electronics

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

New styles for radio sets

•

Tubes for detector-output

•

Back to quality in radio

•

Single-tube inverters

•

Manufacturing electron-tube equipment

Photo shows Italian radio plant using American methods

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

APRIL, 1933

Now . . . *Hygrade Sylvania Announces*

A Complete Electronics Department

■ full production facilities ■ leading electronics engineers

FOR more than 30 years, the Hygrade Sylvania Corporation, and its predecessors have supplied the electric light industry with standard lamps of highest quality and uniformity. And since earliest days of radio, this company has pioneered in the development of radio tubes.

Now, with the formation of its new Electronics Department, the Hygrade Sylvania Corporation expands to meet the newer demands of electronics. In addition to lamp bulbs and radio set tubes, this company now produces radio transmitters, transmitter tubes, special receivers, industrial tubes and custom-built electronic devices of every specialized nature.

A technical staff composed of William J. Barkley, General Manager; D. F. Replogle, Chief Engineer; Victor O. Allen, Assistant Chief Engineer; and 22 other electronics engineers and executives, all formerly associated with the DeForest Radio Company; a complete research laboratory fully equipped for any purpose required in the electronic art; and ample production facilities insured by a new fully equipped plant where all electronics work will be coordinated—all of these factors add to the Hygrade Sylvania resources the same skill and knowledge responsible for today's most important commercial applications of electronics.

The Hygrade Sylvania Corporation invites you to avail yourself of its technical experience, and vast production and research facilities. For consultations, write to:

THE HYGRADE SYLVANIA CORPORATION

Electronics Division

64 Lakeview Avenue **Clifton, New Jersey**

Electronics, April, 1933. Vol. 6. No. 4. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

Vol. 6, No. 4. New York, April, 1933

O. H. CALDWELL
Editor

KEITH HENNEY
Associate Editor

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

A Month of Electronic Events

President Roosevelt, in the midst of the banking emergency, changes the whole public psychology by a 13-minute talk over the nationwide radio networks.

A great Atlantic liner talks with a ship below the horizon, by means of a modulated light-beam playing on a distant cloud-bank.

New realism in sound reproduction—three-dimensional "talkies" or telephony—is made possible by binaural or stereoscopic pickup.

An infra-red "fog-eye" locates hot ships' funnels through a naval smokescreen,—in preparation for iceberg detection through fog later this Spring.

To eliminate troublesome fading, KDKA engineers obtain baby blimp to hold antenna aloft to a vertical height of 1500 ft.

Professor Theremin, musical-instrument inventor, now applies "space control" principle to industrial uses, machinery operation, police alarms.

Sodium-vapor lamp installations, with luminous efficiency sixfold that of tungsten, are put in operation in England, Holland, Belgium, Denmark.

Engineers experiment with 8- and 9-prong tubes; on combined detector-output tubes; on two-tube superheterodynes.

A plane takes off in fog in Washington, never sees ground until guided to earth by short-wave landing beam at Newark Airport.

Bergen County Police Hackensack, N. J., install police radio system on 2480 kc., get reports on reception all over state and N. Y.

Leading radio manufacturer produces a four-tube radio receiver, to retail complete with tubes and dynamic speaker, at $12.95. Factory price, $6.40.

WE pick the above at random from the crowded record of electronic happenings in a span of thirty days. These examples show how varied, how potent, and how far-reaching are the changes which the electronic tube is injecting into the world around us.

THE TIME TO RE-STYLE

New outlines, new materials, new arrangements, new conveniences, new colors

AS SPRING days roll around, hundreds of shining, new-styled automobiles are appearing on the American scene. Each such car with its striking new lines so "different" from preceding years' patterns, is exerting throughout its whole town or neighborhood, a subtle and insidious influence to make all earlier models obsolete! As each new car appears in town, watch how restlessness is instilled in even the most conservative households; how in homes where budgets are balanced by the slenderest margins, dinner-table conversation has now veered to the possibility of "turning in the old bus" and getting one of the beautiful new cars.

And there you have an example of the work of the industrial designer. The automobile industry is only one of the fields where styling and new artistic models have been put to work as a powerful lever to move merchandise.

How long before radio manufacturers will apply similar striking new models and radical new designs to make all preceding radio sets obsolete?

So far, the radio industry has made its chief bids for sales with new circuits and tube developments. With technical-sounding big words in the ads, these claims have appeared impressive in print. But all the novelty has been intangible and inside the case, where only a radio engineer could detect it. The new sets have sounded little different, and they have looked little different from year to year. The makers of radio sets have been going on from year to year making models that looked like preceding models. And incidentally they seem to have been models that make little direct appeal to women from the standpoint of external appearance. Radio manufacturers have not yet fully utilized the principle that women do 75 to 90 per cent of all spending and buying for the home. And that therefore "eye value" now becomes of increasing importance if a radio set is to be so designed that the woman of the household will set her heart on having it as a welcome addition to her home interior—instead of considering the radio set as an extraneous, mildly-objectionable object to be suffered, in order that the rest of the family may enjoy the wonderful broadcasts the radio set brings.

Probably no other object or article to which styling and modern industrial re-design can be applied, offers such possibilities for radical new outlines, new forms, and new materials, as does a radio set. It is not limited in shape or substance as is an automobile or a clock. Its control elements and operating mechanism may be disposed at will, for the convenience of the user and the taste of the designer. Externally it may employ a wide range of materials, metals, compounds, compositions, fabrics, lacquers, colors,—as listed on these pages.

Wide influence of Chicago World's Fair

Another factor coming into the design picture this year, is the Chicago "Century of Progress" Exposition, which will open in June. The architectural conception and execution of this whole group of exposition buildings, is of the most modernistic design. Not only will these buildings and exhibits be pictured in every newspaper and magazine throughout six months of 1933, but millions of American citizens in towns large and small, will get out the family automobile and motor to Chicago to see the Exposition for themselves. Indeed it is figured that with 1933 conveyances, the average American home is only about one-tenth as far away from Chicago as it was from the Chicago World's Fair of 1893.

The Chicago exposition this year may be expected therefore to have a tremendous effect on the tastes of people throughout America, even in the small towns and in rural districts. The modernistic outlines of the exposition will definitely affect designs of radios, clocks, plumbing, and many other things. The many thousands

What Re-designing and Re-styling Have Done for Sales in Other Fields

The re-designed Big Ben alarm clock started up Western Clock Company's factories and kept them going during 1932 depression year

New modernistic gas ranges have increased gas-range sales 25 per cent

Macy's drug department, New York, redesigned packages, increased sales 200 per cent

New artistic platform scale of Toledo Scale Company, in 1932 broke ten-years' sales records

Tycos Stormoguide, redesigned along modern lines in 1931, doubled its 1929 boom sales

New Eastman camera, with improved design, has proven camera sensation of Europe and America, despite depression year

Every recent major success in automobile industry can be traced to a new-design idea

Novel attractive preserve jar, justified doubled price, and tripled sales volume.

The new Corona typewriter, introducing improved lines and color, speeded sales

China and glassware, re-designed, have increased pre-depression sales activity

The acousticon, deaf aid, re-designed, immediately doubled sales

AMONG OTHER PRODUCTS now undergoing re-styling are bottles, tools, hardware, office furniture, watches, suspenders, ice-boxes, pencils, sky-scrapers, busses, street-cars, lamps, electrical appliances, safety-razors, gasoline-pumps, radiators, plumbing fixtures.

RADIO SETS IS NOW!

Cabinet designer's job is to give sets new merchandising appeal for 1933 sales

Re-styled, this table barometer has sold twice as fast during depression years, as the old model sold during the 1929 boom

of people who attend, and the many millions who look at the pictures in magazines and rotogravures, are bound to be influenced. It may be expected that an entirely new trend in design of radios and other articles, will become acceptable to the public as it has never been before.

Radio Style Clinic at New York

Such re-styling of radio sets is a matter to be carried out by each radio manufacturer in his own way, in collaboration with designers of his own selection. It would seem desirable to have the radio industry itself hold conferences for the interchange of design ideas, working with the best industrial designers of the country, so that a common direction might be given to the new styling trend, which would make its acceptance easier in the case of individual manufacturers' models.

The first move in this direction was a Radio Style Clinic held at New York City, March 20, under the auspices of the National Alliance of Art and Industry, an organization supported by Rockefeller and Carnegie endowments and individual memberships, and having as its purpose the bringing together of executives in various fields with competent designers and industrial artists. Similar clinics have been held for a number of other industries, and the style influences growing out of these contacts have exerted marked improvements in design and merchandising results in those fields.

This March 20 Radio Style Clinic was attended by a number of radio manufacturers, and by such leading American industrial designers as Henry Dreyfuss, Walter D. Teague, Margaret Dargan, Christoph Castou, Ruth Gerth, Hugo Gnam, Ray Greenleaf, Vahan Hagopian, Gilbert Rohde, Lee Simonson, Marion Taylor, John Vassos, David Wald, J. M. Streng, George E. Ball, L. Walsh and others.

The purpose of the Clinic was to obtain free discussion of the problem of increasing radio-receiver sales through improved external design and artistic appearance. The meeting broke all records for similar clinics, lasting from the luncheon hour of 12:30 until 4:30 p.m. during which time a wide variety of opinions was discussed, and the manufacturers present got from the designers and from merchandisers, some very frank statements and comments regarding present radio models. In this way the radio men in attendance had an opportunity to contact the design people, and to become acquainted with individuals.

Of course, no recommended designs for radio receivers were exhibited, perhaps to the disappointment of some of the radio men present. Obviously, leading designers who are busy with designing in other fields, would not be willing to throw before a public meeting their best ideas for radio-set designs, and of course they would not want to be represented by any designs not their best. The matter of bringing out such designs therefore would seem to be a subject to be handled by individual manufacturers in connection with their own re-styling plans.

