog, clouds or other weather conditions.

The Macneil sextant is not an optical instrument. It detects infra-red or invisible rays originating in the sun, after they pass through, or are the cause of re-radiation by clouds, fog, etc.

The artificial horizon used is an entirely new development, is extremely easy to handle and very accurate.—*—Electronics, June, 1932.*

Insulated coupling unit

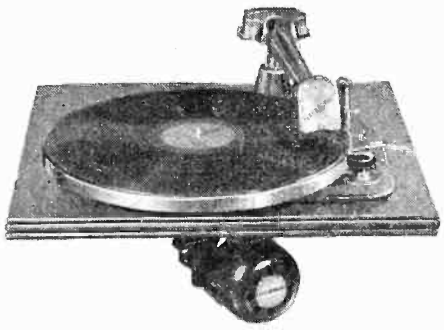
The National Company, Malden, Mass., has developed a line of new Isolantite insulated coupling units for use in connection with transmitting condensers, variable inductances, switches, etc.

James Millen, general manager of the National Company, explains that these couplings are made in various lengths to provide desired length of leakage paths for various particular uses.—*Electronics, June. 1932.*

✦

Two-speed automatic pick-up

The Electromatic Record Changer Corporation, 203 N. Wabash Ave., Chicago, has announced a guaranteed two-speed pick-up. Manufacturers claim this device to be a fool-proof, posi-



tive-acting unit which starts the motor with every action automatic, working both on 33 r.p.m. and on standard 78 r.p.m. It will play any make of record, 10 or 12 inch, fast or slow speed, is a self-contained complete unit, ready to be installed on motor-board, includes motor, counterpoised pick-up with ball-bearing inertia arm, volume control and two-speed lever.—*Electronics, June, 1932.*

✦

Sensitive relay

American Instrument Company, 774 Girard Street, N.W. Washington, D. C., announces the new Aminco supersensitive relay.

This relay is made in two general styles, intended for installation in appliances where a relatively large current must be broken as the result of a sensitive mechanical movement, such as the make and break of a thermostat, or by a slight change in resistance of a circuit, such as takes place in a photoelectric cell when light of varying intensity falls upon it.

The relay coil has a resistance of 1,300 ohms and operates on 4 milliamperes at 6 volts direct current. For special purposes, it can be wound for as high as 50,000 ohms.—*Electronics, June, 1932.*

U. S. PATENTS

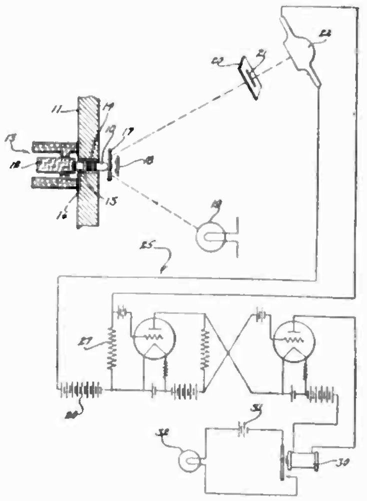
IN THE FIELD OF ELECTRONICS

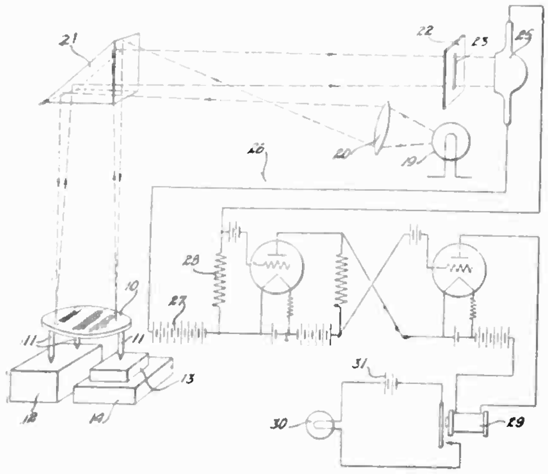
Electronics Applications

Switch for automobile radio. Method of turning on and off a radio using the ignition battery to operate the filament circuits of the tube, C. R. Wexler, Cambridge, Mass. No. 1,854,533.

Light testing device. Method of testing a light by modulating its output by means of a light sensitive cell and amplifier measuring the output. F. H. Owens, assigned to Owens Development Corp. No. 1,854,715.

