electronics

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

Industrial electronic opportunities

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Copper-oxide photocells

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Design data on the new 59-type tube

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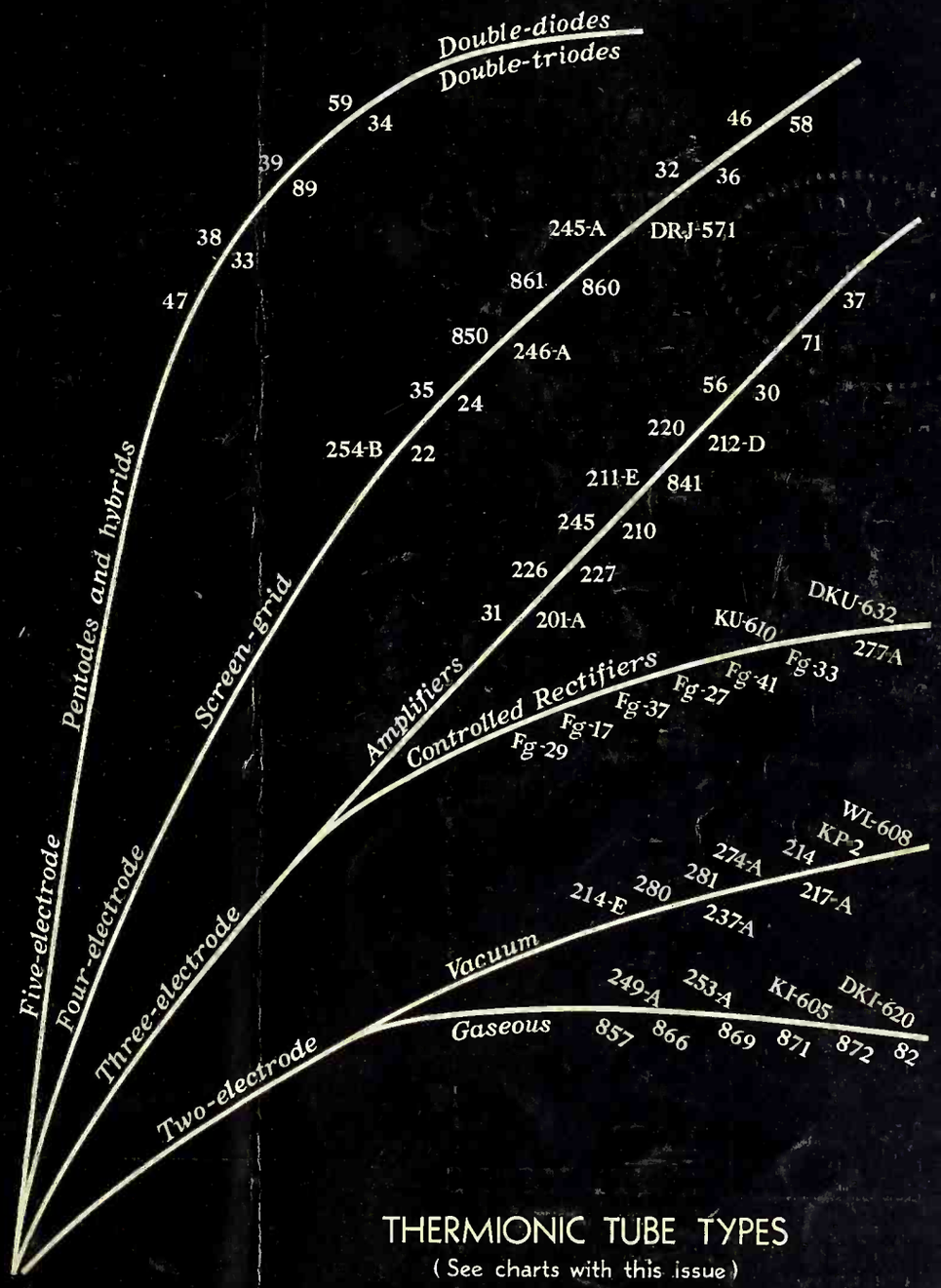
Patents in the field of electronics



THERMIONIC TUBE TYPES
(See charts with this issue)

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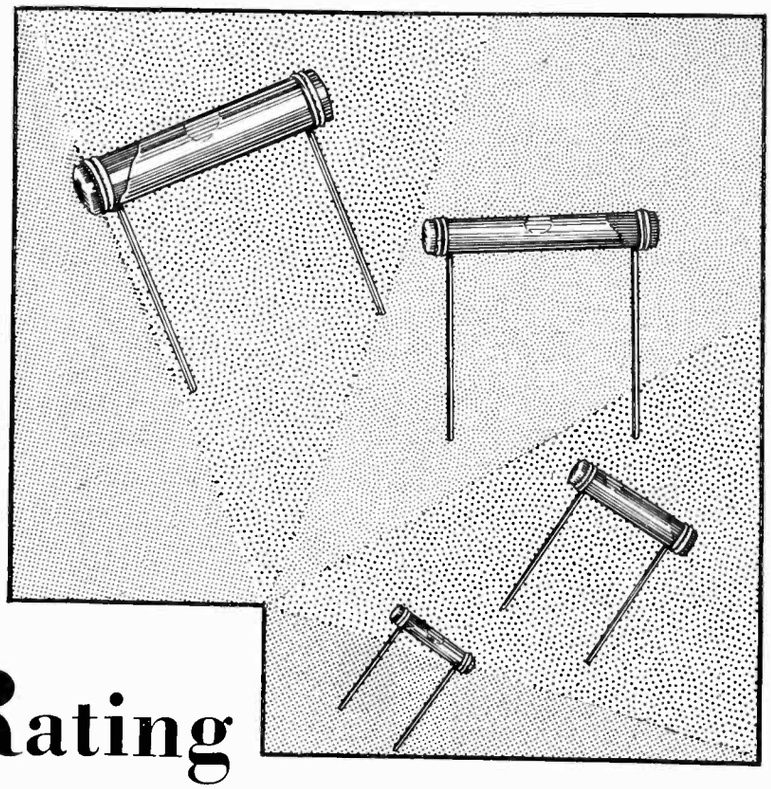

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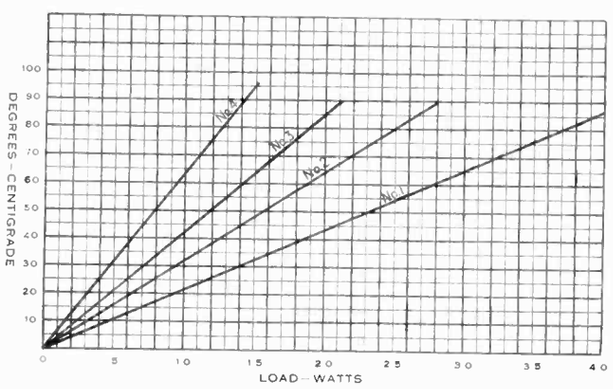

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No. 2	1 watt	500 volts	1 1/3 watts	2 watts	1000 volts
No. 3	½ watt	350 volts	1 watt	1½ watts	500 volts
No. 4	¼ watt	200 volts	2/3 watt	1 watt	300 volts

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electronics

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radio
sound pictures
telephony
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telegraphy
counting
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carrier systems
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photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
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The industrial opportunity brightens

FORCES of the Government and of industry are now mobilized on the campaign to stimulate business recovery through industrial re-equipment. Important committees have been appointed, and leading industrialists are at work organizing the campaigns.

Electronic apparatus engineers can take advantage of this more favorable view toward factory re-equipment, using this opportunity to show how electronic methods can speed up production and make for superior products.

And compared with other equipment salesmen, they have the clinching argument that a small investment in electronic control apparatus may make unnecessary major machinery changes in the plant itself, thus giving the plant owner the maximum value for his dollar of outlay.

Factories, mills, machine shops, packing plants, canneries, laundries, printing plants, garages, repair shops, restaurants, office buildings, stores, and hotels are all prospects for electronic devices and electric-eye control.

POWERFUL forces are now paving the way for approach to these many opportunities for electronic applications. Doors are beginning to swing open; executives are beginning to look ahead to future requirements.

Electronic installations can be made only through visits to plants, careful study of the special problems involved, and demonstration of the results that can be accomplished. This will all take time and hard work. But the initial obstacle of "mental resistance" is being removed.

Patent problems in the field of electronics

By H. A. TOULMIN, Jr.

IN ENDEAVORING to expand the market for electronic tubes, much useless development work can be avoided by a careful study of the patents that have already been issued. These patents show either what fields are still monopolized if the patents are unexpired, or will show what fields are open for free use if the patents have expired.

While there are nearly two million patents in the United States Patent Office, yet they are very carefully and expertly classified. For instance, one searching in the patents in the field of electronics and associated mechanisms controlled by tubes would search under the classifications of telegraphy, telephony, electricity, radiant energy, electromagnetically controlled mechanisms, reproducing, duplicating and automatic mechanisms, circuit makers and breakers, electric signalling and the like, while also searching in divisions bearing upon the special mechanisms employed such as the mechanisms of closure operators, conveyors, sheet handling, machine elements and time-controlling mechanisms.

The Patent Office is divided into 62 divisions considering various subjects matter. There are over 300 classes with many hundreds of sub-classes into which the nearly two million patents are classified. A skilled searcher can usually with great accuracy get a picture of the art as it is which can be of the greatest assistance to the experimenter and the developer of equipment.

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THERE is a general feeling that the idea of using light-sensitive cells in industrial applications is very new—but as Mr. Toulmin points out, many of the "remarkable" inventions of today are really as old as the hills. A good knowledge of the past art often saves money in useless research or in fighting infringement suits!

▼

Obviously, if one desires to get patents, it is useless to carry out expensive experimental work in fields that are already old or monopolized. For instance, as early as 1883, a Chicago inventor developed a machine, shown in Fig. 1, by which a light source was used for controlling a cell so as to cut and shape objects of given sizes according to a pattern. S was the source of light which was transmitted to the face of a plate and reflected from the plate to the selenium or other circuit-controlling cell, as indicated at S' by the dotted lines.

The cell included a battery E, an electromagnet F, an armature G connected with an arm H which carried an engraving or cutting tool d. The spring s was regulated to lift the armature from the magnet.

The plate Y, which was to be engraved, moved between the engraving tool in unison with the pattern plate B. The depth of cut and form of cut was, therefore, controlled by the movement of the pattern plate which, in turn, through the light sources and the cell, controlled the operation of the electric circuit. Here is one of the very early evidences of the modern plan frequently used with different types of machinery of controlling operations according to a pattern by a cell and an electric circuit.

In the early 1900's a machine was developed in connection with electric telegraphy shown in Fig. 2 which converted the glow-rays of the vacuum tube generated with the aid of an interrupted or alternating current into sound or into a record. A was the vacuum tube connected to a source of current in proximity to the selenium cell B which was connected to the positive pole of the battery C. The other end of the selenium cell B connected with the end of the coil of the electromagnet D. The light source and the selenium cell are enclosed in the dark chamber A'. Connected to the same battery was the second selenium cell B'.

Control by selenium cell

Enclosed in the dark chamber A^2 and in series with the cell is the electromagnet D'. As long as the globe A is not traversed by electrical current the conditions of both the dark chambers A' and A^2 are equal, but as soon as the globe A is placed in circuit the light lowers the resistance of the selenium cell B and, as a result, destroys the equilibrium between the two circuits causing a movement of the electromagnet. If telegraphing is done according to the Morse code, a shorter glow time representing a dot and a longer glow time representing a dash will result in closing the circuit containing the sounder F in accordance with the illumination of the globe A.

In Fig. 3 is shown a method and apparatus for reproducing photographs dating back to 1897. A drum carries the photograph and a light shining through the photograph affects the light-sensitive cell which is in an electrical circuit which, in turn, controls the operation of a stylus that reproduces the picture.

What is contributory infringement?

These three instances show the rather extraordinary development thirty to forty years ago in what is now commonly regarded by the public as a relatively new development. It demonstrates the necessity for carefully examining the early literature and prior patents so that a great deal of research work may not be done which cannot be later monopolized.

One of the troublesome factors in extending the use of electronic tubes is the question of contributory

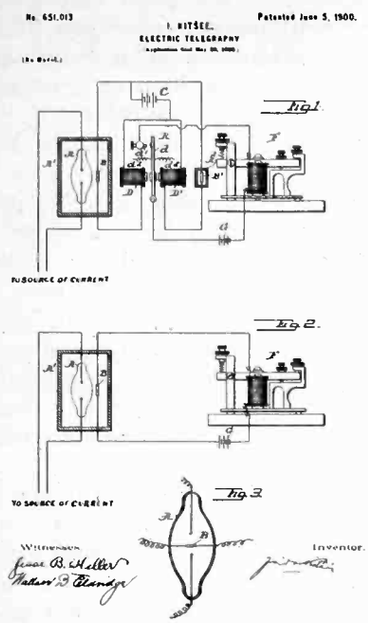

Fig. 2—Selenium cell used in telegraphy—1900

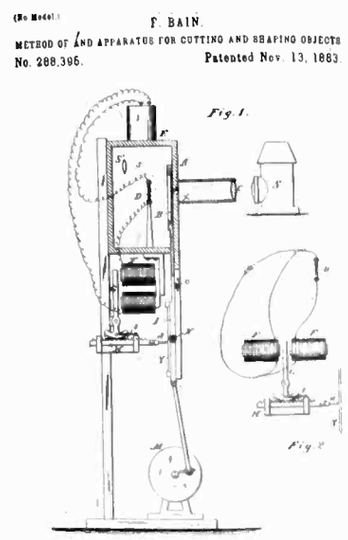

Fig. 1—Light-sensitive cell patent granted in 1883

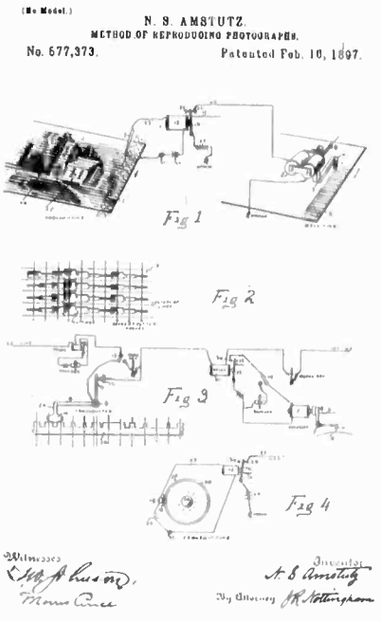

Fig. 3—Facsimile transmission using light-sensitive cell

infringement. For instance, if there is a patent on measuring with an electronic tube the variations in thickness of a sheet of material, such as rubber sheeting, and a manufacturer of tubes supplies tubes knowingly for that particular machine, which is built by an infringer of that patent, then the tube manufacturer becomes a contributary infringer. He is equally liable for infringement with the infringer who built the rest of the apparatus.

There is a distinction to be drawn between furnishing tubes *as ordinary articles of commerce* to the market without knowing that they are going into infringing combinations and the case where they are knowingly furnished or are specially built to fit an infringing machine. In any event this kind of liability can be avoided by a careful check as to whether or not there is infringement without blindly plunging into assisting such manufacture and sale of equipment.

What is invention?

The border line between what is invention and what is design is an important consideration. If the matter is invention it can be protected and monopolized by a patent for seventeen years. If it is mere engineering design, it cannot be. Obviously, if the manufacturer has a choice between a design that is one of invention and one that is not, he should select the one that can be monopolized by a patent to give him greater control over his market.

One of the most troublesome problems is to determine on which side of the line between engineering design and invention a particular product lies. Even the courts have never settled this question to everybody's satisfaction, save to establish certain guiding principles. Its importance is vital because a valuable patent asset may be lost through a misunderstanding of the situation.

Engineering departments that follow the rules established by the courts have a rather accurate guide to determine when they have an invention to protect and when they have only a design of mere engineering character on which no money should be spent in an endeavor to protect it. Skillful design is not necessarily invention, as an invention most often comes in a crude form. On the other hand, just because an idea has never been commercialized does not prove that it is a patentable invention.

Let us look at some practical illustrations of how this theory works out in specific cases. Practical cases decided by the courts are the only real guiding posts in this kind of analysis.