The National Alliance of Art and Industry, which has headquarters at the Art Center, 65 East 56th St., New York City., has no designs for radio sets to offer to manufacturers. It is a disinterested clearing house for information regarding designers, design trends, etc., and offers its services to advise radio manufacturers in finding the types of designers they desire. Mr. Alon Bement, director, has invited individual manufacturers to consult with the Alliance in attacking their design problems, and in getting into touch with competent and experienced designers. In the event that a group of radio manufacturers desire to discuss general future trends in radio-cabinet design, it would appear that the Art Alliance, with its facilities, could offer valuable disinterested general guidance.

New materials for re-styling

Products which have been employed in re-designing many other lines

Chromium plate	Inoculated woods
Aluminum	Colored woods
Aluminum colors	Cellulose compounds
Zinc	Acoustic products
Zinc alloys	Leather
Copper	Synthetic leather
Brass	Fabricoid
Bronze	Fabrics
Steel, stainless	Plastics
Steel, laminated	Bakelite
Nickel	Durez
Lead alloys	Plaskon
Tungsten alloys	Lumbreth
Silver trimmings	Glass
Hard woods	Lacquers, paints

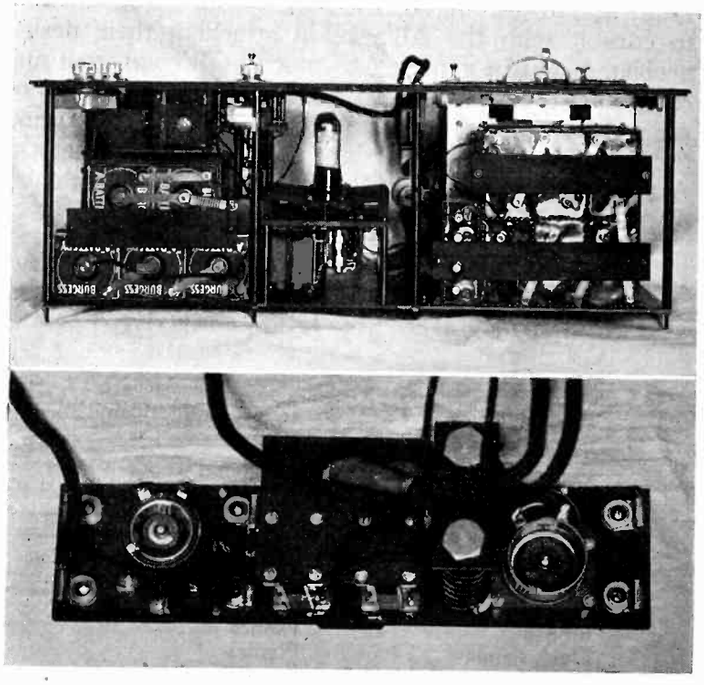
Aids in manufacturing

Electronic apparatus

A RADIO set may appeal for a variety of reasons; it may have convenient controls, extreme sensitivity, excellent fidelity, automatic volume control, compensated audio amplifier, two loudspeakers, and remote control. However, a radio set which is expensive to manufacture will seldom compete seriously, in a quantity market, with a set which is not quite so desirable, but very economical to manufacture. If, in addition, the repairs and replacements needed to maintain the less expensive set over a reasonable period can be effected with a minimum of trouble and expense, the product will have the major features of a success.

There is a close comparison between the electronic apparatus used in industry and the familiar radio set. For industrial apparatus the emphasis should include reliability, and simplicity of maintenance. The three main features may be termed: (1) Utility; (2) Desirable Manufacturing Details, and (3) Simplicity of Repair and Service.

It will be assumed that the engineering work has been done, and that a satisfactory working model has been constructed. This will mean that all leads are properly grouped, shields in place, controls conveniently mounted, and tubes easy to insert. Even after the completion of a working model, there are many problems awaiting the manufacturer. By properly choosing the most desirable of several courses of action, the parts and assembly can be made with a minimum of time, at a reduced labor cost, and with few rejections.



Electro-cardiagraph with cover removed (Westinghouse). An interesting assembly between two panels. Below—the control assembly of an oscillograph

Referring again to the radio set, there are some items which are subjected to mechanical wear; the loudspeaker coil and cone, the volume control, rheostats and potentiometers, tube socket springs, switches, and plugs. These should be chosen, or designed, for ruggedness and ability to stand severe abuse, especially in shipping and handling. The assembly, when packed, should be strong enough to withstand a drop of several feet—as this may be a part of the "baggage smasher's" routine. Intelligent packing is essential, but rugged internal construction is a primary requisite. Before production, an engineer familiar with mechanical principles should go over the model, and provide sufficient bracing, and reinforcing for such parts as may require it.

TOLERANCES Tolerances are an important consideration in assembly and circuit work. By keeping all dimensions within a few thousandths of an inch, absolute interchangeability is assured, but the cost may be greatly increased, due to the shrinkage in passing inspection. For example, if holes are to be drilled, and there is no urgent need for extreme accuracy, a large allowable variation should be specified. Tolerances also apply to materials; the thickness of the material for transformer and condenser cans may be plus or minus several thousandths (depending on how the die is made) without in any way detracting from the proper functioning of the can as a shield and support.

Similarly, the chokes and condensers used in a "brute force" filter do not have to meet very exacting limits, and the proper tests will allow the use of units which are somewhat different in electrical characteristics. The condensers and coils used in a gang-tuned circuit, however, must be held to close limits, to allow the desired "tracking" of the multiple-tuned circuits.

FINISHES The use of expensive finishes for apparatus or parts which are out of sight is seldom justified. A simple rustproofing is usually all that is needed. The advent of cheap cadmium plating has greatly simplified the finishing of steel parts. Sprayed lacquers also are used for this purpose. Spraying can be done on certain partial assemblies where plating is not possible. Some metals, such as aluminum, when used in variable condenser plates, do not require finishing.

Electronic apparatus is likely to become popular in a variety of foreign countries, which may have a different climate from our own. It will therefore be advisable to supply finishes which are permanent under severe extremes of heat, cold, and humidity.

TOOLS AND DIES FOR METAL WORK The manufacture of the small parts which are later to be assembled in the finished product should be given careful attention. If a large quantity is to be made, expensive tools are entirely justified, as the individual cost can thus be greatly reduced. For example, a draw die for making a transformer may cost several hundred dollars, and if ten thousand pieces are to be made, the tool cost per unit will be very low. If this particular can were to be made by hand, the unit cost might be as much as a dollar. Yet if only one hundred were to be made, the

total cost would be only one hundred dollars; not enough to justify the cost of the die.

It may be said that dies are justified when they can liquidate their investment in less than a year, meaning that the expectation is for a reasonably large immediate production of that particular item. The carrying of tool costs over a period of several years is a risk, as changes or improvements may make the tools obsolete. An apt illustration can be drawn from the automotive industry; the expensive body dies are designed to make a single line of car bodies, and are usually obsolete within a year, when a new model is brought out.

DIES FOR MOLDED PARTS Dies for molded parts may not be as expensive as dies for metal work. This means that the use of molded parts does not require the large production which is required for the economical use of metal-working dies. A further advantage of molded parts is the possibility of including fairly intricate parts in the mold, improving the ease of assembly, and reducing the number of parts required. Molded parts, in general, are used for pieces in which the insulation is a feature. Parts having excellent electrical characteristics and resistance to moisture can be made cheaply. Interesting money-saving details can often be included; for example, if several similar pieces are to be made from the same die, the holes may all be spotted, and only those peculiar to the apparatus being made will be drilled. If the minimum die and production cost is desired, it is better to use as few mold parts as possible, and to avoid inserts and threaded parts. Added strength is easily added, thin sections can be reinforced by ribs, and corners provided with fillets.

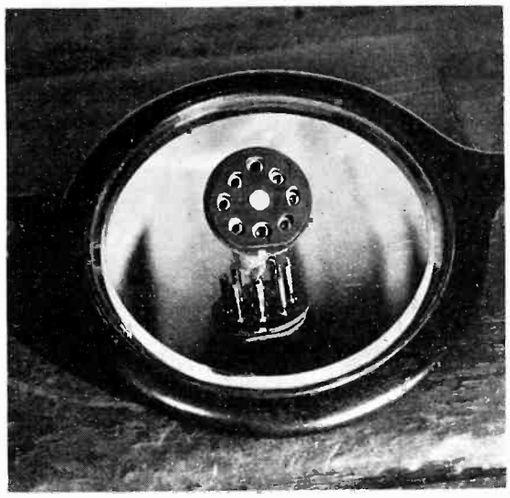
SCREW MACHINE PARTS The set-up cost for an automatic screw machine is not very high, this making it economical for making small round parts in either small or large quantities. Careful design will frequently enable such parts to be made in one multiple operation, a turret head bringing several tools to the work in performing the desired cutting and threading operations. The use of high-speed steel or similar durable tools will enable the manufacture of many pieces without tool grinding. In large quantities, a disk-like tool having the required contour is easily sharpened by simple straight-line grinding. Free-cutting metal which is homogeneous will insure the maximum output from automatic machines.

Testing jigs, or gages, are used periodically to insure the uniformity of the pieces. Here, again, the tolerances should be definitely known, and inspection gages provided for the limits of the allowable variation.

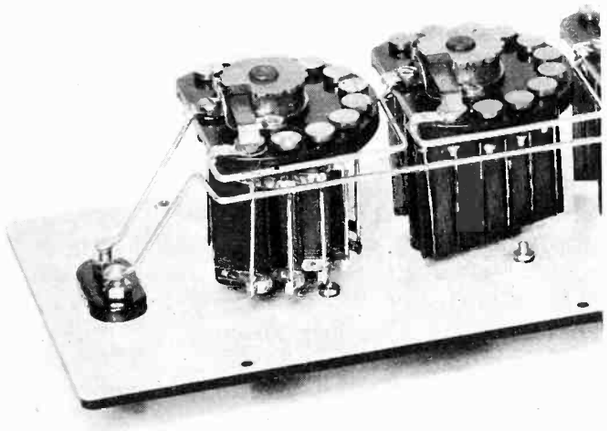
CASTINGS Fairly complicated metal parts can be made cheaply in small quantities by the use of castings. Wooden or metal patterns are suitable for the ordinary sand castings, and the truing up of the cast piece in making a presentable product can frequently be done more cheaply than the assembly and finishing of a similar item fabricated from component metal parts.