Apparatus for gauging material. Gauging the dimensions of a solid object by comparison with the standard using a reflecting mirror, a prism, source of light, photo-cell and amplifier and relay. Christian Paulson, assigned to W. E. Co. No. 1,854,760. Also No. 1,854,838, to R. C. Hartsough of the W. E. Co.





Transmission delay circuit. A method of delaying the transmission of electrical waves representing speech, by converting the electrical waves of varying amplitudes into electrical charges which vary as do the amplitude variations of the waves, maintaining each of these electric charges undisturbed for a predetermined period of time, at the beginning of the conversion. C. H. Fetter, assigned to A. T. & T. Co. No. 1,851,092.

Ignition meter. An alternating current meter, comprising a galvanometer, a rectifier and a network. C. B. Mirick, assigned to National Elec. Supply Co. No. 1,851,947.

Train signalling system. A method using photo-electric cells for signal operation. Wolfgang Baseler and Fritz Hofmann, Munich, Germany. No. 1,851,236.

Method of measuring quantities of loose material. A method of measuring tobacco cut to fleece thickness, by depositing the tobacco spread out in the form of a cloud, directing rays of light through the falling cloud of material and measuring the intensity of the rays transmitted through the cloud. Heinrich Schunemann, Hamburg, Germany. No. 1,851,215.

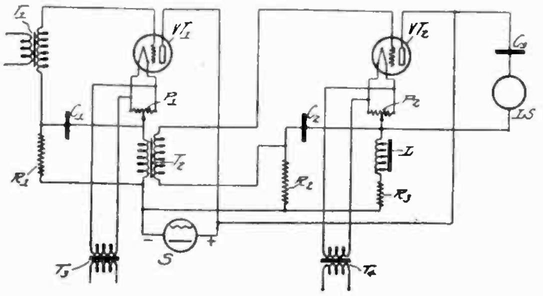
Radio Circuits

A direction-finding system, involving sending pictures from transmitter to receiver, and of correlating the rate at which the picture is transmitted with the rate at which the directional effectiveness of the station is changed. J. Robinson, assigned to British Radiostat Corp., Ltd. No. 1,854,066.

Anti-fading system. A combination of two antennas having members disposed in different planes, and a method of combining them so that fading is overcome. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,853,021.

Anti-degenerative receiver. A tuned r.f. amplifier having an input circuit and an output circuit whose reactance is condensive, and means for feeding back to the input to eliminate the damping effect of the capacity output reactance. W. V. B. Roberts, assigned to RCA. No. 1,853,178.

Amplifier system. System for compensating for hum, etc., by networks imposed in the filament grid circuit. B. F. Miessner, assigned to R.C.A. No. 1,854,854.



Amplifier regulation. A resistance having a positive temperature coefficient connected to an amplifier so that it varies the amplification of the A.C. components in inverse ratio to the applied energy. O. M. G. De L'Harpe Brand. No. 1,854,294.

Superheterodyne receiver. A method for obtaining beat frequencies from the inter-action of local oscillations with an incoming signal, without at the same time producing beat current between two incoming beat signal frequencies. W. V. B. Roberts, assigned to RCA. No. 1,853,179.

Centralized radio system. Antenna system for multiple receivers adapted to be used on mobile structures. C. V. Shumard, assigned to RCA. No. 1,853,181.

Antenna coupling system. A tuned secondary transformer, with the primary resonant with a certain antenna capacity at a frequency below the lowest frequency of the tunable range, and a shunt resistance across the primary sufficiently high to have an inappreciable effect upon the operation of the coupling circuit when connected to an antenna having certain capacity, and low enough to prevent serious detuning for a given frequency adjustment. L. A. Hazeltine, assigned to Hazeltine Corp. No. 1,852,710.