If any engineer had been asked a quarter of a century ago whether it would be invention to take a couple of pieces of fabric and bamboo, connect them by bamboo poles and twist the corners of the fabric by warping, something like an old-fashioned box kite, to make a supporting plane surface, that engineer would have promptly said no, and it would have been a good engineering answer. The two young bicycle repairmen who got up that contraption not only flew, but prevented their machine from turning over. Up to that time the problem of keeping a flying machine on a level keel had been unsolved. After that they combined a rudder and an elevating surface with these warping wings, which altogether made a satisfactory machine. But these plane warped surfaces were the heart of the matter. Now all of these elements—plane surfaces, the rudder, and the elevators—were old in themselves, as old as the box kite, but no one had ever put them into that new combination with that new result.

Hence, a new alignment of old parts securing a new or improved result is invention. The Wright brothers had met that test. The courts said that they had made a basic invention no matter how simple or how crude the original construction.

Invention often involves nothing really "new"

Then along came Curtiss who, instead of warping the wings as the Wrights had done, proposed to adopt the common swinging door idea and to hinge his door on the edge of the plane. That was a very practical step; it again was a new combination of old parts which got an improved result. Curtiss had thus provided ailerons that are used to this day. His ailerons are merely doors

[*Please turn to page 324*]

Characteristics of American electronic tubes

By KEITH HENNEY
Associate Editor, Electronics

DURING 1932 the number of types of thermionic tubes used in the art of communication or for industrial purposes has multiplied at a very rapid rate. Growth has been particularly noticeable in the group of tubes designed primarily for use in home radio receivers, but there are new transmitter tubes and rectifiers as well. At the present time there are over three hundred examples of the tube-makers' art, each with a distinct (but meaningless) code number.

These tubes range in size from the lilliputian "peanut" tube (Western Electric 215-A) which is less than three inches long and less than one inch in diameter to the water-cooled giants used in broadcast stations whose plates can dissipate 100 kw. of power and which are as tall as a man. The filaments of these tubes vary from the 60-milliampere 3-volt hair-like 199 tube to those of the monsters which consume nearly ten kilowatts just to warm them up to the point where the plate current may amount to 8 amperes.

The tubes differ in purpose, in size, in number of elements, and in kind of emitter producing the electrons which are irresistibly forced to the plate and which, enroute, perform such multitudinous functions. Each tube has a name which is a combination of letters and numbers according to a haphazard system of nomenclature to which there is no rhyme and little reason.

The tube picture has become so complex what with the hundreds of tubes and the multi-nomial system of naming them that an engineer seeking a tube for a specific purpose must ultimately give up in despair or sieze upon a commonly-used tube designed for another purpose and perhaps unsuited to the task at hand.

The editors of *Electronics* have collected data on all tubes made in this country and present them in the series of charts to be found in this issue. The information has not been collected and published before and should be useful to anyone interested in using thermionic tubes for any purpose.

The data is conveniently divided into information on radio receiving tubes, power tubes, rectifiers and so on, and all electrical characteristics and physical dimensions are given. Tubes of a given kind are listed only once, no matter if obtainable under another name but tubes of identical characteristics can be ascertained from the table of equivalent tubes. For example, the 203-A tube is a 50-watt amplifier or oscillator made by General Electric and Westinghouse (sold for radio purposes through RCA Radiotron), and by a number of the licensees of the Radio Corporation of America. RCA Radiotron calls this tube a UV203-A, Arcturus calls it a E703-A, Deforest a 503-A and so on. General Electric and Westinghouse may sell the same tube, under another name, for purposes other than radio, i.e., for industrial purposes, or elevator control, etc. For example see the table titled "Tubes With Equivalent Characteristics."

The majority of tubes in the receiving tube list are made and sold by the RCA group of licensees; some are made by a single manufacturer, others by several manufacturers. The complexity of stating which manufacturer makes which tubes precludes the publication of this information with the charts. Data on the suppliers of various tubes are on file and the editors will be glad to aid anyone in locating either a tube with a desired characteristic or a manufacturer who makes it.

Dissatisfaction with the present haphazard method of numbering tubes has led to many attempts to systematize the nomenclature. The most recent, and probably the one having the best chance of ultimate acceptance, has been under consideration of the Vacuum Tube Committee of the RMA and was submitted to member vote late in September. The plan calls for naming tubes according to the following formula. It will be a trinomial system. The first part of the new name will consist of a digit disclosing the filament voltage; the third part will be a digit revealing the number of useable elements having an external connection; the middle part will be a letter arbitrarily chosen.

Thus a filament-type triode would have a final digit 3, and all triodes of this type with filament voltages between 2.0 and 2.9 inclusive would have a preliminary digit 2, the first having a middle character A. Thus the 226 which is a 1.5 volt triode developed after the WD11 and WD12 would have a new number 1C3. The present 46 would become 2D4 and so on.

It remains to be seen whether or not the industry will revamp its clumsy method of giving names and number to tubes according to the system proposed by the RMA Tube committee. At any rate an important step has been taken toward much needed simplification.

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ELECTRONICS' TUBE CHART

With this issue will be found a supplement giving the physical dimensions and electrical characteristics of——

- Radio receiving tubes
- Industrial tubes
- Four-element tubes
- Grid-controlled rectifiers
- Three-element power tubes
- Communication tubes
- Gaseous rectifiers
- High-vacuum rectifiers
- Photocells

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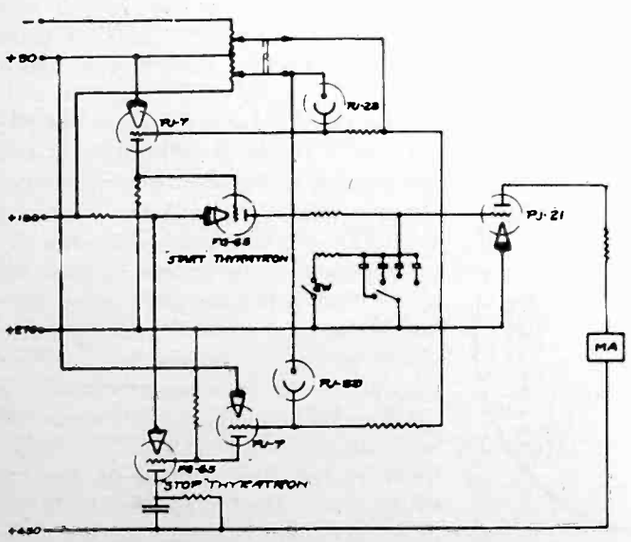
Electronic timer for very short intervals

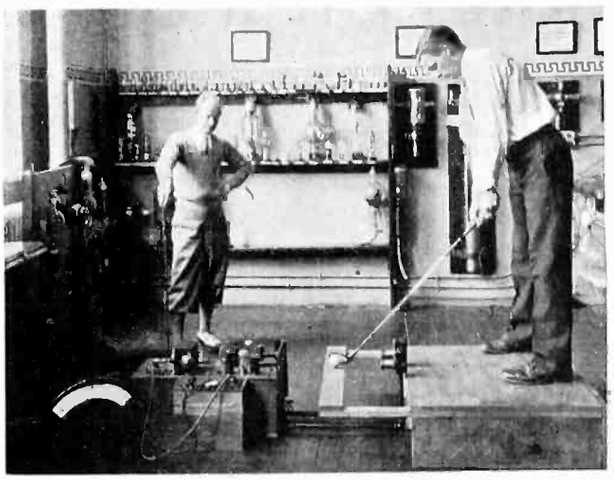
By H. W. LORD
General Electric Company, Schenectady, N. Y.

A CIRCUIT for timing intervals shorter than stop-watch periods has been developed, and an instrument has been built using this new circuit, which covers a range of 0.5 second to 0.0005 second in four scale ranges.

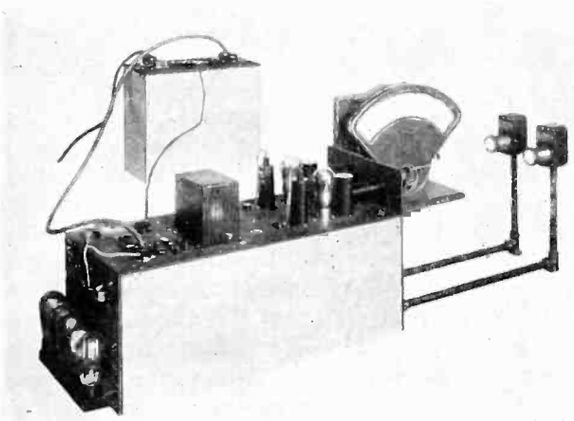
The basic idea of the timer includes one thyratron tube, tripped by the starting impulse, to initiate the circuit timing, and a second thyratron tube, tripped by the finishing impulse, to stop the circuit timing, the time between impulses registering on an ordinary milliammeter in the plate circuit of a vacuum tube, the grid voltage of which is a function of the time between impulses. The elapsed time in seconds between the two impulses is obtained by a calibration curve with "seconds" and "milliamperes" as co-ordinates. The different scale ranges are obtained by changing the constants of the timing circuit. The arrangement is entirely electrical involving no mechanical elements or moving parts.



Circuit diagram of photo-cell timer for recording intervals down to 1/10,000 second



The timer in use to measure speed of golf-club swings in front of photo-cells



Apparatus as assembled in present experimental form of timer

A timer using the interruption of a pair of light beams as sources of the "start" and "finish" impulses is shown in the accompanying photographs. An electrical impulse produced in the output of the phototube by interruption of the light falling on it is amplified by a vacuum tube amplifier to obtain sufficient voltage swing to trip the thyratron tube. Additional sensitivity to very slender objects is obtained by bringing the light beams to a sharp focus approximately midway between the light sources and the phototubes. The "start" thyratron tube with its phototube, amplifier, and light source is built in a box separate from the remainder of the apparatus. Power is supplied to this box through plug-in cables which may be as much as twenty feet long when using the longer time scales. This timer has been used as a display in the exhibit room of the Vacuum Tube Engineering Department of the General Electric Company at Schenectady. Particular interest has been shown in the use of this instrument to measure the speed of a golf-club head as it strikes a ball.

Other uses have been suggested such as measuring the speeds of pitched baseballs, golf balls, automobiles on the road, and projectiles in flight. Other novel and useful ways of using this device may suggest themselves to the reader.

Notes on the 59-type power output tube

By K. W. JARVIS
Director of Engineering
Zenith Radio Corporation

ALTHOUGH the various tubes of the 50-class brought out this year are well known, the final member of that series, the 59, is as yet too recently designed to be familiar to all engineers. It is a tube with so many inherent advantages and possibilities that the following notes should prove useful.

Heater-type tubes have distinct advantages as output tubes; freedom from hum and the allowance for independent cathode connection for bias are among the more important of these reasons why the heater-type pentode was desired. It was slow in coming because of the low thermal efficiency (ratio of milliamperes emission to heater watts) but because of the advantages when operated from a.c. its final arrival on the market was assured.

The first place of application of this heater cathode was in the development of a higher output pentode. This tube was so successful that it has been placed on the market and is now being used by several companies. The dual use of the 46 tube and the introduction of the suppressor grid on the 57 and 58 tubes paved the way for the seven-lead power-output tube. The heater-type pentode then had the suppressor grid brought out to a prong on the base. Some grid modification was necessary to properly use the tube in a triple role, but excellent engineering on the part of the tube companies made this an accomplished fact. This achievement was noteworthy, for due to the success of the heater-type pentode, there were threats of bringing out a heater-type 46, and a heater-type 45. Now instead of having three new tubes, we have a single tube which may be used in three ways.

The tube is put in the dome-shaped envelope. It uses an ST-16 bulb and a seven-prong base having two large pins and five small pins. The filament voltage is 2.5 volts and the filament current 2.0 amperes. The base arrangement is shown in Fig. 1. This view is of the base looking toward the bottom of the tube. G_1, G_2, and G_3 are the grids, the subscripts indicating the number of the grid starting nearest the cathode. Detailed comparison of the operation of the 59 against the corresponding tube in common use at present is outlined below. One fact should be noted. At the time the characteristics of the 59 were agreed upon, only small production runs had been made. Since more tubes have been built a better average figure can be obtained. In every case, as shown by the distortion curves, the actual operation is much superior to the rated values.

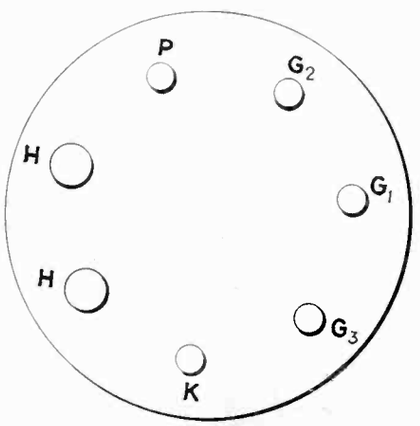


Fig. 1—Base arrangement of the 59 tube

Class A triode operation

The power output as a Class A amplifier is slightly less than the 46 or 45 and is due to the improved power sensitivity. The power sensitivity for a 45 is about 0.034 and the power sensitivity for a 46 is about 0.050. Figure 2 gives typical distortion curves for the 46, 45, and 59-type tubes. In case push-pull is used, slightly over twice as much power can be obtained due to the cancellation of the second harmonics. The limitation then becomes due to grid current. If a Class A power tube be used to supply grid current losses, through a coupling device with good regulation (low resistance, closely coupled step-down transformer), still greater power can be obtained. This method of supplying grid current losses by means of a driver stage is popularly supposed to have originated with Class B development. Actually it is far older, the driver stage first being used years ago in connection with 110-volt d.c. power line

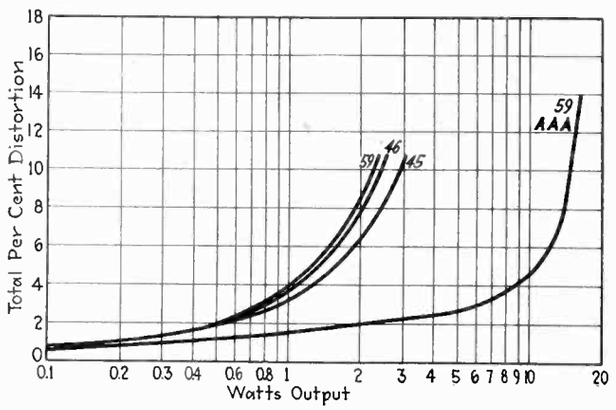


Fig. 2—Distortion curves—Class A triode operation

receivers. This system has been given the name of the AAA (Triple A) amplifier due to the use of three Class A output tubes. It has also been called A prime, Semi A B, and similar coined names for specific receivers marketed in 1932.

The rated plate voltage on the 59 as a Class A triode is 250 volts. Raising the voltage increases the power output about as the square of the plate voltage; 300 volts will deliver about a third more power. The danger of high voltage is that it accelerates the ionization and secondary emission effects and so shortens the life of the tube. In one laboratory the 59's have gone far beyond a 1,000 hours at 300 volts plate without accelerated failure. This statement is not in criticism of the tube rating, nor the tube manufacturer's guarantee, but is noted merely to aid the set designer.

It is interesting to note that G_3 may

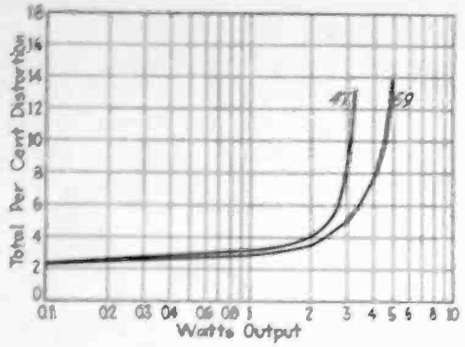


Fig. 3—Distortion curves—Class A pentode

be connected to the cathode without materially affecting the operation, (G_2 still connected to the plate.) As this is the same connnection of G_3 as for a pentode, it was proposed that this connection be permanently made inside the tube. It was found, however, that this grid acted as a shield between the control grid and the plate when used as Class B, and resulted in low grid impedance of the output tubes. The resulting grid loss was prohibitive and so made necessary the provision for G_3 to connect to the plate.