Die castings require more elaborate dies and casting procedure, but present an excellent finished appearance with a minimum of work after casting. Die castings can be made accurately to close tolerances, and for small parts they are especially desirable.

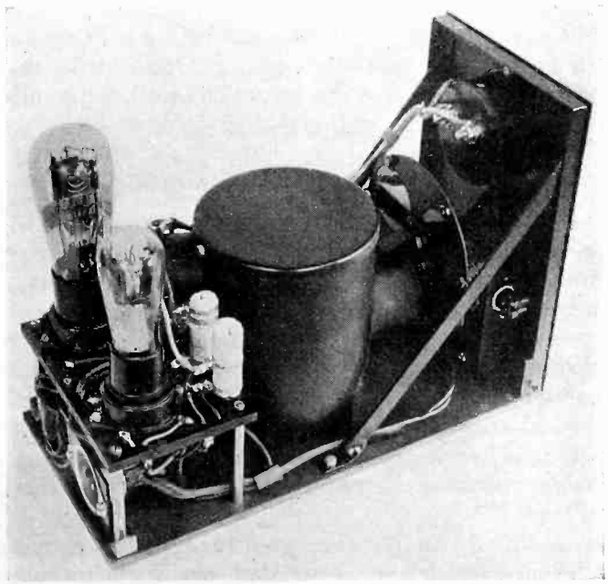
MACHINE TOOL OPERATIONS The use of a milling machine, or planer, usually entails a high set-up cost. To reduce this, jigs can be provided for quickly positioning and clamping the work. (An excellent book, Time and Motion Study by Mogensen, McGraw-Hill Book Company, shows how to ana-



New 8-prong socket for radio tubes under development. The socket is a good example of the use of laminated fiber



Single panel mounting is shown to advantage in this cut of the General Radio resistance box. Note the soldering of terminal connections



A good example of sturdy construction, of the use of bracing and accessibility for wiring. (Westinghouse color matcher)

Typical production line in a radio set factory. (Courtesy of Parker Kalon.) The cover of this issue of *Electronics* was taken in an Italian radio factory, demonstrating the use abroad of American methods of mass production

lyze and improve processes. The following numbers refer to pages in this book.) A kit of all the tools needed for a particular job will also speed up work, by eliminating trips to the tool room, thus avoiding the needless expense of idle machine time.[84]

A drill press is one of the simpler machine tools, and a simple positioning jig will allow its economical use. Multiple drills are justified when large numbers of similar operations are to be performed.

ASSEMBLING APPARATUS The use of "straight-line production" is frequently advocated as an excellent method of assembling a product.[172] This may be taken to mean a moving conveyor from which operators take a partly finished chassis, add their particular item or perform their operation, and then return it to the conveyor. In many cases this general method is excellent, and capable of increasing the speed and facility of assembly. Unless used with an intelligent knowledge of its limitations, however, the use of a long straight conveyor may not be especially desirable. For certain operations the worker may use more time in the removal of the part, and the return, as well as the added effort in these transportations, than is desirable.

Savings by proper process grouping

The main advantage to be gained by the use of a conveyor is a decrease in the transportation of a partial assembly from one operation to the next. This can often be done without a conveyor by strategically grouping consecutive operations, so that upon the completion of one operation the next operator may conveniently obtain the partial assembly.

An ideal arrangement is to have the parts in containers in a circular work place before the operator, so that no extensive reaching is required to collect the desired parts.[46, 63, 100]

Tools already in position greatly expedite assembly. A ratchet screwdriver suspended on a spring within easy reach of the operator eliminates searching and reaching.[77] The release of this tool after use returns it to its former convenient position.

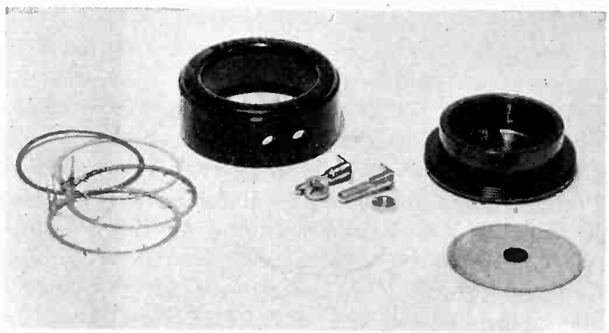
Clamp jigs for eliminating the use of the hand as a "vise" decrease fatigue and increase production, especially when both hands can be usefully employed.[82] Frequently two similar assemblies can be made simultaneously, one with each hand, thus providing symmetry of motion and body balance. The release and "hold" features of the assembly jig can be foot operated.

In making the "delivery" after completion as simple as possible, time and effort is saved. A drop delivery is one in which the operator releases the item from the assembly jig, the piece falling into a chute; which can be of canvas for fragile parts,[36] the pieces being transported for further operations, or collected for temporary storage.

STORAGE AND INSPECTION Temporary storage of partial assemblies may be needed when such items are parts of similar outfits, and set-up time is saved by making up a large quantity at one time.

Inspection of partial assemblies, especially of parts which may be subject to shrinkage, is very desirable. Parts such as resistors, switches, transformers, coils, etc., should be checked for electrical characteristics, both before and after assembly.

REPAIR AND SERVICE DETAILS Some details which improve the ease of servicing, also apply directly to the assembly and design features. Much of the ease of such repair work can be built into the apparatus by careful planning and simplifies the assembly.



Moulded case of Weston Photronic cell. Moulded material enters widely into modern construction

An important feature is the accessibility of each individual item for replacement or repair. This is most easily accomplished when a single mounting base is provided, and no units placed in such a way as to cover other units. As examples, the power transformer and condenser block should be easily removable. The use of rivets is fairly simple in assembly, but the use of self-tapping screws is also a good assembly arrangement, and greatly helps the serviceman. The use of lock washers and screws is desirable for parts where vibration is encountered, such as in loudspeakers, yet the dissembly feature is retained.

Potentiometers and variable resistors can be obtained for single-hole mounting, concentric with the operating shaft, and are easy to remove, and reassemble.

The use of tinned and numbered terminals on transformers and condenser blocks makes for easier wiring and soldering in the original assembly, and they are very convenient for replacement purposes. Color coded cables are a great help in tracing connections.

Complete "picture diagrams" showing the exact location and color of leads, with the numbered terminals of the component parts allow an average serviceman to render expert and speedy service.

NEW TUBES + +

NEW TUBE MATERIALS

MARCH, like all recent months has been an active period for tube manufacturers. Engineers in both tube and set laboratories are elated at having discovered an old law, that of permutations. Given X elements in a tube, the total number of combinations of these elements into different kinds of tubes is X to the *N*th power, or something like that. These engineers need not feel so happy; the law is old, it might even pay them to look it up. Carried far enough it becomes another old law, that of diminishing returns.

New rectifiers of all types, gaseous and high vacuum, heater and filament-type cathodes, single wave, double wave, double wave with center tap, 6.3-volt heaters, 12.6-volt heaters, the same with center tap, and finally 25-volt heaters—all have been announced recently. The characteristics of some of these tubes will be found below. Several new amplifier hybrids have come out since February *Electronics* when the most recent additions to the tube family were described. These include a 2.5-volt tube of the 75 type, detector-pentodes and a variable-mu r-f pentode.

The limit in complexity of tube types does not seem to have been approached as yet. Conversation with various tube engineers, following the introduction of combination detector-oscillator hybrids, brought forth the article in this issue by Mr. Nelson. This represents experimental work on combined detector-output tubes carried out some time ago and pigeonholed. Present trends are toward smaller and cheaper sets (witness RCA Victor getting into the $6.40 to jobber class for a 4-tube set) engineers are aiming at further and further consolidation of tube functions in one bottle. The detector-power output tube would make possible a three-tube super including rectifier. As evidence that work is going along more complex lines, note the 8-pronged socket on page 91 of this issue.

So much for new tubes. In the meantime the manufacturing departments of the tube plants have not been idle in searching for new materials, new processes, and new methods of reducing costs. As reported in February *Electronics* much work is being done with substitutes for nickel for plate material. For power tubes, carbon plates (National Carbon Company) are being used by at least one company. The ability to dissipate considerable heat and somewhat lower cost than molybdenum indicate that although still in the experimental stage, the use of carbon may come into rather wide acceptance.

For the smaller tubes, i.e. those for use in radio receivers, the new material is "Svea" metal, manufactured by the Swedish Iron and Steel Company. This is a specially prepared grade of iron which by reduction of impurities, elimination of gas, and other special treatment, offers the tube trade a new metal for plates, getter cups and other parts now made solely of nickel. (See *Electronics*, December, 1932, page 379.)

Although manufacturers are showing characteristic caution in not swinging over whole heartedly to the new materials, all of them are experimenting with Svea metal and a number are already in production with it. The first advantage is that of cost, there being an immediate difference in cost, over nickel, in sheet form amounting to as much as 40 per cent on the weight basis and because of lower density there is some further advantage In the form of wire and woven mesh the differential is much less.

NEW RECTIFIER TUBES

Type	Description	Cathode Type	Cathode Voltage	Cathode Current	R.M.S. Volts per Plate	Max. peak inverse Voltage	Average Output M. A.
6Z-3	Half wave	Heater	6.3	0.3	350	1,500	50
6Z-4	Full wave	Heater	6.3	0.3	...	....	..
6Z-5	Full wave	Heater	12.6	...	...	....	..
12Z-3	Half wave	Heater	12.6	0.3	230	....	60
25Z-3	Half wave	Heater	25.0	...	...	....	..

Reports indicate that the iron can be handled about as easily as nickel but that it has a tendency to oxidize, that it may be somewhat easier on forming and stamping dies but probably somewhat more liable to distortion and warpage on subsequent heating. On exhaust, iron heats up more quickly to a certain critical temperature and then more current in the heating coil is required to boost the temperature to the final value. This may call for some changes in exhaust schedules.

If marked economies in manufacture can be secured, iron, or other metal or material, will undoubtedly be used widely, always provided there is no decrease in life or change in characteristics after the tube is in service. For cathodes and filaments it seems totally unsuited. Other parts of the tube will probably not be adaptable to other materials than nickel due to manufacturing and processing difficulties.