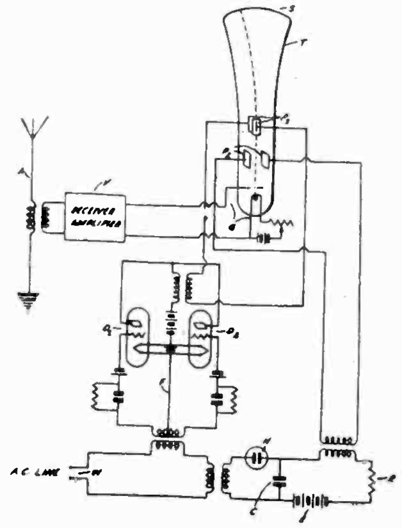
Radio beacon. Several transmitting loop circuits relatively angularly located, common means for supplying oscillating energy to the circuits. Guy Du Bourg De Bozas, Paris, France. No. 1,854,733.

Regenerative amplifier. A system for multiple selective amplification, including a number of amplifiers, coupled to non-selective interstage devices, and separate feedback circuits for each amplifier into the tuned input to the system. Friederich Meyer, and H. J. Spanner, assigned to E. H. Loftin. No. 1,852,182.

Television, Sound Recording

Scanning system. A method of damping undesirable angular fluctuations in the movement of a scanning system. Frank Conrad, assigned to W. E. & M. Co. No. 1,853,661.

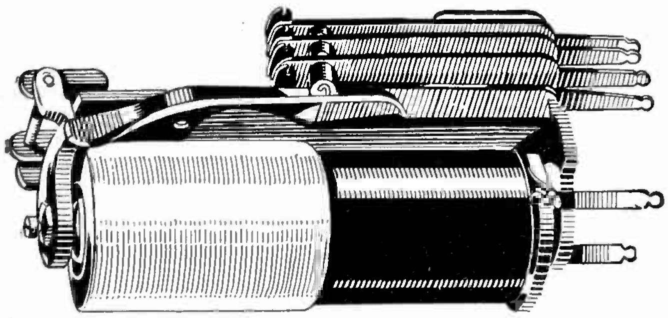
Television system. A cathode ray system. Dietrich Prinz, assigned to Telefunken. No. 1,854,274.



Anti-ground noise recording. A method of making a photographic sound record, producing a minimum amount of ground noise, by varying the light beam in accordance with the wave form of the sound being recorded and varying the zero of the beam in accordance with the volume of the sound. L. T. Robinson, assigned to G. E. Co. No. 1,854,159. Also No. 1,853,812, to C. W. Hewlett, assigned to G. E. Co.

★ VETERANS ★ ★

Ready for Further Conquests



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Television, Facsimile Reception, Etc.

Television receiver. Apparatus using a member which becomes double refracting when put under electrical strain, optical means for rendering visible those portions subjected to electrical strain. R. D. Kell, assigned to G. E. Co. No. 1,857,154.

Picture transmission. A system using lens, disc type of scanning, plurality of six photocells, etc. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,857,130.

Picture transmission. A means for producing potential changes on an amplifier and for producing at time periods of relatively wide separation an abrupt change in grid bias to points above and below the normal bias. R. H. Ranger, assigned to RCA. No. 1,857,329. See also No. 1,857,330 to R. H. Ranger on picture transmission.

Synchronizing system. Apparatus for picture receiving system. Gerhard Rieper, assigned to Siemens & Halske, Berlin. No. 1,857,742.

Picture transmission. An electrostatic light valve with method of regularly interrupting the frequency of light. Rudolph Schmook, assigned to Siemens & Halske, Berlin. No. 1,857,745.

Vacuum Tubes, Photocells, Etc.

Lead-in conductor. A member, having a uni-crystalline structure whereby gas leaking through the envelope in the region of the metallic member, is prevented. J. A. M. Van Liempt, assigned to G. E. Co. No. 1,857,203.

Double grid structure. In combination with a radio system, comprising circuits of different frequencies and a tube having a unitary anode, a unitary cathode and separate grids, means for impressing a periodic e.m.f. derived from one circuit upon one grid, and for impressing an e.m.f. from the other circuit upon the other grid. F. K. Richtmyer, Ithaca, N. Y. No. 1,857,608.

Method of treating tubes. Reducing leakage between conductors and vacuum tubes comprising causing high tension current to flow between the conductors. W. L. Krahl, Arcturus. No. 1,854,376.

Screen-grid tube. Two patents granted to A. W. Hull, G. E. Co. Nos. 1,855,885 and 1,855,886 on the use of a screen grid and conductive shielding to effectively screen the lead-in conductors of grid and plate and for eliminating electrostatic coupling between grid and plate internally.