Class A pentode operation

The power sensitivity as a Class A pentode (0.184) compares with the value of 0.135 for a 47 pentode. Comparison of the distortion under rated conditions shows the 59 to have less harmonic distortion than the 47 at all power outputs.

Corresponding to the increased voltage under Class A triode conditions, the pentode screen voltage may be safely raised to 275 volts and the plate voltage to 300 volts. The plate and screen current should be kept about constant by increasing the bias voltage. Under these conditions, and with the 59's as now constructed, about 3.5 watts may be obtained with 5 per cent distortion. Higher screen voltage increases the screen current and heats the wires in the screen to a dangerous point.

Typical distortion curves of the 59 and the 46-type tubes as Class B amplifiers are given. It is interesting to note that if 5 per cent be taken as the distortion limit, neither tube is much good. Actually the ear begins to notice the distortion usually at a higher figure, depending somewhat on which harmonic contributes most to the total harmonic content.

In explaining the difference between these curves one point should first be discussed. These tubes were matched together to form a pair. Selecting tubes at random will give considerably worse average curves. In case one 46 of a pair be removed, the distortion very quickly becomes prohibitive due to the non-cancellation of the even harmonics. This high distortion with one 46 tube out is due to the very low initial plate current (about 8 ma.). A small grid voltage quickly swings the 46 tube to cutoff, and even harmonic distortion results. A similar condition, although not so extreme, occurs when the 46 tubes are unbalanced. The condition is much worse than unbalance in a Class A system where large amounts of power are delivered before swinging to cutoff, and the power-to-distortion ratio is much better. This means that in Class B, to obtain low distortion at low volumes, the tubes must be carefully matched. Even with careful matching, the distortion between ½ and 1 watt is usually greater than that at about 5 watts when using 46's.

OPERATING CONDITIONS

	Class A triode	Class A pentode	Class B triode
G_1—control grid bias	-28	-18	0
G_2 voltage	250 (to plate)	250 (screen)	0
G_3 voltage	250 (to plate)	0 (cathode)	400
Plate voltage	250 volts	250	400
Plate current	30 ma.	35 ma.	15 ma. (0 bias)
Plate impedance	2500 ohms	50,000	
Load impedance	5000 ohms	7,000	1500 per tube
Amplification factor	6	125	
Effective amp. factor with 5000-ohm load	4	14	
Power output	1.25 watts	2.5 watts	20.0 (2 tubes)
Power sensitivity	0.060	0.184	
Power output (7.5% distortion)		3.5 watts	

Effect of unbalanced 59 tubes

In the case of the 59's, a higher initial plate current (15 ma.) is used and the tubes can deliver about four times as much power (at low inputs) with the same distortion. If one tube of a Class B pair of 59's be removed, the remaining tube will function as a Class A tube and deliver up to about ½ watt without too much distortion. As a result of this condition, unbalance in the 59 Class B stage is not so critical and the initial distortion is lower than for the 46's. With increasing power output the 59 Class B approaches the 46 Class B, but will always deliver slightly more power with the same degree of distortion. While the continuous power rating is limited to 20 watts, outputs as high as 50 watts

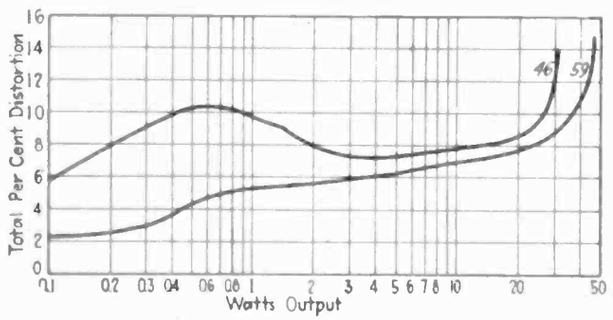


Fig. 4—Distortion curves—Class B triode operation

have been obtained from a pair of 59's in a Class B system using a special driver stage and special power supply. Fortunately such power requirements are not yet needed for home receivers.

Another point should be mentioned in connection with the use of 59's in Class B amplifiers. The absence of hum from the driver stage heater is a blessing to those who require a low hum level. No filament balance arrangement quite equals the humless 59 driver stage.

The fundamental idea of the 59 tube is also incorporated in the 89, a triple purpose tube used as the output tube for automobile receivers. This tube is rapidly replacing all others for such output purposes. The use of a single tube to perform three functions reduces the number of different tubes which might be built, reduces cost by increased production of a single tube, and similarly effects other economies.

Going beyond the use for which the tube was originally designed, and the superior way in which it seems to meet these present problems, new functions of using the extra grids for tone controlling and harmonic suppression are already in evidence. The 59 seems to be not just another tube, but a versatile tool in the hands of the radio engineer, a fitting tube to complete the 59 series.

Photocells from rectifier disks

By E. D. Wilson, Ph.D.

Westinghouse Research Laboratories

EARLY in 1924 Dr. L. O. Grondahl of the Union Switch and Signal Company discovered the photoelectric effect in the dry copper oxide rectifiers which he had invented. Erratic behavior of a bank of rectifier disks used out in the open was found to be correlated with intermittent shadows cast on the unit by men passing inadvertently between it and the sun. Engineer P. H. Geiger was assigned to an investigation of the phenomenon and discovered that light incident upon a standard rectifier disk caused an electromotive force to be created between the two electrodes of the device.

The cuprous-oxide rectifier disk consists of a copper washer 1.5 inches in diameter and 1/32-inch thick, which has been heated to a high temperature in a furnace and subsequently quenched. This treatment produces a thin layer of cuprous oxide on the surface. An outer film of black (cupric) oxide is removed by a brief dip in a solution of sodium cyanide. Figure 1 shows a standard disk with the thickness of the oxide layer exaggerated for the sake of clearness. The hole in the washer is ½ inch in diameter and is intended for the purpose of admitting an axial bolt for binding a number of rectifying elements together.

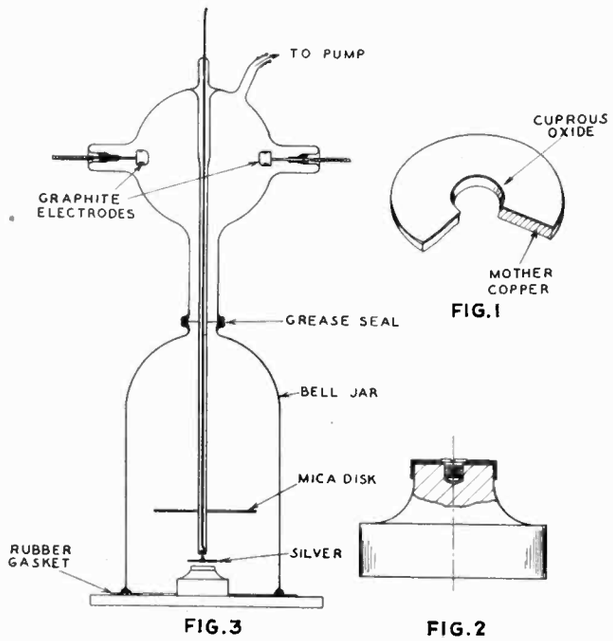


Fig. 1—Sectional view of standard rectifier disk

Fig. 2—Copper block for holding disk during sputtering process

Fig. 3—Diagrammatic view of sputtering chamber

The interface between the mother copper and the oxide film has the valuable property of permitting electrons to flow much more easily from copper to oxide than in the reverse direction. Contact is usually made to the outer surface of the oxide by means of aquadag (a graphite preparation) and a lead washer under pressure. In normal usage, if an alternating voltage is applied between the lead contact and the bare copper on the reverse side of the disk, the conventional current flow from oxide to copper will be about 1000 times as great as in the other direction.

Fig. 4—Appearance of laboratory mounting of cell

The original cell which was suggested by Grondahl and Geiger consisted simply of a rectifier disk with contact made to the oxide by means of a flat spiral of copper wire pressed down by a glass plate. Light incident through the glass penetrated the wire grid and oxide film and generated a potential difference at the interface in such a way that the mother copper became negative with respect to the spiral grid.

The currents which could be obtained from the Grondahl-Geiger cell in sunlight were of the order of microamperes only chiefly because of the high contact resistance between the wire spiral and the oxide.

Early in 1930 B. Lange[2] announced that he had made a marked improvement in cuprous-oxide cells so that relatively large currents could be generated. For one cell having an area of 2 sq.cm.,[1] he reported a current of 10^{-8} ampere per lux. This corresponds to a sensitivity of 500 μa. per lumen. Not long afterward, Duhme and Schottky[3] described a different type of cell which gave 5×10^{-8} ampere per lux per sq.cm. This was equivalent to 5 ma. per lumen, a truly interesting value. In the latter case, the light was supplied by a gas-filled tungsten lamp.

The Lange cell differed from the Grondahl-Geiger "light-actuated generator" chiefly in the manner of making contact with the oxide surface. Lange sputtered either an opaque grid or a transparent film or a combination of both on top of the oxide which had been formed on the mother copper in the usual manner. The effect of the light was localized on the back side of the oxide as described above. The Schottky cell, on the other hand, consisted of a plate of pure crystallized cuprous oxide not adherent to unoxidized copper. One surface was etched and then sputtered with a translucent film of some metal such as gold or silver.

[1]British Patent Specification—No. 277,610.
[2]Lange, *Physikalische Zeitung*, 31, 139 and 964, 1930.
[3]Duhme and Schottky, *Naturwissenschaft*, 18, 735, 1930.

Contact was made to the reverse side by a layer of conducting material applied, for example, by spraying. The notable feature is that the effect of the light took place at the interface between the oxide and the sputtered film. To distinguish this type of cell from the former types, Schottky introduced the terms "Vorderwandeffekt" and "Hinterwandeffekt." We shall use the terms "obverse effect" and "reverse effect" respectivly to indicate the same phenomena.

Schottky[4] and also Auwers and Kerschbaum[5] have investigated the behavior of cuprous-oxide cells both theoretically and empirically. The chief conclusion is that the effect of the light is to eject electrons from the oxide into the adjacent electrode. If the two electrodes are not connected externally, a potential equilibrium is reached which depends on the intensity and spectral distribution of the light. If the two electrodes are connected externally through a resistance, a definition fraction of the ejected electrons will return to the oxide through the external path. For zero external resistance, all of the electrons will return externally rather than trickle back through the interface through which the light originally ejects them.

The potential discontinuity at the interface is termed a "Sperrschicht" by the Germans. We might call it a "barrier plane." With respect to the rectifying properties of copper-cuprous-oxide disks, the light always ejects the electrons through the barrier plane in the high resistance direction.

Lange's cell was of the reverse type made of a rectifier plate; Schottky's cell was of the obverse type made of a crystal plate requiring more than a day to be formed in a furnace. A description will be given here of an obverse cell made from a standard rectifier disk.

The disk is prepared for sputtering simply by dipping it alternately into an acid bath and into flowing water until the oxide acquires a glassy, cherry red surface. The bath may be concentrated nitric acid. After thorough rinsing from the dips, the disk is dried with a clean cloth.

To prevent the disk from getting hot during sputtering and also to mask the peripheral edges, it is mounted on a massive copper block shown in cross section in Fig. 2. While being held tight against the block, the disk has only an annular area exposed.

The sputtering chamber is patterned roughly after

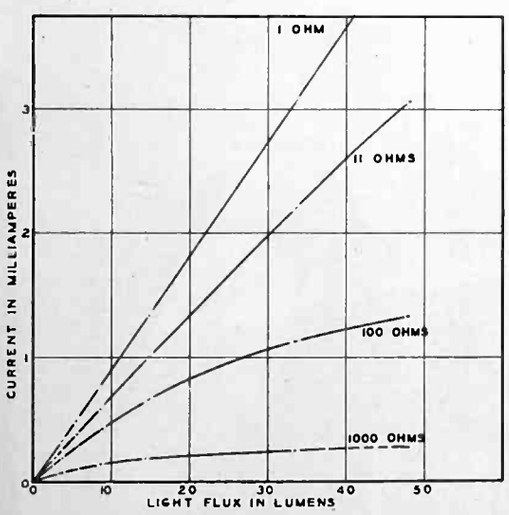


Fig. 5—Current-light curves of a typical cuprous-oxide cell

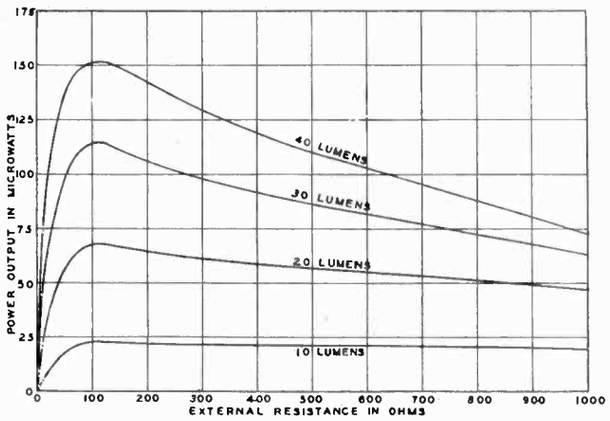


Fig. 6—Power-load curves of a typical cell

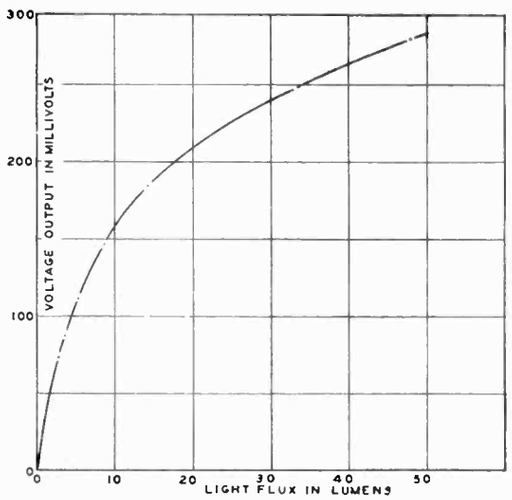


Fig. 7—Voltage-light curves of a cuprous-oxide cell

the system described by Cartwright[6]. It is shown diagrammatically in Fig. 3 and requires no additional description. A-c voltage to the terminals is supplied directly from a 200 volt-ampere transformer with a step-up ratio of 20 to 1. A resistance of 20 ohms is used in series with the primary.

In practice, the cleaned disk is mounted on the copper block which is set in position under the silver plate about 2 cm. distant from it. The chamber is then exhausted by means of a Hyvac oil pump. The degree of pressure is estimated by the appearance of the discharge between the graphite terminals when the supply voltage is impressed between them. When, upon trial, the discharge appears quite diffuse, it is permitted to continue for several minutes. This operation has the effect of cleaning up most of the oxygen, leaving presumably mostly nitrogen. Now the graphite terminals are both connected in parallel to one voltage lead while the other lead is attached to the silver through the tungsten wire at the top. The discharge which now occurs should be striated in the neck of the chamber and should be of a sky-blue color with no trace of pink.

In all, five 15-second discharges are given with at least one-minute intervals. After this, air is admitted and the disk is removed. There should be a distinct silvery annulus on the oxide with the edges of the oxide bare. A coating of collodion is applied to help preserve the freshness of the film, and the cell is finished.

[4]Schottky, *Physikalische Zeitschrift*, 31, 913, 1930.
[5]Auwers and Kerschbaum, *Annalen der Physik*, 7, 129, 1930.
[6]Cartwright, *Review of Scientific Instruments*, 1, 758, 1930.

[*Please turn to page 324*]

HIGH LIGHTS ON ELECTRONIC

Photocells could record freight-car movements

AS FREIGHT CARS ARE CARRIED about the country on one train and another, often far distant from the owning or originating railroad, it is necessary that a complete record be kept of cars incoming at junction points, cars leaving, etc.

Keeping such records requires that an observer with a notebook and flashlight spend much of the time in the yards, day and night, watching the cars as they come through, and marking down their numbers, train destination, etc.

Such freight-car records could be kept automatically by the aid of photoelectric cells, suggests W. C. White of Schenectady, N. Y., if in addition to the car numbers, a dot code corresponding to the numbers were painted on the cars. A photo-cell mounted at the side of the track, so as to be opposite this code number, would record the number of each car as it came by in the train, automatically printing the number on a tape in the yardmaster's office, and giving a written record of all car movements past the point in question.