NEW AMPLIFIERS AND DETECTORS

Type	Description	Cathode Type	Cathode Volts	Cathode Amps.	Plate Volts	Plate Amp.	Plate Res.	Voltage Grid	Voltage Screen	gn	μ
6C6	Det-Pentode	Heater	6.3	0.3	250	.003	1.5 meg.	—3	100	1225	1500
6D6	Var. Mu-Pentode	Heater	6.3	0.3	250	.082	0.8 meg.	—3	100	1600	1280
2A6	Same as 75 except for 2.5 volt heater.										

Considerations on detector-output tube systems

By J. R. NELSON
Raytheon Production Corporation

RECENT publicity to the possibility of 2-tube superheterodyne[1] receivers involving one of the recently announced oscillator detector tubes and a possible detector-output tube makes it desirable to consider such a tube. This article is devoted to a discussion of some of the possible types of combination tubes for this latter service. It is assumed that a tube of this type would be of use chiefly in small sets where low cost and economy of space are important features. In general it is not to be expected that a combination tube can give results equal to those that could be obtained from separate tubes involving similar elements and the larger cathode areas that could be used in separate tubes. This discussion is theoretical to the extent that it refers chiefly to tubes that are hypothetical and the advisability of whose production is at present, questionable.

Necessity of a new tube

First consider the equivalent circuit of a conventional tube with two internal generators of different frequencies, an internal resistance, and an external resistance. The total current that may be used by the device without distortion will be limited to the steady current of the tube and the voltage that may be built up externally is limited to something less than the B voltage; otherwise considerable distortion will occur. It is thus seen that if we have the two voltages acting in the tube, and one, V_1 is considerably greater than the other V_2, the power which V_2 can deliver to the external load will be small because we cannot eliminate the effect of the V_1. If we use a choke to cut down the current caused by V_1, the effective voltage is reduced, while if we bypass the external load, the current caused by V_1 will be large inside the device thus limiting the current which we can obtain from V_1. If we assume that V_1 (the larger) is the carrier and V_2 (the smaller) is the audio modulation frequency, we may arrive at some estimate of the undistorted power output obtainable with any percentage of modulation. Assume that M is 33 per cent so that V_2 is one-third of V_1. Thus V_1 may be only one-quarter of the value we could use if V_2 were zero. Thus if the power is proportional to the square of the input voltage, the reduction is one-sixteenth. Actually, however we can run up the input voltage above this value so that the reduction will be something less than this.

[1]See *Electronics*, Page 64, March 1933.

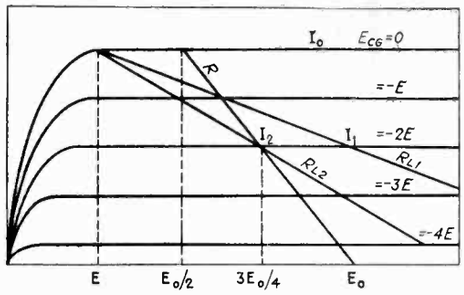


Fig. 1—Plate characteristics, hypothetical duplex control-grid pentode

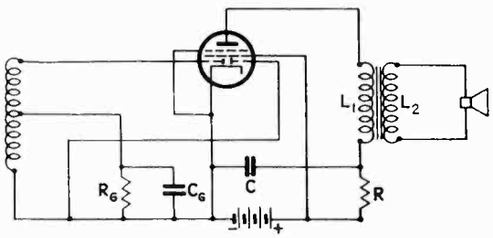


Fig. 2—Circuit diagram for duplex-grid pentode

Four methods of getting around the fundamental limitations in the conventional type of tube suggest themselves. These methods involve ideas already applied to detector and combination detector-amplifier tubes.

1. Twin control-grid pentode amplifier.
2. Combination diode and pentode amplifier.
3. Combination triode and pentode amplifier.
4. Combination diode, triode and pentode amplifier.

Method 1 will be considered first. Assume that the plate characteristics of a pentode having two control grids are given by Fig. 1 when the two grids are tied together. The circuit in which such a tube might be used is given in Fig. 2. The two grids are symmetrical so that the effect of the high frequency is balanced out in the plate circuit. The rectified voltage across R_g and C_g is, however, applied in phase to the two grids so they act as one grid. The reasons for the circuit elements R and C will be explained below.

Twin control-grid pentode

The plate current curve for no signal is represented by the curve for zero bias. If the inductance L_1 has very low resistance and if R is zero the operating point will be I_0 at the voltage E_0 where it is assumed that E_0 is the maximum rated plate voltage. The operating point of the tube is supposedly I_1 at E_0. The power dissipated in the tube will then be approximately twice that for which the tube is designed and the tube would be overloaded. If the resistance R is used so that it intersects the curve for zero bias at $E_0/2$, the d-c wattage in the tube will then be approximately the rated value with no signal.

If a signal is applied which gives a bias of $2E$, the operating point is I_2. The load resistance R_{L2} should be such so that it would intersect the zero curve at E. The power may then be easily found. If a bias $-2E$ could be applied so that R could be made zero, the load resistance could be R_{L1}. As the same current is assumed

in each case, that is, R_{L1} and R_{L2}, both intersect the zero bias curve at the same point, the power will be proportional to the two load resistances. It is thus seen that some reduction of power must occur because it is necessary to use a resistance R as shown in Fig. 2 to limit the power taken by the tube with no signal and hence no bias on the grid. The resistance R although bypassed will obviously reduce the power because it reduces the effective plate voltage.

Theoretically the r-f input voltage swing should not be more than the bias voltage of the tube as an amplifier. For example, consider Fig. 3 where it is assumed that the operating voltage is $-2E$. If enough r-f voltage is used to bring the operating point to $-2E$, the r-f current is cut off in the negative swings while it reaches the value of I_0 on the peak positive swings. If the value of the r-f is increased, the current can decrease no further on the negative swings while it can still increase on the positive swings which would thus cause the average plate current to increase. If we stop at the theoretical limit the power is reduced on the lower percentage of modulation by the ratio of $(M/100)^2$ as we can only realize the full power output with M equal to 100 per cent. In practice we can, however, stand considerable unbalance of plate current so that we can run the power up considerably over the ratio given above.

Experimental results

An experimental tube was made up with two grids to see how much improvement of performance over a regular pentode could be obtained. The improvement was checked by connecting the grids out of phase and then in phase, thus using the same tube in each case. The tube made had rather poor G_m, but the results serve to indicate the improvement that may be obtained against per cent modulation.

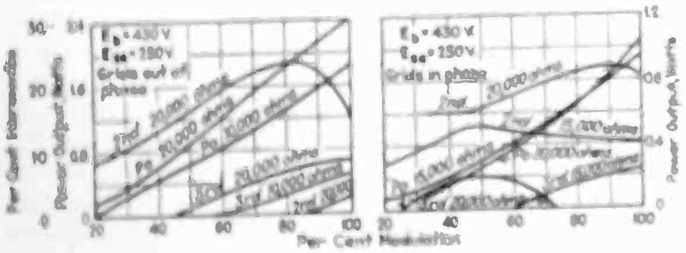


Fig. 3—Power output and distortion of duplex control-grid pentode

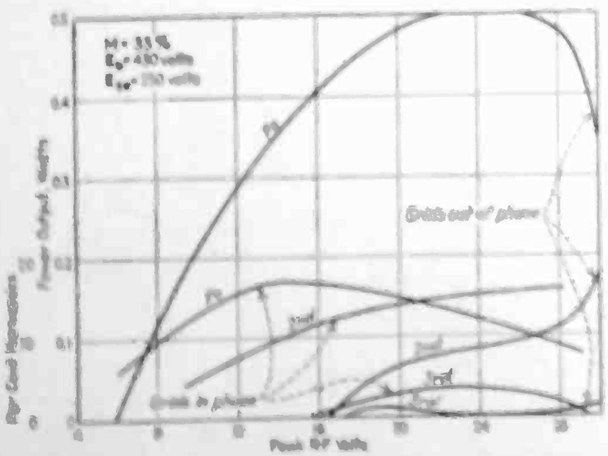


Fig. 4—Output characteristics of duplex control-grid pentode

A circuit similar to Fig. 2 was set up. A carrier frequency of 1,000 kc. which could be modulated any desired percentage was used to supply the input. The results obtained for various modulation percentages using two plate load resistors are shown plotted in Fig. 3. The grids were out of phase in Fig. 3a and in phase in Fig. 3b. In each case about 20,000 ohms was the optimum value of load resistance. It can readily be seen that considerable improvement both as regards maximum output and distortion result when the grids are connected out of phase. The power output was about 2.5 times as much when the grids were in phase. As a matter of interest the power output with an a-f voltage only on the grids was 3.1 watts so that the efficiency for 100 per cent modulation was about 75 per cent.

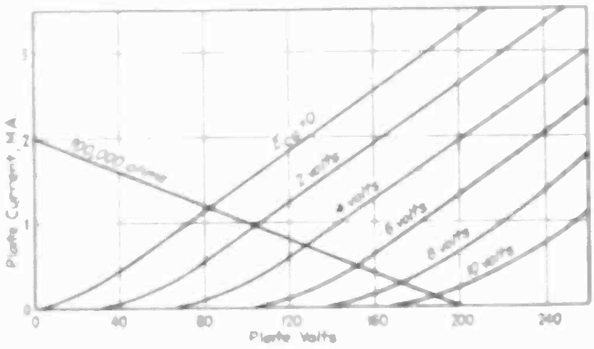


Fig. 5—Plate characteristics of triode section suitable for insertion in pentode structure

Figure 4 shows the results obtained when the modulation was kept constant at 33 per cent and the carrier voltage was varied. Figure 4 shows that considerable improvement is obtained when the grids are connected out of phase over the condition when the grids are connected in phase as shown there. The maximum power with the grids out of phase is about 0.5 of a watt compared with 2.5 watts for 100 per cent modulation. It is thus seen that the maximum power for 33 per cent modulation is about one-fifth that for 100 per cent modulation instead of one-ninth as previously calculated.