Glow discharge tube. Rectifier with one electrode substantially larger than the other. D. D. Knowles, Westinghouse E. & M. Co. No. 1,855,637.

Method of introducing mercury. No. 1,855,901 to Max Bareiss and Erich Wiegand, assigned to G. E. Co.

Photo-cell construction. A method of producing a light-sensitive surface, consisting in applying a silver-oxide coating to a metallic plate, heating the plate to reduce the silver oxide, placing an atmosphere containing oxygen around the plate, re-oxiding the plate and subsequently forming a light-sensitive surface on the plate. A. J. McMaster and C. E. Parson, assigned to G. M. Labs., Inc. No. 1,858,210.

Tube harness. Apparatus for adapting a direct current radio circuit for alternating current operation. W. L. Krahl, assigned to Arcturus Radio Tube Co. No. 1,857,646.

Unitary structure. A method of mounting vacuum tube elements. W. L. Krahl, assigned to Arcturus. No. 1,857,647. See also No. 1,857,645, to W. L. Krahl.

Patent Suits

1,620,244, F. E. Swope, Jr., Variable condenser, filed Feb. 29, 1932, D. C., S. D. N. Y., Doc. E 65/353, Radio Condenser Co. v. De Jur-Amsco Corp. Doc. E 65/354, Radio Condenser Co. v General Instrument Corp.

1,635,117, F. W. Dunmore, Signal receiving system, C. C. A., 3d Cir., Doc. 4279, Radio Corp. of America v. Dubilier Condenser Corp. et al. Claim 9 held invalid March 18, 1932.

1,757,357 (b), Cramer & Cramer, Electrical condenser; 1,780,172, 1,800,719, S. S. Cramer, same, filed Oct. 14, 1931, D. C., S. D. N. Y., Doc. E 62/251, Radio Condenser Co. v. General Instrument Corp.

1,231,764. F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier, filed June 8, 1931, D. C., S. D. N. Y., Doc. E 60/124, Radio Corp. of America et al. v. The Poughkeepsie Gold Seal Electrical Corp. Consent order of discontinuance (notice Sept. 28, 1931).

1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,313,094, I. Langmuir, System for amplifying variable currents, D. C., S. D. N. Y., Doc. E 60/125, Radio Corp. of America et al. v. The Poughkeepsie Gold Seal Electrical Corp. Consent and order of discontinuance (notice Sept. 28, 1931).

1,258,423, F. Lowenstein, Variable electrical apparatus, appeal filed June 11, 1931, C. C. A., 3d Cir., Doc. 4644, M. Balistocky et al. v. Scovill Mfg. Co.

1,377,405, L. de Forest, Audion circuit, D. C., S. D. N. Y., Doc. E 39/385, De Forest Radio Co. et al. v. Triangle Radio Supply Co., Inc. Consent order of discontinuance (notice Oct. 17, 1931).

1,448,279, Pridham & Jensen, Electrodynamic receiver, D. C. N. J., Doc. E 3856, Magnavox Co. v. O'Neil Mfg. Corp. Dismissed under rule 57 April 16, 1931.

1,258,423, F. Lowenstein, Variable electrical apparatus, filed Nov. 3, 1931, D. C., N. D. Ohio, W. Div., Doc. 1218, Scovill Mfg. Co. v. The American Steel Package Co.

1,371,404, R H. Wappler, High potential electric machine, C. C. A., 2d Cir., Doc. —, Wappler Electric Co., Inc., v. The Bronx Hospital & Dispensary. Discontinued (notice Oct. 24, 1931).

1,648,989, D. R. Lamont, Electrical measuring instrument; 1,748,847, J. H. Miller, Radio tube testing instrument; 1,805,089, D. Hawley, Radio testing device; 1,805,074, J. A. Burtch, same; 1,508,094, J. C. Hoover, Set checker, filed Oct. 29, 1931, D. C., N. D. Ohio, W. Div., Doc. 1217, Jewell Electrical Instrument Co. v. The Diller Mfg. Co. (Readrite Meter Works).