The necessary dot code could be stencilled on the cars along with the usual painted numbers. Once the cars were so equipped, all work of keeping records of car movements, both day and night, would become automatic.

As evidence of the practical character of the proposal, Mr. White calls attention to the fact that the original suggestion was made to him by Mr. William G. Knight, mechanical superintendent of the Bangor & Aroostook Railroad Company, Derby, Maine.

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Electronic welding of new structural sections

LARGE NEW OPPORTUNITIES FOR electric welding and the tube control of the welding operation, are seen in the development of new structural forms for airplane, automobile and railroad construction, built up by welding together light steel laminations, and thus obtaining greatly increased strength for the same weight.

By the new method the steel is placed at a position of greatest usefulness in the construction so that a very light section and small total weight takes the place of former solid castings.

For such welding, electronic-tube control is required, both for automatic timing of the welds, and for delivering the proper frequency and number of cycles to each welded spot. By proper adjustment of the tube controls, it is possible to make the weld skip any number of half or whole cycles out of any total number of cycles, thus delivering exact and uniform welds of the greatest effectiveness as determined by experiment and test.

Measuring Instantaneous pressure in shotguns

THE PETERS CARTRIDGE COMPANY has constructed a piezoelectric gage for making time-pressure records in small arms. Although the importance of time-pressure records in ballistics has long been recognized, work along this line until recently has been rather slow due to the complications of recording such curves, imposed by the inertia factors of various apparatus. Among various methods which have been used for recording pressures in small arms the only entirely successful method at the present time is said to be the piezoelectric method. It has the advantage that the direct plotting of the time-pressure curve is possible. This is accomplished by connecting the gage to an especially designed resistance-coupled amplifier. The complete pressure recording apparatus consists of a firing mechanism with provisions for transmitting the chamber pressure to a piezogage, the piezogage proper, a resistance-coupled amplifier to convert the charge developed by the gage to a measureable current and an oscillograph-camera equipment to record the current variations. The construction of the gage and its method of calibration are described in some detail. Typical pressure records obtained with the apparatus are illustrated. The particular gage described has a range of 0 to 15,000 lbs. per square inch.

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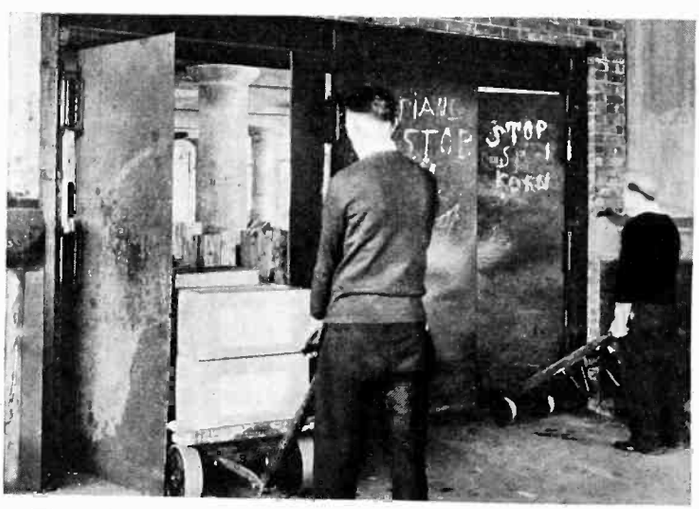
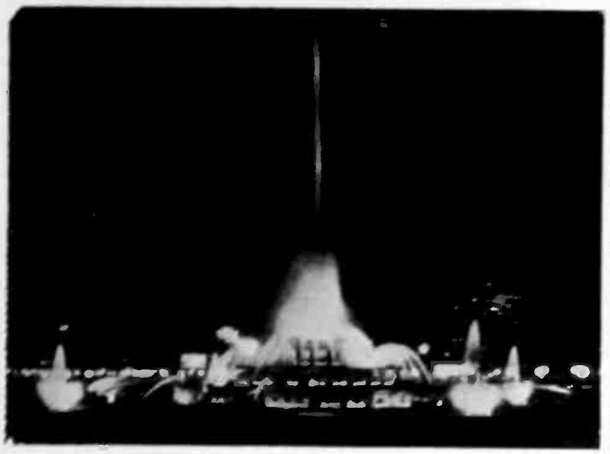
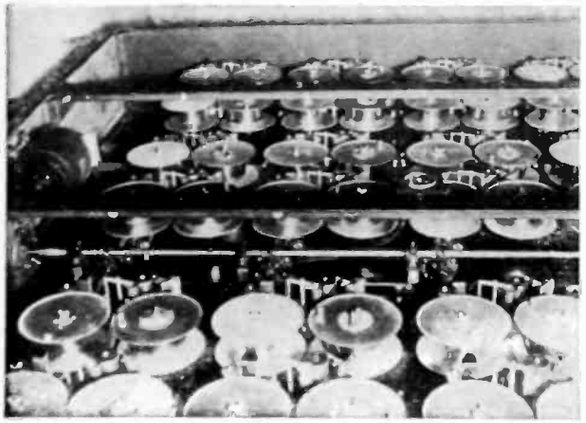
BANGING OF FACTORY TRUCKS NOW SILENCED BY "MAGIC DOORS"



These doors between the shipping room and freight platform of the Stanley Works, New Britain, Conn., are now controlled by a photocell operated by beam of light which shines from floor projector through hole in center of doors (see picture at right). Trucker coming from either direction intercepts beam, silently opening door

DEVICES IN INDUSTRY + +





The Buckingham Fountain on Chicago's lakefront, and the reels of non-inflammable film carrying braid control contact which give an hour's ever-changing program of colored lighting. To lay out a new program, the braid only needs to be sewn on the film in a new path, by an attachment used on a sewing machine.

Thermionic control for Chicago's Lakefront fountain

SPECTATORS OF THE changing lights—red, green, white, and yellow—which flood Chicago's Buckingham Fountain at night, see an hour's program presented by thermionic control and a tape-like record.

There are 23 circuits, and for each of them a long ribbon of fire-proof film, on which the predetermined program is laid out in copper braid. The film moves slowly over a roller wound spirally with resistance wire, and the varying position of the copper braid controls the voltage on the control circuit. This slight variation controls successively three vacuum tubes, which actuate a three-legged reactor which in turn varies the voltage on the lights. Westinghouse engineers point out that as no resistance is used in the lamp circuit, the energy saving is large.

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Uses for photoelectric counters

A NUMBER OF APPLICATIONS for photoelectric counters are suggested by E. B. Lyford, sales manager of the American Photoelectric Corporation, New York City, who lists these uses as follows:

Advertising research and check-up—To count the number of persons, automobiles, etc., passing any given point. To count the number of persons entering and leaving stores, museums, etc.

Commercial laboratory uses — To count revolutions or impacts of a testing machine; for frictionless counting of pendulum swings, etc.

Highway planning and control—To count the number of persons or vehicles using any highway, bridge or tunnel. To study traffic distribution.

Retail stores—To count persons entering or leaving, passing a certain counter, using an elevator or escalator, etc.

Industrial applications — To count rapidly moving, freshly painted or extremely fragile articles moving along a belt or conveyor, where mechanical counters are either undesirable or impossible. Counting animals in stock yards, etc.

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Streamlining and power

IT REQUIRES 230 horsepower to send an automobile 106 miles an hour. The same speed can be obtained with 70 horsepower if the car is streamlined, according to Dr. Oskar G. Tietjens, Westinghouse research engineer. An airplane needs 140 horsepower to do 106 miles an hour but water resistance, being 800 times that of air, makes a speedboat need 4,000 horsepower for that speed.

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Weather's influence on sound absorption

DURING THE PAST TWO YEARS a study has been made at the Bureau of Standards of the sound-absorbing properties of air under varying conditions.

When air is very dry, sound is absorbed much more readily than when the air is full of moisture, it was found. Also when the temperature is high, sound is absorbed better than when it is cold. This increased absorption is most pronounced for sounds of high pitch. Thus the conditions for maximum absorption are those prevailing on a hot, dry day. Under these conditions it has been found that sound can not be heard as far as on a cool, damp day.

This problem is of considerable interest in broadcasting studios where an attempt is made to keep the absorption constant. This can be done by the use of an air conditioning system, and in many studios such control has been installed.

The rate of decay of sound in a room does not follow exactly the uniform law that has hitherto been assumed, but is influenced by the area of absorbing material present and its distribution. Research Paper No. 465, of the Bureau of Standards gives a complete account of this work.

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Office dictating machines need better fidelity

"ELECTRONICS HAS BEEN rather frank in pointing out the deficiencies in existing apparatus and suggesting its improvements," writes a reader, who continues: "I would like to suggest a line of development badly needed by modern business and which could be accomplished by the use of electronic devices.

"In any business where technical terms are used it is essential that dictation be very plain in order that the typist be able to transcribe correctly. The existing dictating machines are so very poor as to necessitate much guess work. The range of frequencies reproduced (350 to 2000 cycles) is little better than that of the average telephone (300 to 1800 cycles.)

"Recording and reproducing means of high quality are available in the electronic art and should be applied to the construction of a high quality dictating machine.

Radiation-cooled power tubes for radio transmitters

By H. E. MENDENHALL

Bell Telephone Laboratories, Inc., New York City

RECENT broadcast transmitters developed by the laboratories, with capacities ranging from 100 to 1,000 watts, have required power amplifiers intermediate in size between those of the largest radiation-cooled types and the water-cooled tubes of much higher ratings. Since 100 per cent modulation is employed in all Western Electric radio transmitters, the output of the power amplifier must be four times the transmitter rating. Tube capacities required for the new transmitters were from 500 to 2,000 watts, while the largest Western Electric radiation-cooled tube had a capacity of 250 watts and the smallest water cooled, of 5,000 watts. Three new power tubes have been developed, therefore, to fill this gap. They are all of the radiation-cooled type with peak power output capacities of 500, 1,500, and 2,000 watts.

As a rule, the higher the rating of a tube the greater is the plate potential and the greater is the heat developed at the plate. Water cooling, being the most effective way of removing heat from metal surfaces, is universally used for the larger sizes. Although it is an effective way of removing heat, water cooling has certain operating and economic disadvantages since hose connections, a water supply, and possibly a cooling system for the water are needed, and add to the operating and maintenance expense. To avoid these various disadvantages, the three new tubes have been designed to dissipate the heat developed in their plates by radiation alone.

The amount of heat that can be radiated from a surface varies directly as the area and the radiation coefficient, but as the fourth power of the absolute temperature. Heat is most effectively radiated, therefore, by increasing the temperature of the plate, but with nickel or iron — the ordinary plate materials — the increase possible is distinctly limited by their low melting points. For the new tubes, therefore, molybdenum was employed for the plate material because its melting point is considerably higher than that of nickel or iron, and with its use the plates may be run at a temperature as high as 1,000 degrees C., a cherry red heat.

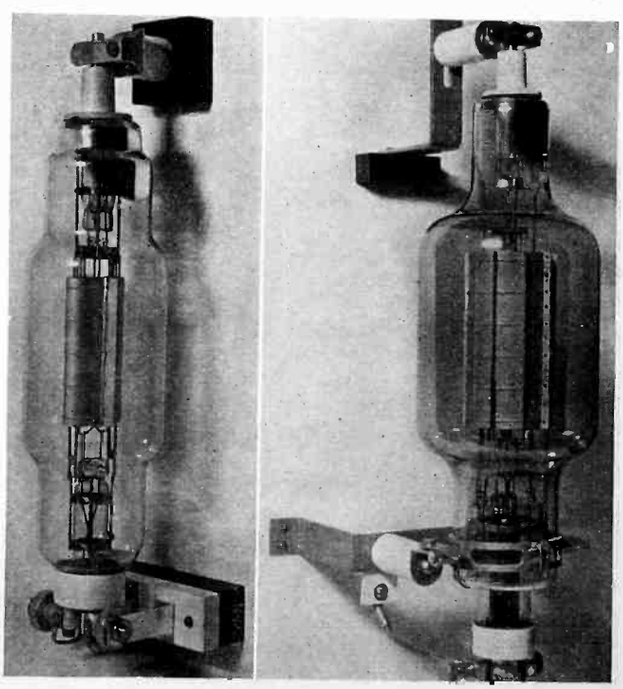
In addition to the gain obtained by the higher temperature, dissipation is further increased by roughening the surface of the plates by carborundum blasting. The emissivity of such a treated surface may be double that of a smooth surface. A further gain is made by increasing the size of the plates and by adding radiating fins. The number and arrangement of these fins vary with the rating of the tube. For the smaller size little additional radiation is required, but for the largest capacity the arrangement and number of the fins have been designed to secure the optimum dissipation.

Since the plates are to operate at so high a temperature, both the grid and filament also have to be designed for high temperatures. Molybdenum was employed also for the grids but here another special treatment had to be resorted to. When these tubes are used in radiotelephone transmitters, the grid may be carried to a positive potential with respect to the cathode during a portion of each carrier cycle. During this period, therefore, a portion of the electron stream will be diverted to the grid where it will produce secondary emission. Without special treatment of the grid surface the number of secondary electrons emitted may be greater than the number of electrons striking the grid, so that a reversal of the grid current may take place. This secondary emission, and thus the current reversal, also varies widely from tube to tube.

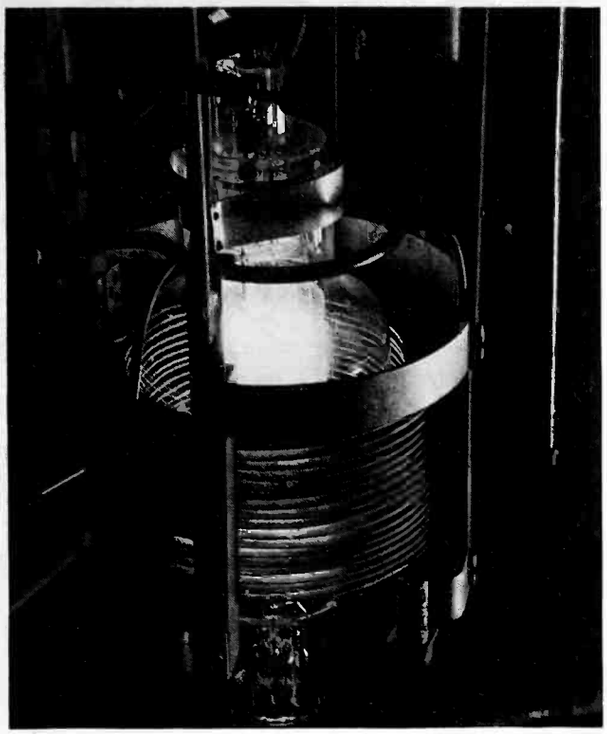
The reversal of the grid current itself gives considerable difficulty to the circuit development engineer, and the superposition of large variations from tube to tube makes the circuit problem still more difficult. In the manufacture of the new tubes, however, a special treatment for the grid has been employed which not only gives a surface that produces less secondary emission, but decreases the variation to a marked degree.

Determination of filament material

The high temperature at which the plate is run also affects the type of filament used. Since the radiation requirements of the plate are already severe, it is undesirable to dissipate any more heat in the filament than is necessary since most of it must be re-radiated by the



The 270A tube is smaller in diameter than the others, uses a plate oval in cross section instead of cylindrical, and employs only two radiating fins On the 279A tube nine radiating fins have been designed to obtain maximum radiation



Induction heating of the metal parts of the tube during the exhaust process

plate, which surrounds it. A high efficiency filament is therefore very desirable, but the oxide-coated filaments used with tubes of smaller capacity, although highly efficient, operate at a temperature which is actually 200 degrees lower than the normal operating temperature of the plate. Since at the same energy input a thoriated filament is about five times more efficient than the pure tungsten, it was selected. Such a filament consists of a core of tungsten containing about one per cent of thorium dioxide. This is covered by a thin layer of tungsten carbide over which lies a monatomic layer of metallic thorium. This single atom layer lowers the energy required for an electron to escape across the surface, and thus increases the efficiency of the filament much as the monatomic film of barium does in the oxide-coated filament.