Other possibilities

Method 2 is by far the simplest. The pentode section may be biased to its optimum value so that R and C shown in Fig. 2 will not be necessary. The sensitivity will be about the same as that of the twin control-grid pentode tube. The performance to be expected with this tube will follow closely that of a separate diode and pentode so that no discussion will be given for this case.

Method 3 is simple enough in theory as the triode would be used as a detector feeding into the pentode output stage. Figure 5 shows the characteristics of a triode suitable for insertion in the pentode structure. The plate resistance is rather high so that it would not be practical to use iron-cored reactors as transformers in the plate thus making resistance coupling the only practical method of coupling to the pentode input. The gain which can be realized as an audio amplifier is considerable as shown by the 100,000-ohm load line drawn in from 200 volts. However, it would not be practical to work such a tube as a grid circuit detector in this particular application. For example, if we impress a three-volt signal modulated 33 per cent we would have

[Please turn to page 98]

The single-tube thyratron inverter

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

THE single-tube Thyratron inverter in its numerous modifications is so often useful as an electronic tool that a brief consideration of its fundamental operation and a few examples of its operation will be helpful to anyone concerned with electronic devices.

There are two general arrangements of the single-tube inverter, each subject to many variations. Figure 1 shows the first to be considered. Assume switch S_1 to be closed on a direct current source. Since the condenser is discharged, the potential of the cathode d is at the same potential as b and the grid is positive by the voltage b–c. If the critical grid voltage of the tube at this anode potential is less positive than this amount, the tube starts to conduct. The current passes from the positive line through the inductance L, the resistance R_1, the Thyratron T and the condenser C shunted by the resistance R_2, back to the negative line. If R_2 is sufficiently high and R_1 sufficiently low the current will build up rapidly and the voltage across the condenser C will soon equal the line voltage. The current does not cease at this instant, however, due to the inductance L. A certain amount of energy is stored up in the inductance and as the current diminishes, the collapsing flux induces an e.m.f. which causes the current to charge the condenser to a voltage greater than that of the line. If R_1 were zero and R_2 infinity, there would be very little damping of the circuit and the voltage of the condenser C would approach twice line voltage less tube drop when the current finally falls to zero. As a consequence of this overcharging of the condenser, after the current has ceased to flow the cathode d of the tube is more positive than the anode, or the anode is negative with respect to the cathode. Since current cannot pass from the cathode to the anode of the tube, due to its rectifying property, this condition exists until the condenser, discharging through the resistance R_2, has reached line voltage. If the resistance R_2 has been chosen large enough, this allows sufficient time for the tube to deionize so that the grid will be effective. Since the grid is at the potential c and the cathode at condenser potential, the grid is sufficiently negative to prevent the tube from conducting when forward voltage reappears until the condenser has continued its discharge to a point where the cathode and grid are separated in potential by the critical grid voltage. At this point conduction is again initiated and the cycle is repeated indefinitely. This overcharging of the condenser which permits the tube to "commutate" cannot be too strongly emphasized, because it is impossible with the ordinary Thyratron tube for the grid to regain control with ionization in the tube unless excessive grid power is employed.

Figure 2 shows the other fundamental arrangement of the single-tube inverter. In this case, when the switch is closed, the cathode is practically at anode potential since the condenser charge is zero and the grid is negative by the amount of a–c. Therefore, the tube remains nonconducting while the condenser is charged up through the resistance R_2 until the cathode potential of the tube has fallen to such a value that the grid-cathode potential is equal to the critical grid voltage of the tube. Then the tube conducts, the condenser discharging through the inductance L, the resistance R_1 and the tube. In the same manner as described in the first circuit, the condenser is first discharged and then over-discharged, or charged in the reverse potential due to the energy stored in the inductance L. This again throws the anode of the tube negative, affording time for deionization as the condenser is first discharged and then recharged in the original direction through the resistance R_2.

Comparison of two inverters

Figure 3a shows an actual oscillogram of the first type of inverter operating one-third the frequency of the 60-cycle timing wave. The input current through the resistance R_2 is shown, as well as the anode voltage, the latter clearly showing the deionization time available for the Thyratron tube. Figure 3b shows the operation of the second type of inverter under similar conditions. It will be seen that in the first type of inverter the condenser is rapidly charged through the tube and slowly discharged through the resistance R_2 and in the second type the condenser is slowly charged through the resistance R_2 and quickly discharged through the tube.

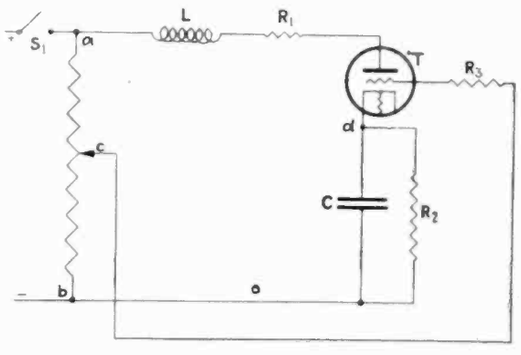


Fig. 1—Fundamental circuit for single-tube inverter

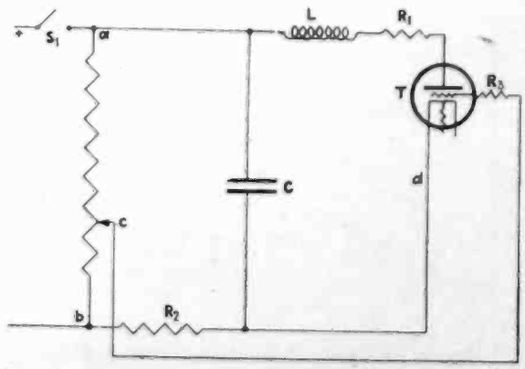


Fig. 2—Variation of fundamental inverter circuit

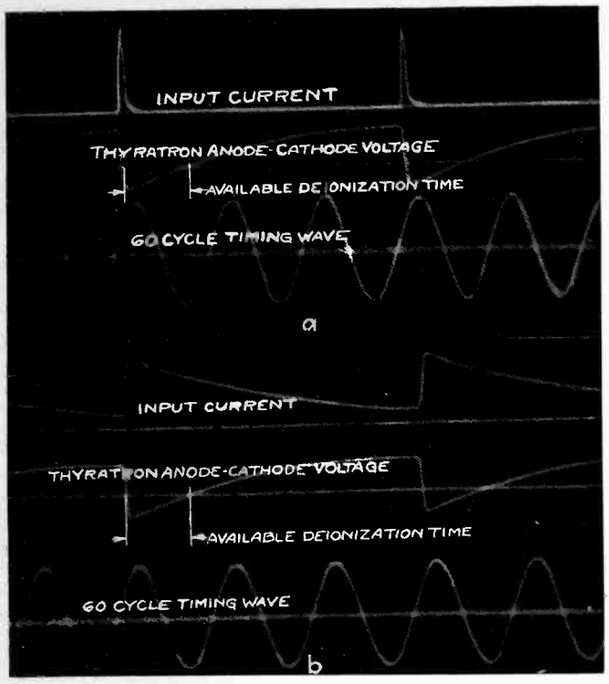


Fig. 3—Oscillograms of inverter. Upper curves are representative of circuit in Fig. 1

Occasionally these circuits are used without the use of the potentiometer, the grid circuit being connected directly to the negative line. This not only removes a convenient frequency control, but also tends to make the timing more susceptible to error. This is due to the low rate of change of the grid-cathode voltage at the time of discharge as indicated in Fig. 4 which shows the lowering of the cathode potential as the condenser in Figure 2 charges up.

Advantage of potentiometer

Assume for the instant that the critical grid voltage is slightly negative. A line x is drawn so that the distance b–x is equal to the critical voltage. Then the tube will start to conduct at the instant the curve crosses the line x. A slight change in characteristic of the tube due to the effect of temperature change, cleanup of an inert gas, or any other cause produces an error shown as ΔT_1. If, however, the grid circuit is returned to point c and the time constant of the RC circuit altered, the tube will trip in the same time T, with a somewhat lower condenser voltage, as shown. A similar change in tube characteristic will then produce a much smaller error ΔT_2 due to the greater rate of change of the condenser voltage, and consequently the grid voltage, at the tripping point.

Still further, the use of the potentiometer compensates for different line voltages. If the anode voltage is doubled, the bias b–c is automatically doubled so that the time is practically constant provided that the critical voltage of the Thyratron tube and the tube drop are both small in value compared to the anode voltage. If these two quantities have a zero value, the time would be absolutely constant with any value of line voltage.

It sometimes happens that it is desirable to have the inverter run in synchronism with a given voltage. If the values of R_2 and C and setting of the potentiometer are set for approximately the right value, a small value of synchronizing voltage introduced in series with the grid circuit will serve to keep the circuit in exact synchronism. By suitable adjustment of the circuit constants submultiple frequencies may also be perfectly synchronized. Multiple frequencies may be held in synchronism although the correction occurs only once per cycle of the synchronizing frequency; and if the circuit constants are not about right, a slight drift may be synchronized.

It will be at once evident that the single-tube inverter is a convenient source for small amounts of a-c power. In general, L and R_1 are replaced by a small transformer the output of which may be stepped up or down to the desired potential. The leakage inductance of the transformer is generally sufficient to overcharge or overdischarge the condenser to insure "commutation." A few of the applications of this nature include the excitation of an a-c bridge circuit at several hundred cycles to improve its efficiency, and the Thyratron tube organ which uses a number of these circuits operating at audio frequencies. If the voltage ratio of the transformer is high enough, we have in effect an induction coil with a tube interrupter which may be used to light neon signs or for other high voltage uses.

If slight modifications are made, such as replacing the resistance R_2 by an emission limited vacuum tube to maintain a constant charging or discharging current for the condenser and the time of the Thyratron tube conduction made very small, a saw-tooth voltage may be obtained across either this tube or across the condenser which provides an ideal linear time axis for cathode ray oscillograph work. The same results may also be obtained by the use of a four-element vacuum tube or by the use of a large inductance in series with R_2.