1,707,545, E. E. Wente, Acoustic device; 1,734,624, H. C. Harrison, Piston diaphragms having tangential corrugations, D. C., S. D. N. Y., Doc. E 57/29, Western Electric Co., Inc. v. Amplion Corp. of America. Consent decree for plaintiff Dec. 18, 1931.

1,640,335, L. O. Grondahl, Unidirectional current carrying device. C. C. A., 6th Cir., Doc. 5789-5790, Union Switch & Signal Co. et al. v. Kodel Electric & Mfg. Co.; Kodel Electric & Mfg. Co. v. Union Switch & Signal Co. et al. Claims 1, 2, 7, 15, and 20 held invalid; claims 10 and 14 held valid and infringed Dec. 30, 1931.

Adjudicated Patents

(C. C. A. Ohio.) Grondahl patent, No. 1,640,335, for unidirectional current-carrying device, held valid and infringed as to claims 10-14, but invalid as to claims 1, 2, 7, 15-20. Union Switch & Signal Co. v. Kodel Electric & Manufacturing Co., 55 F. (2d) 173.

(D. C. N. Y.) Gaumont patent, No. 1,177,697, for developing, fixing, toning, and otherwise treating photographic films and prints, claims 1-6, 15 Held valid but not infringed. Cinema Patents v. Warner Bros. Pictures, 55 F. (2d) 948.

(D. C. N. Y.) Gaumont patent, No. 1,209,096, for apparatus for drying photographic films, claims 10, 11, 12, 14, 16, and 17 Held valid, but not infringed. Id.

Adverse Decisions in Interference

In interferences involving the indicated claims of the following patents final decisions have been rendered that the respective patentees were not of the first inventors with respect to the claims listed:

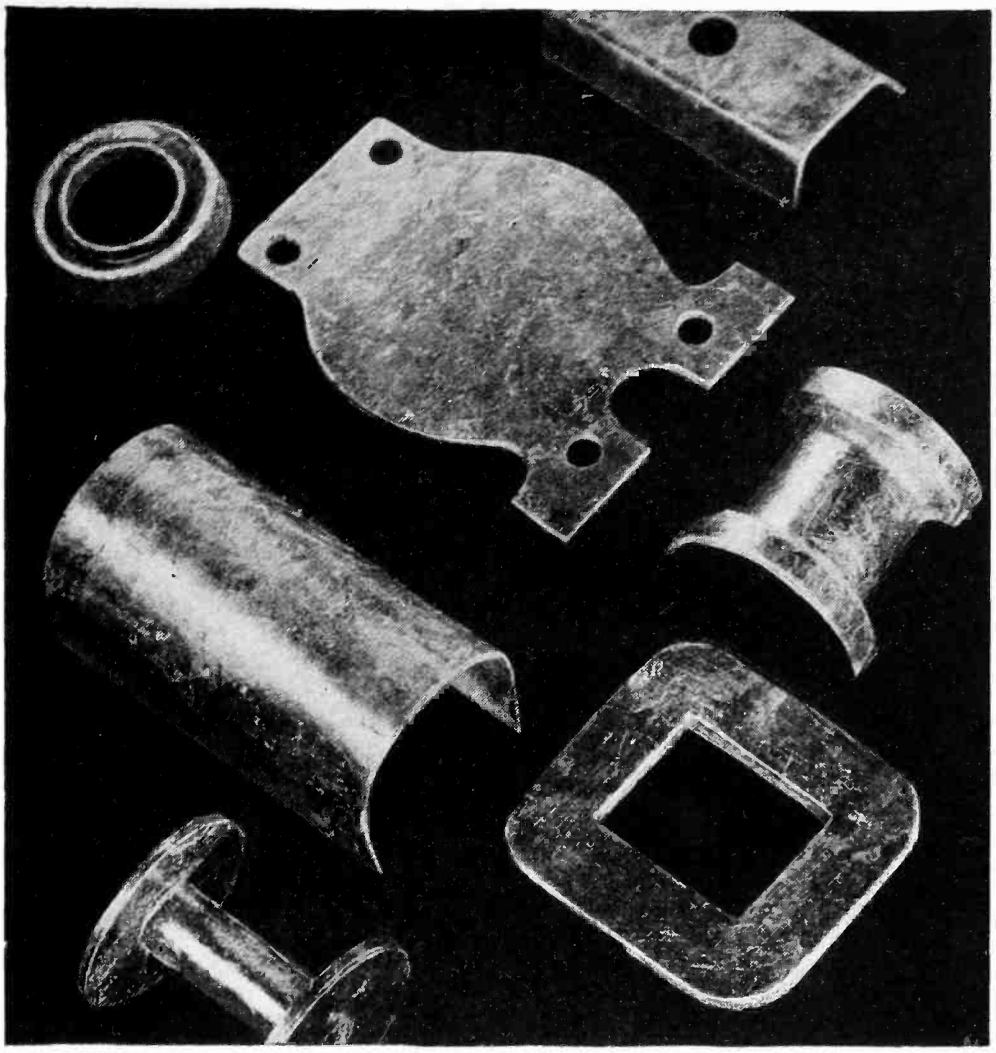
Pat. 1,648,808, L. A. Hazeltine, Wave signaling system, decided September 30, 1931, claims 1, 2, 3, 5, 14, 15, 17, and 18.