During the early stages of the exhaust operation the tungsten carbide layer is formed by glowing the filament in an atmosphere of hydrocarbon gas. The pressure of the gas, the temperature of the filament, and the time of glowing are all so regulated that the quantity of carbide formed is accurately controlled. Then the hydrocarbon gas is removed and the lengthy process of freeing the glass and metal parts from occluded gas is begun. The entire tube, while the vacuum pumps are running, is first baked in an electric oven at a temperature just beneath the collapsing point of the glass. The metal parts are then heated by high frequency induction to a considerably higher temperature than that of normal operation. Some ten hours of continuous exhaust are necessary to gain freedom from occluded gases.

Just before sealing off the tube from the exhaust station a few milligrams of magnesium are vaporized. The vaporized magnesium condenses on the lower portion of the bulb where it forms a mirror that acts as an absorbent of any gases that may be formed during the operation of the tube. At the time of flashing, the magnesium also reacts with small amounts of oxygen or water vapor that may be present and removes them.

After the tube is sealed off the exhaust station, the filament is operated at a temperature well above its operating value, and during this period, as well as during the previous heat treatments, the tungsten carbide reacts on the thorium dioxide in the core of the filament. This results in the reduction of a certain amount of the oxide and the building up in the carbide layer of a definite quantity of metallic thorium. Both the temperature of the filament and the time of heating are accurately controlled to form the right amount of metal. During the life of the tube this metal gradually diffuses outward and maintains the monatomic layer on the surface. All the steps of the process are so controlled and the operating temperature of the filament so adjusted that there will always be an adequate supply of thorium to replace that lost by evaporation or ion bombardment throughout a life of several thousand hours.

All three of the new tubes incorporate the molybdenum plates and grids and the thoriated tungsten filaments, and are subjected to the same manufacturing processes in respect to them. They differ from each other, however, in many other respects. The two larger tubes, the 279A with an output capacity of 2,000 watts and the 251A with an output capacity of 1,500 watts, are of the cylindrical anode type. Both anodes have vertical radiating fins as aids to increase anode dissipation. The 279A tube employs a greater number of these fins than does the 251A tube because of the greater energy dissipating requirements of the larger tube. Its anode is made of nine sections with a radiating fin at the contact surface of each pair. The cylindrical plate construction gives unusually low inter-electrode capacities, which make the tube suitable for high frequency applications. At reduced power ratings they may be used for frequencies as high as 40 mc.

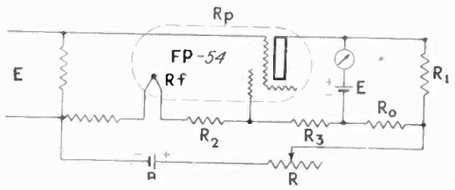
One interesting feature of the 279A tube is a new type of structure for tensioning the filament. Instead of employing a separate tensioning spring for each filament V, a central compression spring is used to tension all four V's. This unit spring is supported by the center rod of the filament assembly, and is specially insulated and shielded. The insulator at the upper end supports a platform member which in turn supports the two whiffle trees or rocker arms. The platform has only point contact with the top insulator so as to give it a universal joint action, enabling it to rock freely in any direction. The universal joint action of the top platform, in addition to the whiffle tree action of the two rocker arms, insures uniform tension on all legs of the filament from a single spring. A weighted jig is used to depress the spring to the proper tension and hold the top platform and cross-arms in their correct relative position during the assembly of the filament hooks. The free end of the filament hooks, which are in contact with the filament, are looped back like a safety pin.

Notable improvement in the precision of glass working has been obtained in the 270A. The anode is first sealed, accurately centered, into one end of the bulb with a special lathe type of seal-in machine. (A photograph of this process appeared on the cover of *Electronics*, September, 1932.) After the seal is cooled, the filament-grid structure is sealed in the other end on the same machine. There is no central mechanical tie between the plate structure sealed in one end and the filament-grid structure sealed in the other, and the process must be so accurate that the two structures are exactly coplanar and coaxial.

+ + + ELECTRONIC NOTES

One tube balanced circuit for d.c. amplifier

W. SOLLER OF THE University of Arizona, states that the single tube balanced circuit using the FP54 or similar tubes takes less time and effort to put in operating condition than an unbalanced circuit. In the diagram from the *Review of Scientific Instruments*, August, 1932, (See also August, 1932,



Bureau of Standards Journal of Research where amplifiers are described which give 50 ma. deflection for a single alpha particle) R_o and $R_f + R_2 + R_3$ are two arms traversed by the filament current R_1 and R_p, carrying the plate current are the two other arms of a Wheatstone bridge. It can be shown that if the characteristic is straight near the operating point, the circuit will balance and remain balanced.

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Grid-controlled rectifier uses

IN ELECTROTECHN. ZEITSCHR., *July-August, 1932*, is a discussion by Wechmann, Petersen, Loebl, Troeger, Reichel, Kleive, Glaser, Nowag, etc. One of the most complete lectures given before an audience of about 1,000 engineers and describing the many branches of the family of ionic and electronic discharge devices. The possibility of restoring d.c. energy to the three-phase source during the proper phase receives careful attention. Many of the uses mentioned in the following table are discussed briefly.

Industrial uses for electronic and ionic devices:

1. *Voltage regulators*

A. With single polyphase discharge tube. (Voltage regulation to ± 10 per cent in substations, battery charges, starting and control of motors (roller mills, rectifier locomotive fed with 50 cycle per sec.).

B. With two polyphase discharge tube. (Elevator drives, transmission of energy three-phase to d.c. to three phase of up to 2,000 cycles, energy transmission three phase to d.c. to single phase, d.c. long distance transmission, load equalizer for railroads).

C. Tubes (regulation of smaller units).

2. *Frequency changer.*

A. With two polyphase discharge tubes. (Low frequency for electro-furnaces, energy transmission three phase to low frequency single phase).

B. With tubes (high frequency).

3. *Switches*

A. With single polyphase discharge tube. (Protection against back fires and short circuits, d.c. or single phase motor without commutator, out-of-phase loads for large distribution networks).

B. Tubes. (Stage lighting, spot welders, shaking racks and tables, signals and relays for controlling manufactured articles, fire protection, cable testing, light relays for traffic control, high tension relays, remote control).

✦

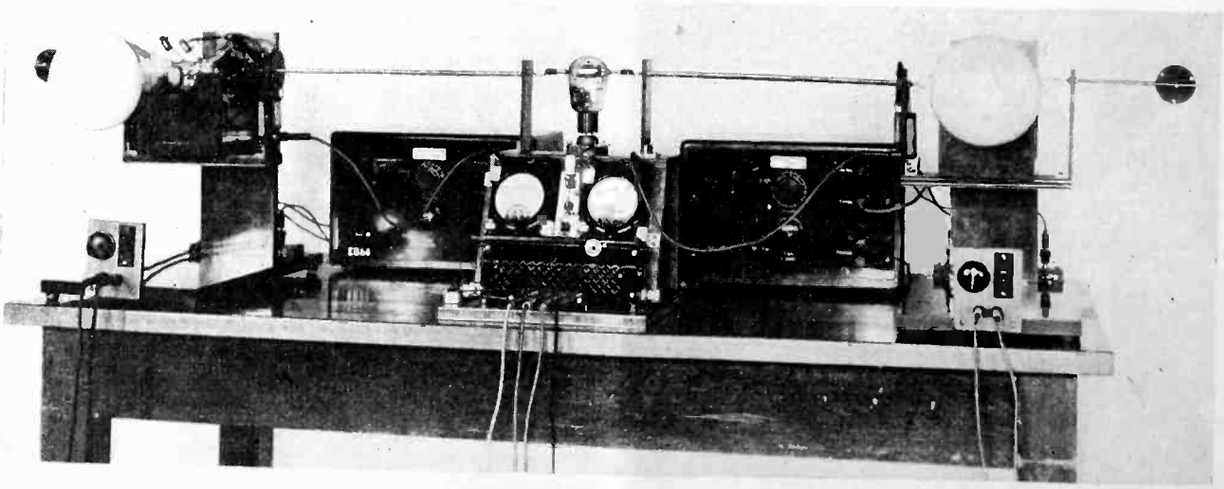
Cathode-ray tubes

TWO NEW CATHODE-RAY TUBES will have considerable value in industrial circuit analysis work, one of them being controlled magnetically (*Electronics*, November, 1931) and the other electrostatically; the magnetic tube will be satisfactory up to a few thousand cycles, the electrostatic type has been used to produce a pattern when 60 million cycles were applied to one set of plates and 15 million cycles to the other set. The tubes which are described in the *Electric Journal*, August, 1932, by Lee Sutherlin and A. J. Harcher, have been used in routine tests of lightning-arrester discs, for testing high-frequency circuits for constancy of frequency, for studying the breakdown of grid-glow tubes, as an indicator for piezo-electric pressure gauges and flash-backs in mercury-pool rectifiers, for observing hysteresis loops, power phase distortion, circuit-breaker functioning, etc.

✦

Barkhausen-Kurz oscillation research

THOSE WHO ARE WORKING in the short-wave field must be interested to learn that Dr. E. E. Hollmann working in the von Ardenne laboratory, Berlin, has developed a Braun tube with a new deflection system, in which the error due to the time of travel of the electrons is automatically compensated. The illustration shows an 80 cm. transmitter installed in the Heinrich Hertz Institute. On the right is a standard Braun tube, connected to the Lecher system, and on the left the new tube. On the right there can be seen an elliptical figure dependent on the anode voltage, the Braun tube on the left with the new deflection system supplies an absolutely definite measurement—in the case of the present connection scheme, a straight line. It is to be hoped that by means of this new technical device, the Barkhausen-Kurz oscillations will soon be fully elucidated.

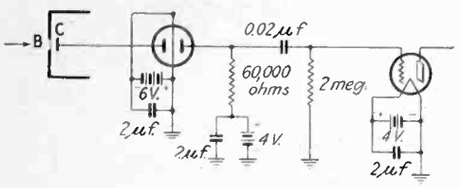


Apparatus in the von Ardenne laboratory for ultra-short wave research

FROM THE LABORATORY + + +

High-gain amplifiers for electronic measurements

RINGUET IN *L'Onde Electrique*, Paris, June 10, 1932, gives a description of an amplifier developed under deBroglie which permits the detection of the arrival on the first grid of any electrical charge exceeding 10^{-16} coulombs per hundredth second. Difficulties of construction are fully covered, due chiefly to the infinitesimal charges to be dealt with and to the need for reduction of tube and other noises. The diagram shows the form taken by the apparatus, the alpha ray or proton traverses the



aluminum window *B*, some microns in thickness. Between *B* and the plate *C* an electric field is imposed (100 to 300 volts per centimeter) so that on the arrival of an alpha ray or proton the positive ions formed are directed to *C* and the negative ones to *B*. The only insulators which proved usable for *C* were natural amber, quartz, or pure bakelite; ebonite and ambroine were tried without success. The first tube is an "electrometer" tube (Philips) working with 4 volts on the plate, mutual conductance 0.03 *ma/V*: this has two parallel plates, one being the equivalent of the grid and the other of the anode, the filament being stretched between these two plates and parallel to them. Practically no amplification takes place in this tube. No grid leak is fitted: it would have to be of the order of 100 megohms, and would give rise to noises, and it is simpler to bring the grid potential back to zero from time to time as required. The remainder of the circuit is normal, except that each stage has its own batteries. A five-tube resistance-capacity amplifier and an oscillograph follow. Special precautions are necessary to prevent the window *B* from acting as the diaphragm of a microphone. Despite electrostatic shielding, rubber supports and suspensions, and an outer case with felt and regenerated rubber damping it is not possible to speak or to walk about in the room where the apparatus is located, or in neighboring rooms, during the experiments. A full description is given of the applications of the apparatus to experiments relating to the transmutation of elements and to rays of high penetration (cosmic rays, etc.), as also a brief summary of some of the results obtained.

Cathode-ray records on sensitive paper

INSTEAD OF FILMS AND PLATES, sensitive paper may be introduced in cathode-ray technique according to W. Foerster of the Dresden Institute of Technology. His methods by which pictures just as sharp as when made on films (one micro-second equalling one centimeter) are possible necessitates keeping the tube on the pumps. The methods are described in *Zeitschrift technische Physik, August, 1932.*

✦

Telemeter using tubes and standard parts

A TELEMETER OF considerable interest is described in *Electrical World,* June 25, 1932, by A. J. Johnston, General Electric Company, Phila. Depending upon the position of the instrument mirror, light from the lamp source is thrown upon it and thence to one of two phototubes or both tubes at the same time. When light is falling only on the left hand cell the grid potential of a pliotron used in the circuit becomes so negative that the current through it is interrupted; when all of the light is falling on the right hand photo-electric tube, the plate resistance is reduced to about 10,000 ohms. allowing a plate current of 10 ma. to flow through the external circuit which perhaps 100 miles away contains an indicating or recording d.c. milliammeter.

✦

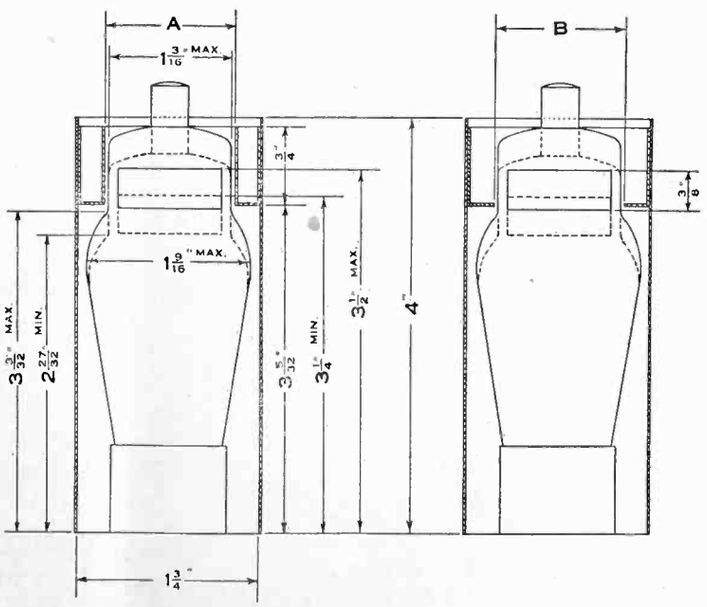
Electronic orchestra at Berlin

ELECTRONIC MUSIC IS NOW getting to be a standard article of musical entertainment in Europe. During the recent Berlin Radio Show, an eight-piece electronic orchestra gave four concerts daily. Benjamin F. Miessner, the American inventor of the electronic piano, was in Berlin at the time, with his family, and reports that the electronic concerts attracted wide interest.

Several electronic bass-viols have been seen in orchestras and dance trios, in New York hotels and restaurants during the past few months, indicating that the new music may spread to popularity on this side of the Atlantic as well.

✦ ✦ ✦

VARIATION OF GRID-PLATE CAPACITY OF 58-TYPE TUBE



Shield No. 1 Shield No. 2

A SERIES OF MEASUREMENTS on the grid-plate capacity of the 58-type tube as a function of the shielding used has been reported by Engineering Division of the RMA. The capacity values given are the average of 25 tubes; the shields were of sheet brass 1/4 in. thick.

	Shield	*Grid-plate capacity*
Shield No. 1	A = 1 1/4 in.	.0030 mmf.
	A = 1 5/16 in.	.0036 mmf.
	A = 1 3/8 in.	.0042 mmf.
Shield No. 2	B = 1 1/4 in.	.0050 mmf.
	B = 1 5/16 in.	.0054 mmf.
	B = 1 3/8 in.	.0059 mmf.

electronics

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Business comes to the man who goes after it

A WELL-KNOWN electronic engineer was motoring home to Jersey with his family, during the small hours of the morning, when a bearing burned out. Deciding to press on, even slowly, with his disabled car, he had limped along only three or four miles, when out of the darkness of the country road a car pulled alongside, and a cheery voice called out "Can we have the job of fixing your car? We heard your engine knocking when you came through that last town back there, so we hurried after you."