This saw-toothed wave also is used as the timing element in a recently developed design of electron-tube welder control. By varying a d-c potential in series with the saw-toothed wave, the ratio of the time the resultant voltage is positive to the complete time may be controlled. This voltage impressed on the grids of another pair of tubes controls the ratio of the time current is passed to the time it is off. By changing the

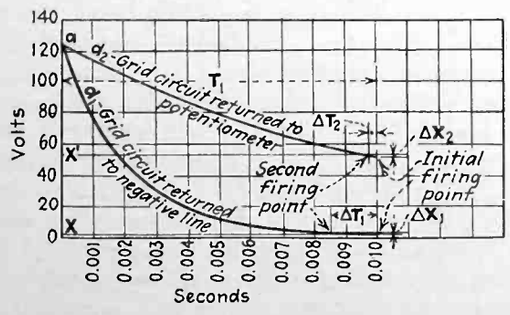


Fig. 4—Errors in firing time when potentiometer is not used

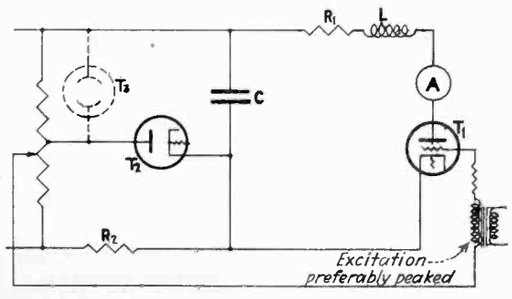


Fig. 5—Frequency meter using electron-tube inverter principle

frequency of the inverter the number of spots per minute of the welder may also be controlled.

Another use of the inverter is for stroboscopic work. If the inductance is made quite small, the time of the tube conduction is so brief that a moving object seen in the light incident to the discharge seems to stand still.

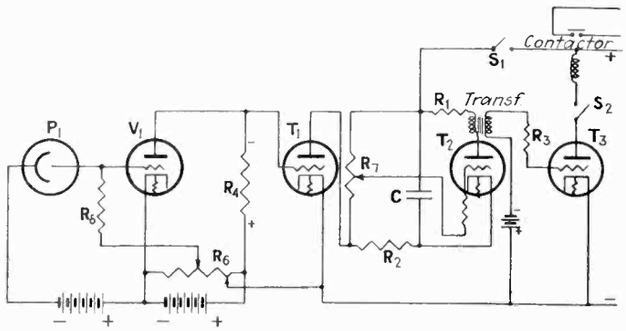


Fig. 6—Flexible time-delay relay using inversion circuit

Thus, a synchronous motor rotor and shaft seems to stand still if the inverter is synchronized from the same source that is used to run the motor and the rotor of an induction motor seems to move backward proportional to slip frequency. If a shaft to be observed is not running in synchronism with any alternating current source, a small synchronizing voltage may be introduced into the grid circuit by the use of small contacts or by some scheme of inducing a voltage in a small pick-up coil once a revolution.

With a slight modification a calibrated variable frequency stroboscope can be produced which may prove useful as a tachometer in observing the period of repeating phenomena without affecting the phenomena. If the voltage *a–c* is held constant in either of the fundamental circuits (Fig. 1 and Fig. 2) and the value of R_2 varied, the reading of a d-c ammeter in series with the Thyratron tube anode will be directly proportional to the frequency. Thus, if the frequency of the stroboscope is varied until the highest frequency which gives a single image of the moving part is obtained, a reading of the meter will give the correct frequency. In order to check this reading, doubling the stroboscope frequency should produce two images 180 degrees out of phase.

If this circuit is further modified for external excitation, as shown in Fig. 5, the reading of the d-c ammeter is proportional to the frequency of the excitation. This makes it applicable to a number of frequency or speed measuring problems. The addition of the tube T_2 insures the condensers always charging to the same value at high speeds and a glow tube T_3 affords freedom from line voltage variation errors.

In addition to these and many other applications of the circuits acting as inverters, there is another arrangement which makes use of a non-recurring type of operating cycle.

The circuit shown in Fig. 6, for instance, forms an extremely flexible time delay relay. If the switch S_1 is closed, a definite time later the tube will conduct, making it possible to operate some further device a definite time after the initial movement which closes the switch S_1. By changing the values of R_2 and C, this time may be readily changed from a fraction of a second to 10 minutes or longer.

If the grid lead is returned to the negative line through a small negative bias, the Thyratron tube will never trip unless an additional signal impulse of a positive nature is inserted in series with the grid circuit. This then forms an impulse amplifier in which a weak impulse trips the circuit, giving a powerful impulse whose magnitude and shape is independent of the tripping impulse. This is one scheme of providing a peaked grid excitation for large power Thyratron tubes in multitube circuits where conduction angles are short and the "Firing point" must be accurately determined.

✦ ✦ ✦

Considerations on detector-output tube systems

[*Continued from page 95*]

the equivalent of a four-volt swing on the input or a three-volt bias with one volt peak swing. The one-volt audio signal would give about 12 volts peak output. Not much more signal could be used on the input because of plate overload. The pentode requires about 16 volts peak to give maximum output. Preliminary calculations indicate that about 50 to 60 per cent modulation would be required to give full output.

Method 4. Our first thought to improve the above performance is to place a diode element in the structure and to use this for a rectifier. The rectified voltage could then be applied to the triode and the output of the triode could be applied to the input of the pentode. The performance of this combination would be entirely satisfactory both from the standpoint of sensitivity and ability to give full power output on relatively low percentages of modulation.

Four possible methods of making tubes capable of acting as detector-output tubes have been given.

Method 1. Considerable improvement over a regular output tube is possible by using twin control-grids. The voltage sensitivity as a detector is rather poor and it is impossible to load up the output tube section with low values of modulation.

Method 2. This method is by far the simplest. It has the advantage that bias may be applied to the pentode output grid and that the audio voltage supplied may be controlled. The voltage sensitivity is rather poor and considerable r-f would have to be applied to give full output on low percentages of modulation.

Method 3. A triode used with a pentode would give considerably better voltage sensitivity than the preceding methods. The plate impedance would be rather high so that resistance coupling would have to be used. The modulation percentage required to give full power output with reasonable distortion would be 60 per cent.

Method 4. The use of a diode, triode and pentode seems to be the only solution both as regards output and sensitivity. A minimum of eight connections with nine preferable would be required involving practical difficulties. The complicated tube structure involved would necessarily mean relatively high manufacturing cost. It would be problematical whether or not there would be any saving over two standard tubes.

Notes on the manufacture of

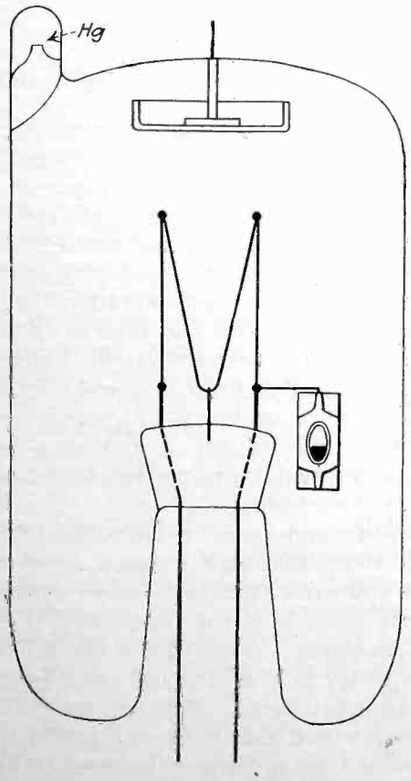
Mercury vapor rectifier tubes

By PAUL G. WEILLER

ONE of the major problems facing the engineer who designs or who uses tubes is that of life. Broadcasting stations which use vapor tubes as high-voltage rectifiers are satisfied with a life of approximately 1,000 hours. Many industries, however, have set their minimum life requirement at 5,000 hours, with a premium on extending the period of usefulness of the tubes to over 10,000 hours.

Such requirements are quite reasonable.

When tubes are used in elevator control for instance, expert supervision in many cases is not available. Changing tubes at frequent intervals is quite inconvenient, particularly when failure of a tube will cause the elevator to stop in the shaft between floors. The resulting impression on passengers is apt to create distrust of the particular make of elevators.



Construction of mercury-vapor rectifier with receptacle in top into which mercury distills to maintain vapor pres ure

There are uses for tubes where reasonably frequent changes are of no particular detriment. Equipment manufacturers, however, are loath to use tubes which would have to be replaced before any other parts of the equipment wear out. It is also true that there is a prejudice against using anything made of glass in connection with heavy machinery, a prejudice indulged in by engineers who are not accustomed to tubes. It is a potent factor which added to other factors, makes 5,000- and 10,000-hour tubes necessary.

Different technique is necessary when designing and making tubes of this life. In fact, so different is it that many of the current connections and practices of vacuum tube practice must be done away with.

The life of a mercury vapor tube depends on a variety of factors. Some of them are well known. Others are still enveloped in a good deal of mystery.

If a vapor tube is designed and exhausted properly failure after lapse of the normal period of life is caused either by disappearance of the coating from the base metal of the filament or by destruction of the base metal itself at a point near one end of the filament. The former type of failure is found most frequently with tubes with generous filaments, say 60 watts used for filament heating for each ampere mean d-c plate current. The latter type of failure is common to tubes where the filament is heavily loaded, for instance in tubes with only 10 watts per ampere mean d-c plate current.

The coating process

The disappearance of the coating is evidently due to evaporation either of the oxides of barium and strontium or the metals themselves, the latter operation caused by electrolysis of the oxides when the tube is in operation. In fact it may be said that, other conditions being equal, the life of the tube is roughly proportional to the amount of coating on the filament. It is obvious then that we must pack the maximum possible amount of coating on the filament, and provide means to keep it there.

The customary process of coating by running the filament ribbon through a suspension of barium and strontium carbonates in a solution of barium nitrate yields tolerable filaments for the smaller types but is inadequate for large filaments because the amount of coating which can be put on uniformly is severely limited by the surface tension and viscosity conditions of the coating suspension. Much heavier coatings can be obtained by shaping individual filaments first and then spraying the coating on.