Pat. 1,747,234, John Geloso, Indicator elements, decided November 16, 1931, claims 7, 8, and 9.

Pat. 1,747,045, Stuart Ballantine, Method of and means for reducing retroactive currents in audion amplifiers, decided March 4, 1932, claims 1, 2, 3, 5 and 6.

Pat. 1,639,414, J. M. Miller, Radio receiving system, decided February 9, 1932, claims 5 and 13.

Pat. 1,572,773, Alfred Crossley, Piezo electric crystal apparatus, decided December 15, 1931, claims 13 and 15.



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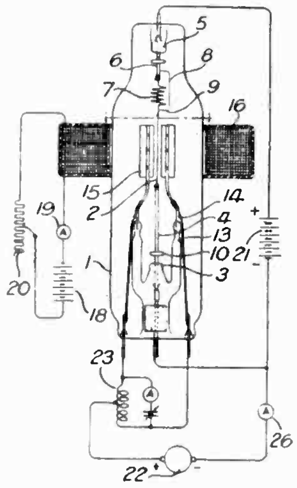
BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Amplification, Generation, Etc.

Magnetron tubes. Circuit and tubes for producing very high frequency oscillation. E. D. McArthur, assigned to British Thomson-Houston Co. No. 358,185.



Kerr cell. An electro-magnetic bias is applied to an electrostatic control Kerr cell of appropriate strength to introduce a path difference of a quarter-wavelength between the two waves having vibrations parallel and perpendicular to the magnetic field. S. Bloomenthal, Marconi Co. No. 358,368.

Volume control. In a multi-stage low frequency amplifier an input volume control potentiometer is associated with an interstage volume control potentiometer in such a manner that a substantial decrease in signal strength is effected in the last stage of the amplifier before the volume control is applied to the preceding stages. This insures a constant ratio of signal strength to noise without overloading the amplifiers. R. A. Miller, assigned to ERPI. No. 362,502.

Amplifying circuits. Constant current regulation despite large variations in source voltage is effected by varying the impedance of a main space discharge device by means of an auxiliary space discharge device connected with the control grid of the main valve, so that the impedance changes of the main device are great in proportion to the changes in the load current. L. R. Harness and S. A. Bokovoy, assigned to Westinghouse E. & M. Co. No. 362,171.

Interstage coupling. Rejector circuits, one in series with the anode lead of a tube and the other between the anode of this tube and the grid of the following tube. The circuits are shunted by piezo-electric, magneto strictive or similar devices, which damp the rejector action at a desired frequency. P. R. Coursey, Richmond, Surrey. No. 350,513.

Anti-radiation superheterodyne. Detector-oscillator of a superheterodyne receiver is arranged so that feed-back from the local oscillation circuit to the aerial circuit is prohibited. The arrangement also permits of satisfactory ganging of the two tuning condensers. W. Van B. Roberts, Marconi Company. No. 360,289.

Superheterodyne receiver. A pair of valves in push-pull, a signal receiving circuit and a local oscillation circuit, one of said circuits being symmetrically coupled with the input circuit and the other coupled to the input of one valve only, while the intermediate frequency is differentially associated with the output inductance of both tubes. When the local oscillator is operating, no signal is passed to the intermediate frequency amplifier owing to the in-phase input and differential output; interference from undesired signals is thus eliminated. W. Van B. Roberts, Marconi Company. No. 360,305.