The surprised engineer explained that he would have to get his family home, as it was then 2 a.m. and he couldn't leave the car. "Oh we'll take care of that," explained the repairman, "We'll drive you all on home in our car, then come back and repair your bearing, and have the car at your house by breakfast-time." All of which they did!

Which illustrates that there is business today, in electronics and in other lines, for those who *go after it.*

Counting the ninety and nine

A FEW YEARS AGO in some industries *counting* went out of style in the matter of handling large numbers of small pieces. *Weighing* of small parts in quantity, was recommended as a quick and efficient substitute for the laborious process of hand counting.

But one manufacturer of food containers who made this shift to weighing instead of counting, had a shock recently when one of his largest customers sent in an order for 50,000 containers, but no 50,000 covers to correspond! Knowing that the containers were useless without the covers, an explanation of the strange order was requested. Back came the answer that the customer already had in stock 50,000 covers accumulated from overshipments on previous orders, and so would need no more until these were used up. The container maker then checked over his weighing methods and found he had been regularly overweighing all covers.

Now he has installed photo-cell counters, so that he now counts—not weighs—every cover and container leaving his factory, incidentally getting an automatic inspection in the process.

Infra-red, the next playground of vacuum tubes

INFRA-RED rays seem to offer the next great field for exploration with electronic apparatus. Navigation, industrial applications, remote control, and safety protection all present striking opportunities for infra-red detection.

During a recent broadcast demonstration of the Macneil thermo-electric sextant, which can measure the position of the sun through thick, obscuring clouds, the sensitive thermo-couple was pointed out the studio window and used to "feel" heat from smokestacks six miles away. Commander Macneil is now experimenting with locating airplanes flying *above* the clouds at night, by "feeling" the heat from their exhaust—this instrument will detect the heat of a man's face at a mile, a horse at two miles. Smokescreens will be useless in future wars: warships' hot funnels can be located through the thickest black smoke masses and guns aimed as easily as if the ships were in plain view.

Detection and warning against icebergs will undoubtedly be another service of the future to be rendered navigation. During the broadcast mentioned a cake of ice was hidden in the studio behind a thick sheet of black rubber, to stimulate fog, and then all the lights were turned out. Under these conditions, simulating a thick foggy

night, the thermo-couple was swung around the "horizon" and instantly located the concealed "ice berg" there in the dark!

Many potentialities at once suggest themselves for such wonder-working apparatus—as sensitive in "feeling" as the electric eye is in "seeing."

Take the hurdles out of the dealer's path

IF radio is to be put on a firmly stable basis, the average radio manufacturer must give more thought to the retail problems of the dealer, and the relation of these difficulties to the manufacturer's own selling policies.

Too many models, too many price changes, too little territorial protection, too little aid in the practical work of merchandising,—these are the charges which the dealers bring against the set makers.

It is essential that the set manufacturer give interested concern to the dealer's selling problems. Sympathy and study will bring about a fuller understanding, and relief from the unnecessary hurdles which the retailer is now called on to jump.

The market for "pocket portables"

SUCCESS already attained in England with a "pocket portable radio set, indicates that an interesting market might be opened up on this side of the water for a tiny set weighing a pound or so, and capable of giving "one man service."

The British set was designed for police use, and measures $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in. by 2 in. It weighs 1 pound 14 ounces, three-quarters of which weight is batteries. A novel factor is a call bell to attract the attention of the police wearer. The antenna is worn in the back of the coat.

Although originally constructed for use on 150 meters, these little miniature sets have been successfully employed in the broadcasting band.

Railroad jobs for electron tubes

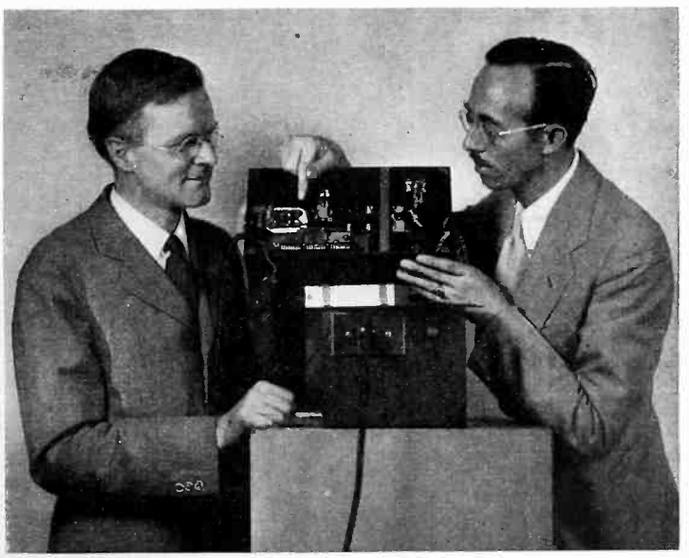
ALREADY electron tubes are employed in force on that most important of safety uses, railroad block-signalling and engine-cab indications. Other possibilities include freight-car classification as proposed on another page.

Work is already underway on an electronic Pullman door-opener which will not wreck the constitution of a frail woman or child, or spoil the breakfast or dinner of even a strong man who has to fight his way to the diner through half a dozen vestibules, with their imposed jui-jitsui and calisthenics at each opening.

And we suspect the day will come when every little wayside railroad station and waiting room will have a melodious loud-speaker playing sweet music and giving out interesting news items and adventure stories, sandwiched in between good-will messages from the railroad management to its public. Loudspeakers in each waiting room could be operated from the railroad's own telegraph circuits without interfering with the regular code communication, going over the lines.

With all the money that the railroads have been spending on advertising to general readers, it is surprising that no use has been made of this logical, inexpensive channel to reach their own passengers and shippers.

NBC'S CHIMELESS CHIMES



Captain Richard H. Ranger, (left) inventor of the pipeless organ, the bell-less carillon, and RCA's facsimile transmission, explains his latest invention to O. B. Hanson, manager of technical operation and engineering of the National Broadcasting Company. The new automatic device now supplants the familiar three-note NBC chimes

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Decimeter waves by ordinary reaction

[W. KROEBEL] Gottingen University. In the Barkhansen circuit (grid more positive than plate) a single short-wave tube gives only 1/1000 to 1/10 of a watt at wavelengths of 10 to 20 cm. On the other hand, the lowest wavelength obtained by ordinary feedback circuits was 60 cm., the oscillating circuit consisting of the anode-grid capacity and the holders for the electrodes. The author points out that the voltage required in this circuit is high because plate and grid voltage are not 180° apart. When instead of a helix a plane wire gauze is used, thus making the electrode arrangement more symmetrical, waves of 31 cm. length can readily be obtained in the ordinary reaction circuit with the plate more positive than the grid. — *Annalen d. Physik, July, 1932.*

✦

The German radio show

[NOACK] The arrival of true single-knob tuning is specially commented on, with notes on some of the manufacturing methods used to attain it. The improvement in selectivity and tone-quality of even the cheaper sets is also emphasized, and is stated to be due largely to the increasing use of pentodes feeding dynamic loudspeakers. In many of the smaller sets compensation for the decrease of the higher audio frequencies is fitted in the audio amplifier, in place of the band-filters to be found in the more elaborate receivers. Most superheterodynes use 650 meters in the intermediate-frequency amplifier, usually with variable-mu tubes. Built-in loudspeakers are on the increase. Battery sets show great improvement, some 50 per cent of German listeners having as yet no electric supply. Loudspeakers in general are much more efficient and very much cheaper. Tube prices are 15 to 20 per cent down. In component parts, special mention is made of band-filters, especially types with simple arrangements for altering the width of the band; of multiple condensers with compensators easily adjustable by the amateur builder; and of new radio-frequency condensers and chokes (e.g. those on "Ferrocart," a new magnetic core material). Great progress has been made with interference preventers, especially small types for household apparatus, costing about 1 mark each.—*Radio Amateur, Vienna, September, 1932.*

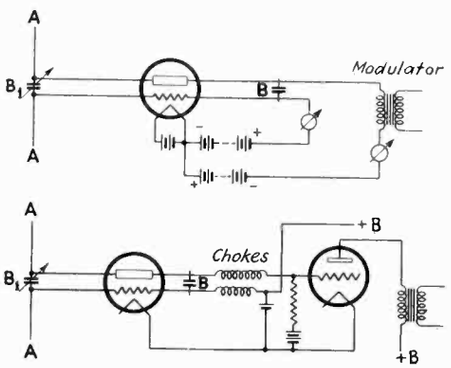
"Dual" purpose valves

[EDITORAL] A radio listener who had occasion to replace worn-out tubes of the bright emitter type was induced by a dealer to try the more modern dull emitters. He came back quite satisfied that he was getting a better volume, but as he and his wife had been using vacant space in the radio cabinet to store a tobacco jar and other trifles, they preferred to have tubes which would also act as light sources and to sacrifice the extra efficiency for the sake of the illumination.—*The Electrician, August 12, 1932.*

✦

New transmitter and receiver for ultra-short waves

[HOLLMANN] Details of work at the Heinrich Hertz Institute using a new type of tube in which the grid and anode are each led out through the two opposite sides of the glass bulb, so that two Lecher-wire systems, each with its own condenser-bridge can be fitted. On the transmitter diagram B_1 is variable in order to adjust the coupling of the dipole A-A to the oscillating circuit. The novelty of the receiver is in the form of coupling of the detector to the first a.f. tube (followed by further stages normally), both these tubes being contained in one shielded cylinder. Excellent photographs and diagrams are given, as also details of experiments and results. —*Funktechnische Monatshefte, Berlin, August, 1932.*



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Self-registration of gramophone discs

[E. G.] Specially deals with the Braun apparatus, using a steel or diamond needle in a normal pick-up, registering on gelatine plates.—*Radio Amateur, Vienna, September, 1932.*

Loudspeakers at the Berlin show

[NESPER] Special mention is made of the large double system of Telefunken (one dynamic cone plus two dynamic exponential horn speakers) and good diagrams are given of this. Resonances and the undue favoring of the lower notes with midget sets are strongly criticized, and the addition of an auxiliary loudspeaker for the higher audio frequencies is recommended. It is regretted that no commercial products with two self-contained speakers are available. The special Grassmann dynamic coil is described, allowing of unusually small separation, and photographs are given. The new light-weight permanent magnets produced by Dietz and Ritter are praised. Membrane-stiffening is discussed, with photographs of the methods used by Müller (radial supports), Grassmann (folded membrane), Schwarzer (flat folded membrane). — *Funk Magazin, Berlin, September, 1932.*

✦

Meeting of the German Society for applied physics

[H. HERTZ SOCIETY and GERMAN PHYSICAL SOCIETY] The program of the meeting from Sept. 20 to 24 included many subjects of interest to the radio engineer (photoelectric response of thin films of alkali metals by Fleischer, selenium barrier layer cell by Bergmann, selective photoelectric effect by Kluge of the G.G.El., inertia of gas-filled photoelectric cells), and a discussion on the electro-physics of the high atmosphere (new results on northern lights and ionized layers, fading) a discussion on discharges in gases, where the Dutch physicists describe results obtained with sodium tubes (*Electronics*, August, 1932). F. Trautwein presents results showing that musical sounds judged to be of the same strength by trained musicians may show differences of 1:20, the ear judging apparently from the components of constant frequency rather than the fundamental. The reports will be dealt with in these columns.

✦

Typographical errors

MR. T. R. BUNTING, who described the design of pitch-control circuits for electronic musical instruments in September *Electronics*, states that the correct abscissa label for Fig. 2 in that article should be L_p/L_s and for Fig. 3 L_r/L_p.

Technical advances at radio show Berlin 1932

THE CHEAP AND SIMPLE "local" receiver (usually a regenerative detector and one audio-frequency stage) has practically disappeared, the relatively more elaborate and costly sets having been so greatly lowered in price as to make the simpler sets unsalable. Among the most interesting novelties was the five-tube superheterodyne produced jointly by Telefunken, Siemens, and the A.E.G., using an intermediate frequency of 460 kc. The three products are practically identical in circuits and construction, differing only in the style of tuning-scales and casing fitted. All the superheterodynes exhibited combine the oscillator, modulator, and first detector in one tube, in most cases a double-grid tube although some makers prefer the extra amplification of a screen-grid tube. All have true single-knob tuning for the first time, and practically all have automatic volume control. Some of these compensate for very wide variations, such as the receiver already mentioned where ratios of up to 1 to 40,000 can be handled. As a rule the volume control is by a resistance device, a separate regulating tube being rare. One superheterodyne, produced by the SABA firm, uses two intermediate frequencies, switching from one to the other so that on the normal and long broadcast bands an optimum value can be employed. This receiver has also an unusually elaborate tone-control, consisting of a series of adjustable filters. Several of the superheterodynes shown allow of short-wave reception, usually by double frequency-changing. One receiver for automobile use was shown, a superheterodyne using a small d.c. dynamo driven by the starting battery as a source of anode potential. Receivers other than superheterodynes show great progress, especially as regards true single-knob tuning and the absence of regeneration. Sets having more than two r.f. stages are rare. Among the small sets the three-tube type (screen-grid, regenerative detector, pentode) is the commonest. As regards prices, several of the new five-tube supers cost less than 300 marks, three-tube sets run from about 130 to 200 marks, and there are some smaller receivers as low as 100 marks.

Loudspeakers have simplified down to a very few types, and progress has been chiefly in precision manufacture (decreased clearances and hence greater field strength), better manufacturing methods and as a result lower prices, and better magnetic materials. Two unusual types are the Görler electrostatic and the American piezo-electric speakers, the latter manufactured in Germany by Neufeld and Kuhmke. Prices range from 20 marks upwards. In general there has been a drop of 20 to 25 per cent since the spring. Pick-ups show few novelties. Neufeld and Kuhmke show here also an American piezo-electric type.

As regards television, Telefunken showed an apparatus using a cathode-ray tube at the receiver but normal mechanical scanning at the transmitter, while the Loewe apparatus uses cathode-ray tubes at both ends. As far as can be judged, very considerable progress has been made as regards clearness and luminosity, and it is stated that the life of the tubes is now satisfactory. Mirror-screw apparatus is shown by the Telehor-Tekade firm. The scene is not directly scanned but first photographed onto a normal cinema film which 15 seconds later is developed and scanned. The Postal authorities show television on the ultra-short waves.

The Heinrich Hertz Institute had a special show of electro-musical instruments, especially a simple form of Theremin instrument and interested visitors were given the oportunity to practice on it in special sound-proof cabinets. This little apparatus can be used with practically any normal receiver without any alteration, and in most cases without even connecting the two together—the intention is to bring electrical music into the home and take it out of the field of the musical specialist where it has developed up to the present. The concerted performance of two of these instruments, one Trautonium, one Hellertion (a keyboard instrument), electrical violins and cellos (in which electrical pick-up and amplification replace the normal sounding-boards), and a Neo-Bechstein piano proved exceptionally interesting. Another special section was that devoted to interference elimination, more especially by simple and cheap apparatus.—*Funk, Berlin, August 26, 1932.*

✦

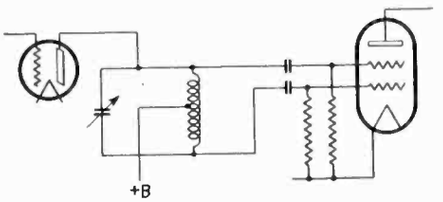
Theory of distortion in screen-grid tubes

[R. O. CARTER] The method assumes that the tubes are correctly operated so that the flat part of the E_p I_p curve is reached for all values of grid bias and the only distortion is due to the curvature of the E_g I_p curve $i_p = f(e)$. For any reasonable function "f" between plate current and grid voltage, an increase in depth of modulation is produced; for small values M of modulation, the percentage increase is independent of M and given by $D_3E^3/4D_1 + D_5E^5/48D_1$ where E is the carrier voltage, and D the derivatives of f. If the input modulation depth be 20 per cent, and the modulation rise of the same order, the second and third harmonic introduced by the valve is 3 per cent and 0.03 per cent. The percentage cross-modulation comes out to be $D_3E_2^2/200\ D_1$. The theory shows that even when the tube characteristic is not exponential throughout the range used, it is perfectly possible to design tubes which will handle inputs as large as 5 volts, and which give an amplification range of 250:1 with negligible distortion and cross-modulation at all values of input, and with a moderate plate current and grid bias provided a variable conductance tube is used.—*Wireless Engineer, August, 1932.*

✦

Against detector overloading

[SCHR] French 695,282. To avoid the occurrence of anode detection in an overloaded grid detector a double-grid tube is used in the circuit shown, the



tolerance of overloading without distortion being increased by 150 per cent as compared with the same tube when normally connected. More than two grids can also be used, in a suitable circuit.—*Funk, Berlin, August 26, 1932.*

✦

Modifications of the German short-wave transmitter

THE STATION AT Königswusterhausen which has till now used 31.38 meters at all times will in future use this wavelength by dark and 19.73 meters by day. For the moment the only antenna available for this wave is directional on the United States, but a non-directional antenna is being built. New directional antennas on the United States, for 25 and 49 meter waves are also under construction.—*Radio Amateur, Vienna, September, 1932.*

✦

The "crowned" radio tower

[W] Details and photographs of the ultra-short-wave antenna at Berlin, consisting of a two-meter vertical rod with a star-shaped counterpoise immediately below it and in a horizontal plane, the whole being set on the summit of the well-known radio tower in the exhibition grounds at Charlottenburg.—*Funk, Berlin, August 19, 1932.*

✦

Mr. Diehl's standard microvolter

WILLIAM F. DIEHL calls attention to a typographical error in the labelling of the diagram in Fig. 2 of his article on "A Standard Microvolter" on page 231 of our issue for July, 1932. The letters A and B at the bottom of the curve should be reversed in relation to the lines of figures.