It is standard practice for receiving tubes to use pyroxylin binders for sprayed cathodes with excellent results. For vapor tube filaments it is, however, essential to reduce the amount of lacquer to a minimum. If the usual quantity of lacquer is used results are not satisfactory. Excellent results are obtained by heating the filament by the passage of a suitable current while it is being sprayed with the customary aqueous coating mixture, the latter drying as fast as it is being sprayed on the filament.

Use of netting as filament base

With the larger sizes of filament it is nearly impossible to prevent partial flaking off of the coating, when nickel ribbon is used as base.

The writer has made it a practice during past few years to use netting as filament base with very excellent

results. The coating surrounds the individual wires and fills the meshes. If the coating process is properly carried out there is no flaking whatsoever.

In deciding on the proper amount of coating several factors have to be considered. Coating is a good heat radiator in spite of its white color. Up to a very definite limit the heat dissipation of the filament increases with increasing coating weight. The filament would therefore run colder unless it is shortened. If the coating thickness is further increased, heat conduction from base to surface is insufficient. The base runs too hot, the surface too cold.

The proper amount of coating presumed, the life of the tube is dependent on the ratio between mean plate current and filament wattage. The more generous the filament, the longer the tube life will be.

Relation between gas pressure and life

Another factor seriously affecting tube life is the operating pressure of the mercury vapor. The latter is in a general way dependent on the temperature of the coldest spot of the glass envelope. Too great reliance may not be placed on this principle for tubes of relatively small bulbs.

Since the movement of gases at a pressure of a few microns prevalent in properly dimensioned mercury tubes is very sluggish, establishment of an equilibrium between evaporation and condensation of the mercury takes an appreciable time. Consequently the pressure prevailing in some parts of the bulb may be higher than at the coldest spot. The vapor pressure over a mercury drop may for the same reason be higher than required by theory.

For long life it is important to keep the vapor pressure very low, the temperature of the bulb considerably less than 100 deg. C. Unless other means are employed to lower the vapor pressure, this means inconveniently large bulbs. The writer has obtained excellent results by providing a small trap on some convenient part of the bulb which is so placed as to keep cooler than the bulb itself, as shown in the figure. During the seasoning process the mercury distills into the trap and remains there during operation. No mercury remains adherent to the bulb walls.

By this means the vapor pressure always corresponds to the temperature prevailing in the trap which can easily be kept sufficiently low. It is significant that it takes several hours to distill a fraction of a gram of mercury from the bulb into the trap through an orifice of $\frac{1}{8}$ in. diameter. On some types of tubes the increase in life obtained by this design feature amounted to 500 per cent.

For very large tubes proper cooling must be provided by an air blast or by cooling in an oil bath. For long life vapor tubes should be designed either with low voltage filaments or with indirectly heated cathodes.

The drop in vapor tubes measured with d.c. is from 6 to 12 volts dependent on vapor temperature and pressure. If the filament voltage is 5 volts it is obvious that one end of the filament will be idle while the bulk of the discharge will be crowded towards the other end. This effect is aggravated by the fact that the resistance of the positive column decreases when the discharge is concentrated in a narrow path.

Under improper conditions the discharge will concentrate within one-quarter of the filament length. The filament will then deteriorate very rapidly, presumably because the base metal is caused to sputter by intensive positive-ion bombardment. The discharge under such conditions is sea green with a very bright sheath surrounding the filament. When filament and bulb are of the best proportions the discharge is purplish or pure blue. It is obvious from the aforesaid that the filament voltage of the larger types of tubes which run hot should not be over $2\frac{1}{2}$ volts.

If a vapor tube is properly exhausted and operated high inverse peak voltage does not affect its life, as long as no breakdown occurs. The breakdown in the non-conducting direction of a well-designed tube is above 35,000 volts on the test stand. The breakdown voltage is however materially affected by the prevailing vapor pressure. For the highest operating voltages (20,000) it is necessary to design the bulb of ample dimensions. Cooling can be made more effective by providing a trap and by a fan or oil bath. The spacing of the electrodes apparently does not affect the breakdown voltage.

Designers of equipment with which mercury vapor rectifiers are associated should note that the breakdown potential is severely affected by even slight radio-frequency fields. Even the small radio-frequency discharges generated by the spark or arc when an inductive circuit is broken by a switch may be sufficient to cause breakdown and destruction of the tube. It is also to be remembered that the wave form of the rectifier output may contain some radio-frequency harmonics.

These are caused by the straight sides of the wave produced by the constant drop across the rectifier and by a slight peak produced by the fact that the starting voltage may be slightly higher than the operating drop producing an abrupt wave form.

Wave form distortions may also be caused by the effect of the magnetic field produced by the heavy filament current on the electron stream. The rectifier may also go into actual oscillations due to a combination of design features and peculiar circuit conditions. If frequent breakdowns are experienced in some transmitters they should not always be blamed on faulty tubes. Breakdown ratings of vapor tubes should therefore be taken *cum grano salis*.

Long life, the reward of many items

Generous ventilation or forced cooling will safeguard against the effect of high temperature, proper r.f. chokes in the plate leads and shielding with copper screen will help prevent breakdowns because of radio-frequency fields where extreme voltages are required.

In describing the conditions conducive to long life we have always limited our consideration to "properly" exhausted tubes. Long life and high breakdown potentials are attainable only with thoroughly exhausted tubes.

The small 866 rectifier must be given a more thorough treatment than receiving tubes. Amounts of gas which would not materially affect a receiving tube would noticeably lower breakdown potential and tube life in a mercury vapor rectifier.

Extra long life and freedom from breakdown are the reward of a most thorough exhaust, comparable with that of large transmitting tubes. Such a high degree of exhaust is not possible if the mercury is present in the tube during exhaust. When the tubes are exposed to the high frequency field of the induction heater a heavy ring discharge is produced. So much energy is absorbed by the ionized vapor that sufficient heat to soften the glass is produced on prolonged treatment.

The following method permits any desired degree of exhaust without interference from that source. A drop of mercury is placed in a narrow glass tube and

exhausted. The mercury is heated to remove absorbed gases. The glass tube is then sealed off short. This glass enclosed mercury drop is placed in a small nickel cylinder and welded to a part of the tube structure.

In this way the tubes can be exhausted to any desired degree without trouble. The nickel cylinder is then heated with the induction heater. The glass within softens and releases the mercury. A few minutes' operation of the tube on the pump will evaporate the bulk of the mercury, the vapor effectively sweeping out any gases evolved from the glass. The tube is then sealed off. Very little mercury remains in the tube. As there is no appreciable disappearance of mercury during operation the minutest drop of it is sufficient to furnish vapor for normal operation.

Except for the high voltage rectifiers for use in transmitters no hard and fast standards have as yet been evolved for mercury vapor tubes. The great variety of specifications to which they must be built have prevented fixing of such standards up to the present time.

The desire to make equipment small and compact, is in the way of using sufficiently large bulbs; the desire to put equipment in cans or steel boxes militates against proper ventilation. Prejudice against glass gadgets does the rest to make life hard for the vapor tube designer.

If the equipment designer can be persuaded to design his device around a tube instead of forcing a tube into a device not designed in accordance with tube practice we can furnish tubes with up to 500 hours life.

With improvements in filament and cathode construction which are in the offing nothing will stand in the way of making steel-envelope hot-cathode tubes for one thousand amperes or more. Considering that such tubes can be used for several thousands volts it is not difficult to see what large powers can be handled with relatively small tubes. The hot cathode rectifier will compare with the present steel tank mercury vapor rectifier as the steam turbine does with the mastodonic Corliss engine.

✦ ✦ ✦

BOOKS ON ELECTRONIC SUBJECTS

Einführung in die tonphotographie

(elements of the photographic recording of sound)

By Dr. John Eggert and Dr. Richard Schmidt. Published by S. Hirzel, Leipzig 1932. 137 pages, 122 illustrations. Price R.M. 7, unbound.

IN THE FIRST TWENTY pages a brief review of the properties of sound waves is given; sound amplitude, energy and loudness as measured in dynes and decibels are explained. A similar second section deals with the principal methods of sound recording and sound reproduction. Then the main subject of the book is introduced by discussing the blackening curve of the developed photographic plate, that is, the curve showing the logarithm of the reciprocal of the transmitted light as a function of the light received by the plate. It is shown how two of the three parts which form this curve lead to two distinct methods of recording, the lower or curved portion with variable slope to toe recording, and the middle or straight portion of slope gamma to straight line recording. Faithful recording is obtained when the products of the gamma of the negative and positive film is equal to unity. The choice in film material, however, is limited because the positive film is by agreement a film with gamma equal to 1.8 in its straight portion. These two conditions furnish the starting point for a detailed comparison of faithful recording by the toe and straight-line method for variable density and also for variable films. The book concludes with chapters on noiseless recording, frequency response of the film material and a description of 6 different kinds of Agfa films.

A remarkable feature of the book is the very skillful way in which the illustrations render the text clearly understood. Moreover as many subjects in the book correspond more or less closely to material which has been discussed in *Electronics* (see *Electronics* February and March, 1931, February 1932, etc.) the book can probably be read with profit even by those engineers who have only a limited knowledge of German.

✦

Table of arc spectrum lines 2785 to 3505 A.

By Welton J. Crook, published by Stanford University Press. 30 pages.

THE PERFORMANCE OF MANY electronic devices depends on the purity of the materials used. The detection of small amounts of impurities in metals has become a speedy and certain matter through the recent application of spectroscopy to chemical analysis which allows the approximate concentration to be determined, that is, whether for instance 0.001 or 0.01 or 0.1 per cent of thorium or iron is present in tungsten. The author gives a table of 6,630 wavelengths for this work which are nearly complete as regards copper, molybdenum, nickel, platinum, tantalum, tungsten, zirconium and many other elements. He regrets that no numerical standard of line intensity exists, but he could have indicated the approximate relationship or the excitation voltage of the lines, which are often a more reliable guide than the intensity. Also in view of the fact that iron is often used as the comparison source, it would have helped to print the iron lines in heavier type. It may be mentioned in passing that the Osram has developed a standard lamp with iron electrodes containing substances which give off electrons at a low red heat so that the lamp can even be run from 110 volts a.c.