Frequency modulation. A low constant-carrier frequency is modulated in accordance with the signal amplitude, and at a rate dependent on signal frequency, the frequency modulated carrier being multiplied until the sidebands are raised above audibility, and the amplitude modulation component is simultaneously suppressed. R. B. Dome, assigned to British Thomson-Houston Co. No. 364,603.

Stabilizing circuit. Oscillations of a low frequency are stabilized by the use of a Piezo crystal or vibrator operating at a higher frequency, a harmonic of the low frequency oscillation being modulated by a crystal-controlled oscillator and the resulting difference frequency fed back to maintain a low frequency oscillation. For example, a tube oscillating at 20,000 cycles feeds a harmonic producer, the plate circuit of which is tuned to 80,000 cycles. This oscillation, after amplification, is combined with an oscillation of 100,000 cycles, produced by a tube controlled by a crystal. The different frequency of 20,000 cycles resulting from this combination is fed back to the 20,000 cycle oscillator, and strength of the feedback is such that this tube is forced to oscillate at the different frequencies. W. Albersheim, assigned to Marconi Co. No. 364,658.

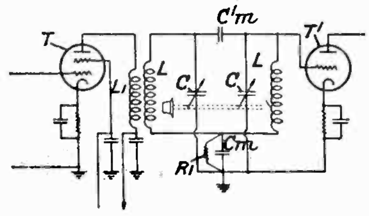
Interstage coupling circuit. An equalizing system for increasing the application over a certain frequency range. Siemens & Halske. No. 364,949.

Interference eliminator. A method of using a highly selective resonator other than piezo-electric, to reduce interfernce. J. Robinson. No. 352,942.

Harmonic generator. An over-biased tube has its plate circuit tuned to multiple frequencies of the fundamental oscillation supplied to the grid. Ericsson, Stockholm. No. 350,593.

Vacuum tube voltmeter. A push-pull voltmeter; in the common lead from the negative "B" battery to the filament, is placed a microammeter. Westinghouse E. & M. Co. No. 350,819.

Interstage circuit. Two tuned circuits are coupled by a common reactance at their low potential end and at their high potential end through a coupling reactance of the same character as the first, to provide a circuit of constant selectivity and amplification over a given frequency range. R. F. L. No. 360,062.



Modulating control. A method of automatically controlling the depth of modulation, for example to prevent microphone blasting. A part of the microphone current is supplied to regulate the grid bias. Philips, Holland. No. 350,857.

Modulating system. A valve has two anodes on opposite sides of a linear cathode. One anode is kept at a fixed potential, while the other potential is modulated. British Thompson-Houston Co. No. 352,836.

High frequency generator. A method for producing shortwaves with four-electrode tubes, by applying positive potentials to the grids. H. E. Hollman, Charlottenburg, Berlin. No. 360,063.

Radio

Modulation system. A method of permitting modulation of a radio transmitter up to 100% without distortion, by distorting the microphone voltage prior to its application to the modulated tube in such a way as to neutralize the distortion, due to the non-linearity of the curve, relating high frequency output modulation to input. Telefunken. No. 359,650.

Superheterodyne system. A low-pass filter, passing only frequencies below the upper limit of a desired frequency range, an intermediate frequency amplifier, tuned to a frequency above that numbered limit, and a pair of frequency-changing tubes, so arranged that beat currents due to interacting signal frequencies are balanced out, while those due to the heterodyne are additive. W. Van D. Roberts, Marconi Company. No. 359,760.

High frequency amplifier. The output impedances of successive stages are made capacitive over the operating range by the use of a large neutralizing condenser. Winding dimensions and inductance values are given in Specification No. 359,890 and 359,901. H. A. Wheeler, Hazeltine Corp. No. 359,571.

Television system. This patent relates to a colored television system in which several primary color light sources pass through a disc and photo-electric cells receive the reflected light. Considerable description of the apparatus in use between 463 West St., The Bell Telephone Labs., and 195 Broadway, the A. T. & T. Co., which has been demonstrated for some time, is given in this patent. H. E. Ives, assigned to Electrical Research Products, Inc. No. 365,166.