Photocells from rectifier disks

[*Continued from page 313*]

For convenience in measuring, the cell is mounted on a piece of Micarta as shown in Fig. 4. Contact is made to the bare copper by means of a lead washer, while contact to the silver is made through a concentric metal

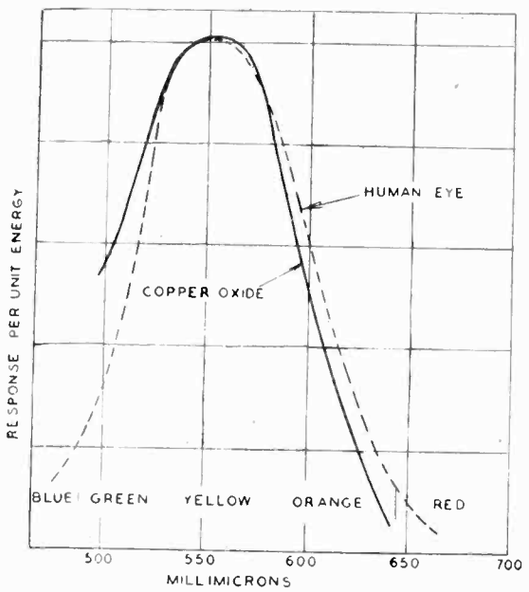


Fig. 8—Color curve of copper oxide cell compared to that of the human eye

washer. The copper will be positive and the silver negative. Using a meter of about 30 ohms resistance, it should be easy to generate a 1.0-ma. current by holding the cell close to a 100-watt lamp. In direct sunlight several milliamperes will flow. By using a meter of 3 ohms resistance, the writer obtained 10 ma. from one cell in direct sunlight.

For a given illumination, the amount of current which will flow in the meter circuit depends greatly upon the external resistance. Figure 5 shows a family of curves for various load resistances and various illuminations up to 50 lumens from a projection lamp. For this typical cell, the short-circuit sensitivity is seen to be about 0.1 milliampere per lumen.

Because the cell is a direct converter of radiant energy into electrical energy, it is of interest to investigate its actual optimum power output. This can be plotted by calculation from the curves of Fig. 5. The resulting power-load curve shown in Fig. 6 indicates that optimum output results for a resistance of about 100 ohms. One of the best cells having an area of 1.2 square inches delivered 3 ma. in direct sunlight through 100 ohms. This corresponds to a power output of 0.75 milliwatt per square inch or about 1 watt per square yard.

While the short-circuit current is linear with respect to illumination, it may be seen from Fig. 7 that the open-circuit voltage is not linear. This curve was obtained by plotting the potential drop across a load resistance of 100,000 ohms.

The color curve in Fig. 8 illustrates why these cells respond better to daylight than to lamplight. Most of the response is for wavelengths shorter than 650 millimicrons. A lamp emits most of its energy at longer wavelengths. If the color response could be shifted bodily over into the near infra-red, the current output would be enormously increased.

Simply connected to a low-resistance meter, these cells even now made good indicators of light intensity. When the power output is increased about 100 times and the stability is retained, cuprous-oxide cells will afford other types of light sensitive devices a very uncomfortable competition.

▼ ▼ ▼

Patent problems in the field of electronics

[*Continued from page 307*]

hinged on the side to the place surface of the plane.

In order to have the freest market for the widest possible use of electronic tools the manufacturer must have a close control over his own designers, engineers and executives as well as his employees. Many of the disputes over invention which have been repeatedly developed in industry have arisen from the fact that no contract was provided between the owner of the designs, the executives and employees relative to who should own the inventions. Generally speaking, the manufacturer has no right other than a mere shop right, which can be lost upon moving the shop, to inventions of his employees and executives unless they are especially hired for the purpose of inventing. As most of the most valuable inventions come from other departments of the business than from the few men especially hired to do development work, heavy losses often have been incurred and much litigation resulted through a failure to have a clear understanding of the ownership of such developments.

Probably the most important and troublesome question is the question of infringement. Fortunately, there is a way to determine this that is reasonably satisfactory. The United States Patent Office has provided a complete file of all issued patents. A competent searcher can pick out all those patents that are unexpired which may be infringed by a comparison of the apparatus under consideration with the claims of those patents.

In that way, it can be readily determined whether the combination of those claims is found in the apparatus. If it is, then there is infringement. If this is found out in time, necessary changes to avoid infringement can usually be made. Infringement only becomes serious and dangerous when such a check is not made and it is allowed to run on over a period until a large liabilitiy for profits and damages has accumulated.

It is also wise, if any development work has to be done in the plant of the customer, that a provision be made for the customer and his men not laying claim to any invention made while the work was being done.

In short, a clear understanding by way of contract in writing before the development work starts is the surest road of keeping out of Court. The companion rule is to find out whether what you are doing belongs to someone else before you start. The patent system receives a great deal of complaining comment, which is due to the neglect of the complainants not taking ordinary precautions in accordance with the rules of the system. If they would do so, they would find that such precautions would keep them out of difficulties with the patent system and they would find it to be a very ready instrument for profit and protection.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Sound-picture equipment

WITH THE PURCHASE of the Q.R.S. DeVry Corporation by Herman A. DeVry, Inc., the latter company moves to its former location, taking over the building at 1111 Center Street, Chicago, which Mr. DeVry built to house his company in 1922, and will also increase its manufacturing schedule into new lines. Besides the DeVry sound-on-film projector used in modern selling and teaching, the corporation will manufacture sound-heads for theatrical machines, amplifiers, public address systems and a recently developed 35-mm sound camera complete with amplifier to sell at a popular price.

New developments are also planned in the 16 mm. field.—*Electronics, October, 1932.*

✦

Radio convenience outlets

THE COMPLETE YAXLEY LINE of radio convenience outlets for radio and public-address installations in single and multiple gang combinations, with selector switches and volume controls included, are described in a new bulletin just published by Yaxley Manufacturing Company, Indianapolis, Ind., (a division of P. R. Mallory & Company). A wide range of designs is available from which can be made almost every conceivable combination. The Yaxley portable control used at The Hague Peace Conference and Geneva League of Nations Conference is one of the new features illustrated.

The complete new line of Yaxley rheostats, potentiometers and volume controls and a replacement manual giving the right replacement control for each type set, are shown in another bulletin, Form S-18, which gives illustrations, dimensional drawings, resistance in ohms, carrying capacity in amperes and price, for each product.—*Electronics, October, 1932.*

✦

Two-stage vacuum pump

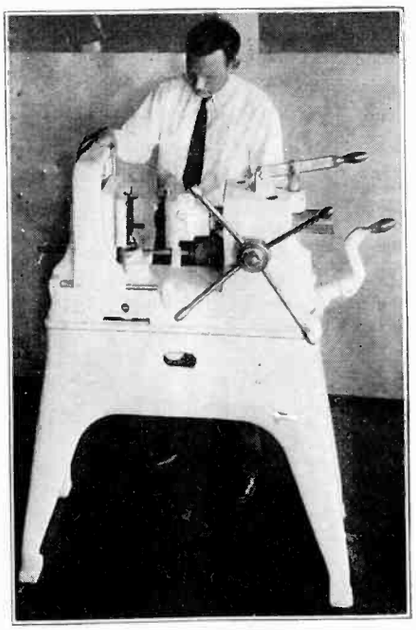
W. M. WELCH MANUFACTURING COMPANY, 1515 Sedgwick St., Chicago, Ill., is putting on the market a new high-vacuum pump of the Wegner two-stage type.

In the development of the single-stage Wegner vacuum pumps the Welch company has been able to produce a movement which, by careful machine methods, will provide a routine vacuum of 0.005 mm. of mercury. Upon receiving repeated requests for a pump of larger capacity and lower vacuum but with the same durability the company has now produced a two-stage pump with the same type of movement but with larger rotor and stator. By exercising extreme care in grinding and lapping so that a high speed can be maintained without excessive heating, the pump has been found to produce a vaccum better that 0.00001 mm. mercury.—*Electronics, October, 1932.*

✦

Die-casting machine

THE MADISON-KIPP CORPORATION, Madison, Wis., announces a new small die-casting machine known as Kipp-Caster No. 11—"The Mechanical Foundry." Some of its interesting features are its small size; its ability to handle all common die casting alloys including the comparatively new metal magnesium; its quick die-changing arrangement; its convertability into a permanent-mold

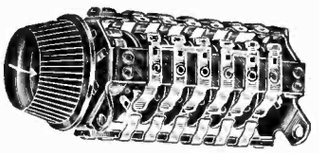


machine for casting brass; and its simplicity of operation which requires no previous training or skill in the art of die casting.

To convert this pressure die-casting machine into a permanent mold machine for gravity-casting brass, one adjustment screw is turned which causes the metal well to remain stationary in its lowered position. The metal plunger and plunger handle remain inoperative, but the die is closed and opened the same as for pressure casting and core pulls and casting ejection are automatic.—*Electronics, October, 1932.*

Short-wave switch

INCREASING POPULARITY of multi-wave-band radio receivers has created a serious design problem for receiver manufacturers due to the critical electrical and mechanical requirements of a multi-polar, multi-position switch suitable for the high-frequency circuits.



For such short-wave use, the H. H. Eby Company, 22nd St. and Lehigh Ave., Philadelphia, Pa., has developed a switch of ingenious design which has resulted in the following points of superiority: Sturdy construction permitting "ganging" of a number of units; compactness, permitting switches of the most intricate circuits in the smallest possible space, flexibility, providing any variety of circuit arrangements and contact sequences desired; negligible capacitance effects, low contact resistance, common ground connection of shaft, and plates, and all electrically inactive metal parts; smooth action and positive alignment.—*Electronics, October, 1932.*

✦

Paper tubing

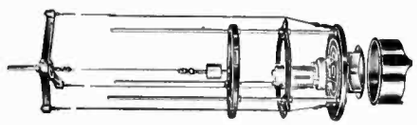
PAPER TUBING OF ALL SHAPES for coil winding is now manufactured by The Paper Tube Company, 1718 N. Damen Ave., Chicago, Ill. Automatic machinery permits production to very close limits, with wall thickness to specifications offering a complete tube service to all winders, insuring accuracy, strength and uniform coil cores.

Over 200 stock sizes are made, including all shapes—square, rectangular, round, also square with rounded corners.

This tubing is built up layer by layer, with each lamination securely cemented to the next. It is spiral wrapped in a diagonal manner giving side walls greatest strength. The stock used is manufactured according to most rigid specifications and under a special process during which magnetic extractors remove mineral and metallic matter. Likewise, the cementing materials are carefully selected. This tubing carries a high dielectric test, is of uniform strength and is very rigid, free from blisters and has proven to be most economical for coil cores—*Electronics, October, 1932.*

Galvanometer suspension

THE NEW GALVANOMETER SUSPENSION of the G-M Laboratories, 1735 Belmont Ave., Chicago, fills a very urgent need among laboratories located in factories, along car tracks and railroads, or near buildings housing heavy engines and machinery. In such locations it has heretofore been virtually impossible to obtain stable galvanometer readings for accurate measurement, and many laboratories in such locations have been forced to make galvanometer measurements only at night. This new unit



overcomes such difficulties, and even when attached to a ceiling which also supports heavy vibrating machinery, galvanometers of 1,100-megohm sensitivity have a perfectly stable index line on a scale nine meters distant.

When correctly adjusted, vibrations transmitted to the supporting tripod travel down the three wires in phase and result only in a slight raising or lowering of the unit. The oil pan and vanes underneath the bottom plates in turn effectively damp vertical or lateral movements and prevent the suspension from being unduly affected by air currents or by touching the unit with the hands.

Further information is contained in the manufacturer's bulletin No. 149.—*Electronics, October, 1932.*

✦

Insulators for radio antenna towers

THE LAPP INSULATOR COMPANY, Le Roy, N. Y., has developed its compression-type cone insulators particularly for use in insulating radio antenna towers. High-quality porcelain when formed into truncated cones of the proper shape, correctly mounted and confined in steel retaining cups and loaded in compression, develops extraordinarily high strength, — approximately twenty times its tensile strength. The porcelain used is made by the vacuum process, developed exclusively by the Lapp company, and use is made of the company's 1,250,000-lb. testing machine and of its complete high frequency laboratory for design and proof testing. More than 2,000 of the insulator units are now in use, without any record of failure. Many of the outstanding broadcasting stations are equipped with these insulators, including the new vertical antenna of WABC, the towers of WENR, WBZ, etc., and also airway beacon towers.—*Electronics, October, 1932.*

Power units for broadcast amplifiers

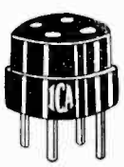
THE DELTA MANUFACTURING COMPANY, 39 Osborne St., Cambridge, Mass., manufacturer of transformers, choke-coils, amplifiers, voltage regulators, photo-electric cell devices, and custom windings, has developed a new Delta rectified alternating-current power supply unit designed to excite the filaments for all types of broadcast amplifiers. In addition they will also supply direct current for operating relays, signal lights, and other accessory equipment. The company calls attention to the superiority of this method of excitation over batteries or rotating machinery in that replacement expense and maintenance expense are negligible. Its use is superior to a.c. filament excitation in high-gain amplifiers in that it permits full frequency coverage without compromise to suppress line-frequency components in the output. The units are available in the following outputs of 15-volt direct current 5 amp.; 7.5 amp.; 10 amp. and 15 amp.—all with minus-100 decibel ripple. Larger units for three-phase supply can be supplied upon specification.—*Electronics, October, 1932.*

✦

Adapters for modernizing sets and testers

IN ORDER TO PERMIT the utilization in older model radio sets and set analyzers of the many new tubes which have recently made their apearance, Insuline Corporation of America, 35 Park Place, New York City, has developed a complete line of ingenious adapters.

Since most of the radio receivers now in general use which employ variable-mu tubes are designed for '35 and '51 tubes, a special type '58 tube adapter, known as model 1701, has been produced, which permits the new '58 tube to be substituted without fuss or bother. In fact, no technical knowledge is necessary to apply any of the I.C.A. adapters. The '58 is a variable-mu r.f. pentode and because of its special long "cut-off" characteristic and certain other important features, it gives much better results than the '35 type tube.



In addition to the adapters described above, test adapters are also available to enable the service man to keep his tube testers, analyzers, etc., up to the minute. I.C.A. test adapters are made for all the latest type tubes including the '57, '58, PZH, Wunderlich, Duo-Diode, '41, '42, '43, '46, '82 and many others.—*Electronics, October, 1932.*

Remote-control switch

ZENITH ELECTRIC COMPANY, 537 S. Dearborn St., Chicago, has developed a new remote control switch, which is mechanically held, with three-wire control.

A simple toggle arrangement allows it to be held in a closed position by the compression of the heavy laminated copper brushes.

Levers actuated by solenoid spread the switch arms into closed position. As levers are forced past a center, they are held against a bumper until the opening coil pulls the arms into the off position.

The construction gives accessibility of all parts. Any part of the switch can be inspected without dismantling. The switch is very compact, being only 3½ inches deep. The panel is of ebony asbestos.—*Electronics, October, 1932.*

✦

Photoelectric target practice

F. V. L. SMITH, 142 Liberty St., New York City, has developed a game based on the photo-electric cell, which he calls the "Death Ray and Electric Eye."

It consists of a Weston Photronic relay concealed behind a reproduction of an eye, the transparent pupil of which constitutes the bulls-eye of a target. A special gun or pistol is used to actuate the device. When the trigger is pressed, a single flash of light is projected from the gun if the latter is sighted correctly upon the bulls-eye, the cell will be energized, thus operating the sensitive relay. This in turn draws up the contact arm of a power relay, closing contacts which cause a large electric gong to ring.

Of course, lights, sound effects, numbers or any other indicating devices may be substituted for the gong. A mechanical counter may also be employed to count the number of shots "fired."—*Electronics, October, 1932.*

✦

Operation recorder

THE PRACTICAL INSTRUMENT COMPANY, 2717 North Ashland Ave., Chicago, has developed clock-driven timing recorders and recording thermometers primarily for checking electric refrigerator performance, but adaptable for giving records of other "on-and-off" operations of electrical circuits, temperature conditions, etc.

Designed for practical field use, rather than laboratory conditions, the apparatus is rugged, and the charts can be quickly changed. A sturdy 36-hour New Haven clock drives the chart; the pen is of non-clogging nickel-silver. The bakelite case has space for ink bottle and 25 of the four-inch charts. Motor circuits up to one-half horsepower, either a.c. or d.c., can be recorded. The operation recorder is priced at $35 and the temperature recorder, $30.—*Electronics, October, 1932.*

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Oscillation, Generation, Detection, Etc.

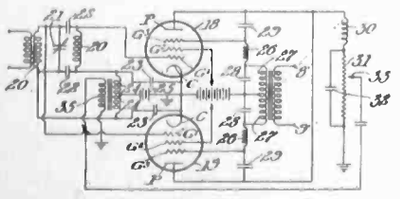
Carrier suppression modulation. Method of increasing the output of energy of beat frequencies and diminishing the output of energy of input frequencies which includes over-neutralizing the carrier suppression modulator in order to provide positive regeneration of the beat frequencies and positive degeneration of an input frequency. G. L. Usselman, assigned to R. C. A. No. 1,876,107.

Frequency regulating system. A control means responsive to changes in frequencies associated with the generator, comprising a saturated inductance coil coupled to the generator output and a variable condenser inserted in the generator output, and a magnet having a winding coupled to the saturated coil and an armature connected to an armature of the condenser. H. Chireix, Paris, France. No. 1,875,329.

Hum neutralizing system. System operating a tetrode with pulsating direct current for screen and plate in such a manner that a continuous smooth anode current is produced. E. R. Hentschel, assigned to Wired Radio Inc. No. 1,877,128. See also No. 1,877,129.

Centralized radio. A system for transmitting sound carrying current from a central station to distantly located dynamic loud speakers. L. O. Painter and H. L. Johnson assigned to Program Service Co., St. Paul, Minn. No. 1,877,034.

Duo-diode circuit. Method of combining in a single tube the diode rectifier and input and output amplifier circuits. K. C. Black, assigned to R. C. A. No. 1,876,841.



Interstage coupling system. Method of amplifying a wide range of frequencies by shunting the primary of an audio transformer by a condenser and placing between the primary and the plate of a tube an inductance. The condenser and inductance have values such that the resonant frequencies determined by them exceed the leakage resonance frequency of the transformer and the ratio between the ohmic resistance and inductance considering the internal resistance of the tube is less than unity for the resonant frequency. P. R. Dyksterhuis, assigned to R. C. A. No. 1,876,645.

Linear detection. Method of operating a radio receiving system suitable for the reception of modulated carrier wave signals including a demodulator characterized by the fact that over a substantial range of impressed voltages, the relation between the impressed voltage and the output current is substantially linear which comprises amplifying received signal voltages to values within said range of linear response and impressing them upon the demodulator. Stuart Ballantine, and L. M. Hull, assigned to R. C. A. Re-issue. No. 18,579.

Constant frequency generator. Comprises a mechanical element having a natural period of vibration, means for vibrating it and for heating it at intervals spaced apart by a period of time proportional to a predetermined number of vibrations. Frank Conrad, assigned to Westinghouse E. & M. Co. No. 1,872,896.

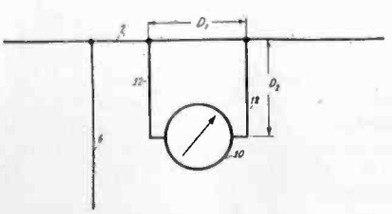
Synchronizing systems. Method of using an electric arc discharge device for maintaining the rotation of a body in synchronism. A. J. Maddock, assigned to G. E. Co. No. 1,874,774.

Frequency modulation. Method of varying the natural frequency at which a piezo-electric crystal vibrates in order to obtain frequency modulated energy by continuously varying the pressure of the medium surrounding the crystal in accordance with signal modulated energy. C. W. Hansell, assigned to R. C. A. No. 1,874,982.

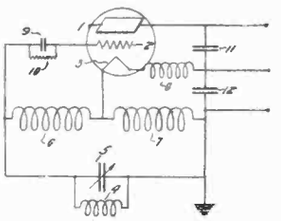
Voltage regulator. An inertialess voltage regulator for d.c. comprising a discharge device, a cathode-anode circuit in series with the supply circuit and a second tube so that the impedence of the first triode is varied in its response to the load but in an inverse sense. C. W. Hansell, assigned to R. C. A. No. 1,874,981.

Piezo-electric crystal circuit. Method of reducing the wear of a crystal by keeping it from contact with its electrodes by passing a stream of gas between the crystal and the electrodes. C. W. Hansell, assigned to R. C. A. No. 1,874,980.

High-frequency meter connection. An antenna fed by a transmission line, has an antenna meter located just outside of the transmission line coupling on the antenna and coupled in shunt with a portion thereof by means of short pieces of linear conductors of them having a definite relation to the lengths of the joint portion of said antenna for effecting calibration of meter for total current. C. W. Hansell, assigned to R. C. A. No. 1,874,977.



Constant-frequency oscillator. Method of using a small inductance and large capacity as a tank circuit so that stray capacities in the associated circuits are negligible in effect. C. D. Barbulesco, Dayton, Ohio. No. 1,874,222.



Controlled-rectifier circuit. Means for establishing control of a controlled rectifier at any predetermined instant within the conducting half-cycle of alternating currents. Aram Boyajian, assigned to G. E. Co. No. 1,866,343.

Harmonic suppression. Apparatus for counteracting harmonics in the output of rectifiers. Edouard Aubort, assigned to Brown Boveri & Cie, Baden, Switzerland. No. 1,873,952.

Compression and expansion of energy level. Transmission circuit method of compressing and expanding a range of energy levels on a transmission circuit. L. C. Roberts, assigned to A. T. & T. Co. Nos. 1,875,156 and 1,875,157.

Filter. A low-pass filter connected between a transmitter and an antenna, with a cutoff frequency above the fundamental and below the first harmonic. P. S. Carter, assigned to RCA., No. 1,866,525.

Stabilized amplifier. A Rice-stabilized amplifier in which a tuning condenser is in two sections with the center point connected to ground through a resistance. H. F. Elliott, assigned to RCA., No. 1,868,162.

Convertible band pass circuit. A pair of tuned circuits, disposed to transmit a constant band width throughout a given frequency range and additional means common to both circuits for controlling the band width characteristic. Alexander Meissner, assigned to Telefunken, No. 1,872,318.

Radio Applications

Signalling system. Generating a master oscillation and a rotating field with the oscillation rotating an element in the field to produce a second oscillation of different frequency and transmitting both oscillations. F. E. Terman, Stanford University, Cal. No. 1,858,349.

Signalling system. A method of radiating low frequency signal by modulating high frequency energy with it, including varying the amplification of the low frequency signal so that the average per cent of modulation of the high frequency energy shall remain substantially constant, and simultaneously reactively varying the strength of the energy radiated, in a manner opposite in sense relation to the manner in which amplification of the low frequency signal is varied. W. V. B. Roberts, assigned to RCA. No. 1,858,810.

Wide-band amplifier. A link circuit is connected between the output of one tube and the input of another, with a circuit comprised of three tightly-coupled cascaded resonant circuits, of which two have the same resonant frequency and the third a different frequency, so that amplification may be secured over a wide band. C. T. Jacobs, assigned to T. A. Edison, Inc., No. 1,867,746.

Coupling circuit. A method of coupling vacuum tubes together, with a network which reduces to zero transfer of energy from the output to the input section, and which transfers energy at a uniformly high degree of stable amplification. H. A. Wheeler, assigned to Hazeltine Corp., No. 1,868,155.

Detector circuit. A circuit for rectifying a modulated carrier wave signal in a double-grid tube. K. C. Black, assigned to RCA., No. 1,869,089.

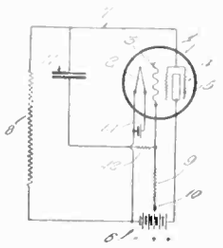
Oscillation generator. A method of maintaining in operation a spare crystal and for switching it into the circuit of a generator without affecting the amplitude of vibration. C. F. P. Rose, assigned to B. T. L., No 1,869,171

Broad-band amplifier The input of one push-pull tube is coupled conventionally to the output of a previous tube, but the input of the second tube has some coupling back to the plate circuit of the previous tube, so that a wider frequency band is accommodated. E. Z. Lane, assigned to A. T. & T. Co., No. 1,868,579.

Vapor electric circuit. Circuit for liquid electrode electron tube. No. 1,869,207. H. M. Martin and No. 1,870,022, D. C. Prince, both to G. E. Co.

Control apparatus. Two tube arrangement and a third tube in series with the second tube and cathode for controlling the bias on the second tube between predetermined negative and positive values. K. C. Black, assigned to RCA, No. 1,869,536.

Relaxation circuit oscillator. A resistance is connected from the filament to the screen, and a capacity from screen to control grid, which is maintained at a positive potential with respect to the filament. R. M. Page, Washington, D. C., No. 1,869,500.



Electronics Applications

Motion study. Method of determining distortion due to high speed motion by a stroboscopic method. L. L. Beck, assigned to Claude Neon Lights, Inc. No. 1,877,713.

Electrical musical instrument. A group of oscillators designed to generate frequencies as required for musical tones, sources of potential and methods for preventing key-thumps. R. C. Hitchcock, assigned to W. E. & M. Co. No. 1,877,317.

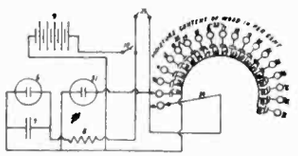
Power converting system. Method and apparatus for converting d.c. into a.c. using vapor electric valves. C. H. Willis, assigned to G. E. Co. No. 1,873,802.

Variable capacitor test. Method of testing uniformity and capacity between the units of a multi-unit condenser. Virgil M. Graham, assigned to Stromberg-Carlson. No. 1,873,704.

Electric regulator. Combination of an a.c. machine, push-pull triodes and rectifying apparatus. H. R. Crago, assigned to G. E. Co. No. 1,872,681.

Train control system. Apparatus using grid controlled gaseous rectifier tubes. A. G. Williamson, assigned to Union Switch & Signal Co. No. 1,866,070. Also No. 1,865,150 to A. J. Sorensen, assigned to Union Switch & Signal Co.

Moisture indicating instrument. Method using a neon glow tube for indicating the moisture content of wood. C. G. Suits and M. E. Dunlap, dedicated to the free use of the government and the public. No. 1,875,359.



Meter testing circuit. A stroboscopic watt-hour meter test, patent No. 1,864,677, to H. P. Sparkes, and a photo-electric method No. 1,864,627 to Samuel Aronoff, both assigned to W. E. & M. Co.

Determination of speed of a vessel. The use of ultra-audible waves in a direction other than the vertical and observation of the changes in frequency occurring according to Döpplers principle. Constantin Chilowsky, Paris, France. No. 1,864,638.

High-frequency synchroscope. Method of determining the phase displacements between currents of two frequencies comprising generating light waves with each of said frequencies, forming interference patterns and detecting the appearance and disappearance of said interference patterns. A. M. Nicholson, assigned to Communication Patents, Inc. No. 1,864,753.

Method of calibrating electrical instruments. A stroboscopic method. H. P. Sparkes, assigned to W. E. & M. Co. No. 1,864,771.

Electrooptical system. The combination of photo-electric cell and triode amplifier. F. W. Reynolds, assigned to A. T. & T. Co. No. 1,864,670.

Train control apparatus. Method using rectifiers, amplifiers, and relays. D. H. Schweyer, No. 1,875,942. Easton.

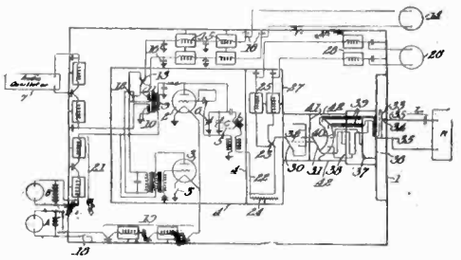
Photo-sensitive device. Combination of photo-cells and triode amplifiers. J. W. Dawson, assigned to W. E. & M. Co. No. 1,877,279.

Electric flashlight. Method of using a luminescent discharge tube, rectifiers, condensers, etc., so that the flashes take place at predetermined intervals of time. D. P. Kayser, Paris, France. No. 1,876,058.

Phase failure and phase reversal protective system. Method using a grid-controlled gaseous rectifier. C. Stansbury and G. C. Brown, assigned to Cutler-Hammer, Inc. No. 1,876,436.

Elevator control. Method of using photocells for the control of an elevator. H. W. Mattingly, assigned to W. E. & M. Co. No. 1,865,937.

Standard signal generator. Generator and attenuator circuits. M., assigned to R. C. A. No. 1,877,287.



Adjudicated Patents

(C. C. A. N. Y.) Hazeltine patent, No. 1,533,858, for method and means for neutralizing capacity coupling in audions, claims 1, 2, 5, 9, 11, 12, 14, and 16 Held valid and infringed. Hazeltine Corporation v. Radio Corporation of America, 59 F. (2d) 203.

(C. C. A. Ill.) Edelman patent, No. 1,680,370, for radio power-supply unit, claims 1-3 Held invalid. Hartman Furniture & Carpet Co. v. Banning, 59 F. (2d) 129.

(C. C. A. Ill.) Edelman patent, No. 1,682,492, for radio battery eliminator, claim 3 Held valid and infringed, claim 4 Held not infringed. Id.

1,231,764, F. Lowenstein, Telephone relay; 1,426,754, R. C. Mathes, Circuits for electron discharge devices; 1,128,292, E. H. Colpitts, Electric wave amplifier; 1,504,537, H. D. Arnold, Power limiting amplifying device, C. C. A., 2d Cir., Doc.—Western Electric Company, Inc., v. S. Wallerstein. Decree modified (notice Aug. 2, 1932).

Patent Suits

1,271,529, M. C. Hopkins, Acoustic device, filed Apr. 18, 1932, D. C., S. D. N. Y., Doc. E 66/380, Lektophone Corp. v. Crosley Distributing Corp. Same, D. C., E. D. N. Y., Doc. E 6252, Lektophone Corp. v. Bushwick-McPhilbin Corp. Doc. E 6253, Lektophone Corp. v. A. A. Straus, Inc., et al.

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. E. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System of amplifying variable currents; 1,728,879, Rice & Kellogg, Amplifying system, D. C., S. D. Calif. (Los Angeles), Doc. T-75-H, Radio Corp. of America et al. v. May Department Stores Co. Dismissed for want of prosecution Apr. 6, 1932.

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