✦

Photocells and their application

By Zworykin and Wilson. Second edition, 329 pages, John Wiley & Sons, Inc. Price, $3.

THE SECOND EDITION OF THIS popular book is much more than a simple revision; it is longer by some 125 pages and five chapters. The old matter has been rewritten to a large extent and new information has been included. As an example, the chapter in the first edition on photo-conductive and photo-voltaic cells has been divided into two chapters and of course greatly enlarged. A chapter giving comparative outputs of the various types of light-sensitive cells is included.

Material on the construction and the mechanism of the photocell is given. Vacuum cells, gaseous cells, copper-oxide cells, selenium cells and so on, all are carefully treated. The approach is that of the engineer rather than the scientist. Therefore the book is practical and deals with circuits and industrial uses of the phototube as well as its application to motion pictures and to television.

With all their faith in the photocell as a tool of potential industrial importance the authors do not lose sight of the fact that the tube has certain limitations. These are pointed out.

Photometry, color matching, color analysis, and applications in which the grid-controlled rectifier is used are handled in a manner any engineer can understand.

HIGH LIGHTS ON ELECTRONIC

Web control of printing press

THE NEW BRITAIN (CONN.) HERALD press has four decks—that is, four independent sets of rolls for printing on newspaper stock. This paper stock (referred to as the "web") is fed through the various rolls from four separate rolls of paper. After passing through the printing rolls the four separate webs are brought together in a folder which folds and cuts the newspaper into the finished product.

If one of these webs breaks while the press is running at high speed, the web wraps around the printing cylinder, and if the press is not shut down immediately, so many layers wrap that the added thickness destroys the rubber covering or "blanket" of the roll which backs up the type. The blanket costs over a hundred dollars to replace and, of course, the printing of the paper is held up.

To reduce the number of wraps to a minimum, four photoelectric units have been installed on the press, one to watch each of the four separate webs passing through it.

Each unit consists of a sheet-metal case containing a phototube and a 40-watt lamp of the 110-volt house-lighting variety. The lamp shines on the paper and the reflection is seen by the phototube. A partition inside the case prevents the light from shining directly on the phototube. This partition is a part of a hinged cover, however, and when the cover is tilted back, it allows the light to fall directly on the phototube, thus rendering the unit inoperative as far as reflected light is concerned.

The four phototubes are connected in series with one relay, so that darkening any one of the cells opens the photoelectric circuit and the contactor which controls the press motor falls out.

Since breaking of any of the webs will remove the source from which the phototube gets its reflected light, the press stops instantly upon the occasion of a break.

There are several variables which might affect the operation of the phototubes, and they include,

1. Whether the paper has been printed upon at the particular station being watched.
2. If the edition is small on a particular day, one or more decks may not be in use and the hinged cover will be tilted back, allowing the full light to fall on the tube.
3. Lamps and phototubes may be dimmed by dirt.
4. Lamps may become dim with age.
5. The caesium tube used varies in sensitivity.
6. The blackness of type varies—that is, large black advertisements may appear on one page and not another.
7. Since part of the reflected light comes from the general illumination of the room, it will vary with the weather, the time of day and the time of year.

A unique feature of the installation is the control of all these variables from a remote knob situated on a pillar of the press within easy reach of the pressman.

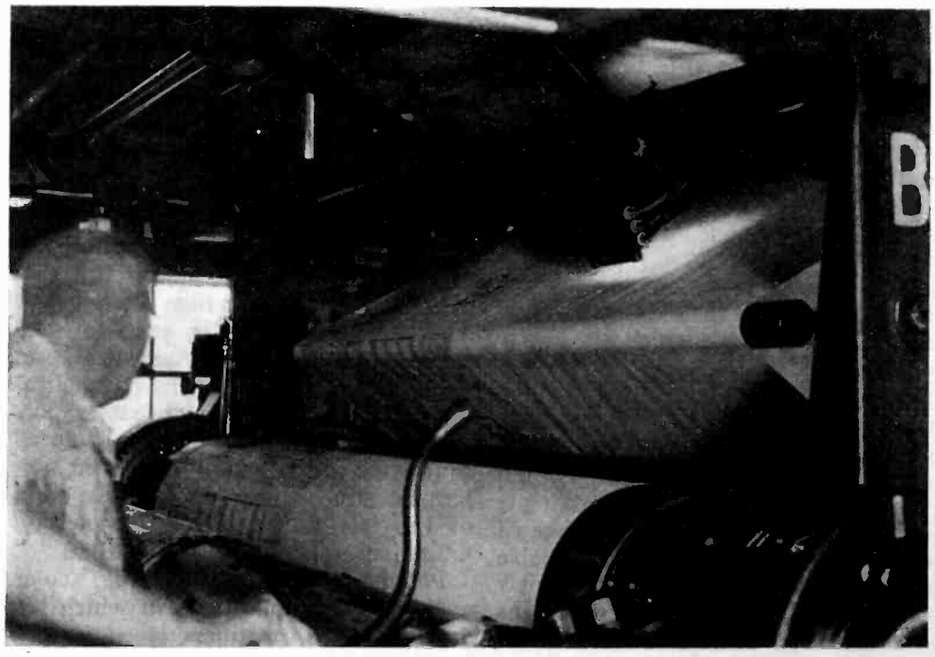
Since all these variables are transmitted to the one amplifying tube of the relay, a milliammeter placed in the plate circuit will show the resultant of the reflected light on the four phototubes. The remote control box contains a milliammeter on its face and below it, a control knob attached to a potentiometer for adjusting the grid bias of the tube.

When the edition is about to be printed, the press is started and the milliammeter observed. If the reading is too high or too low, the pressman turns the knob until the pointer of the milliammeter falls on a red mark placed at the point of most satisfactory operation. No further attention is then necessary.

Thus, all variables are compensated for each day and no service has been required on this installation. Each break has been faithfully caught for many months.

In addition to the electrical control of the press motor, a motor-driven brake mechanism was designed and installed on this press, working in conjunction with the photoelectric relay, so that whenever the press is stopped, either by the breaking of the web or by pressing the stop button, each of the four heavy rolls of paper is stopped. This prevents over-running, with consequent tangling of the web in other parts of the press.

The rolls of paper were already equipped with hand-operated brake shoes for controlling the tension of the paper. An automatic lever mechanism was added to the existing shoes connected to the main motor-operated braking unit by individual cables. The main braking unit includes a 165-pound weight, which drops down, pulling on the cables as soon as the electrical impulse from the photoelectric relay reaches it. The motor pulls the weight up again and releases the brakes to avoid breaking the web as the press comes to rest.



If the paper breaks, the light shining on the photo-cells immediately operates relays to shut down the press, saving serious damage and delay

✦

Ounce crystal mike carried on fish-pole

THE NEW CRYSTAL MICROPHONE has come in very handy for sound-picture crews taking photographs on location. Formerly a substantial and bulky microphone-crane was necessary to swing the usual heavy microphone over the heads of the actors, but out of sight of the camera lens.

Now with the new crystal microphone, which is so light it can be mailed at minimum letter postage, only a slender fishing pole is needed to carry the mike over the heads of those taking part in the scene.

DEVICES IN INDUSTRY + +

Bar and rod heating controlled by electric eye

WELDING HEATERS EQUIPPED WITH photocells and amplifier tubes as well as with timing devices, as built by the American Car and Foundry Company were exhibited at the recent New York Power Show. The operator sets the control for the color produced by the desired temperature; when the steel is heated to the desired temperature, the operator is warned by a red light or a bell. Hourly capacity per electrode ranges from 200 $\frac{3}{8}$-in. pieces $1\frac{1}{2}$ to 2 in. length of heat, to 20 $\frac{3}{8}$-in. pieces $1\frac{1}{2}$ to 2 in. length of heat to 20 $1\frac{1}{2}$-in. pieces having 3 to 4 in. length of heat. Electric rivet heaters and valve-stem heaters are also available with electric-eye control.

✦

Measuring pressure and weight

SEVERAL SCHEMES AVAILABLE for measuring pressure were described by Prof. Harold C. Weber before the Boston Section of the American Chemical Society. The one used to determine the pressure existing in large guns, during firing, involves a quartz crystal which is compressed by the pressure. Pressure exerted on opposite faces of the crystal generates an electric charge, whose magnitude is almost directly proportional to the pressure applied.

To amplify and record the pulse is a simple job for the vacuum tube amplifier. An apparatus used by the author for measuring pressures of about one thousandth of an inch of water consisted of an oscillator whose grid circuit condenser was so designed that a small pressure caused a slight movement of one of the condenser plates. This movement caused a change in frequency of an oscillating circuit which had been previously calibrated for various pressures on the condenser. The device was entirely self contained and portable and in one model read directly in inches of water.

For measuring very low pressures of the order of those measured on a McLeod gage, the ionization manometer consisting really of a three electrode tube whose jacket is connected with the space under measurement, has found frequent use. This gage is said to be more reliable at the lower range than is the McLeod gage.

By building the grid circuit condenser of a tube oscillator in such form that one plate deflects under the load to be determined or is displaced by the thickness of the material under measurement a change of frequency in the oscillator will occur. Measurement of the frequency change gives a method of measuring the weight or thickness. Deflections of a millionth of an inch are easily determined by the method and in one commercial thickness gage of this type a variation of two millionth of an inch in a piece over an eighth of an inch thick causes such a large deflection on the recording meter as to throw the instrument off scale.

✦

River marking lights photo-cell controlled

THE U. S. LIGHTHOUSE SERVICE now makes use of photoelectric cells to control its river marking lights, and has recently installed nine Weston units on electric-battery markers along the Connecticut River. These cells turn off the battery-operated lights as soon as dawn comes, and turn them on again when darkness falls, thus doubling the former useful life of a single battery charge. The circuit is arranged to take no current when the lights are on, but to take a small control current with lights off.

Controlling of water supply

TO KEEP WATCH OVER THE health of the people is a new duty of the "electric eye" described by J. V. Alfriend, Jr., of the Westinghouse company.

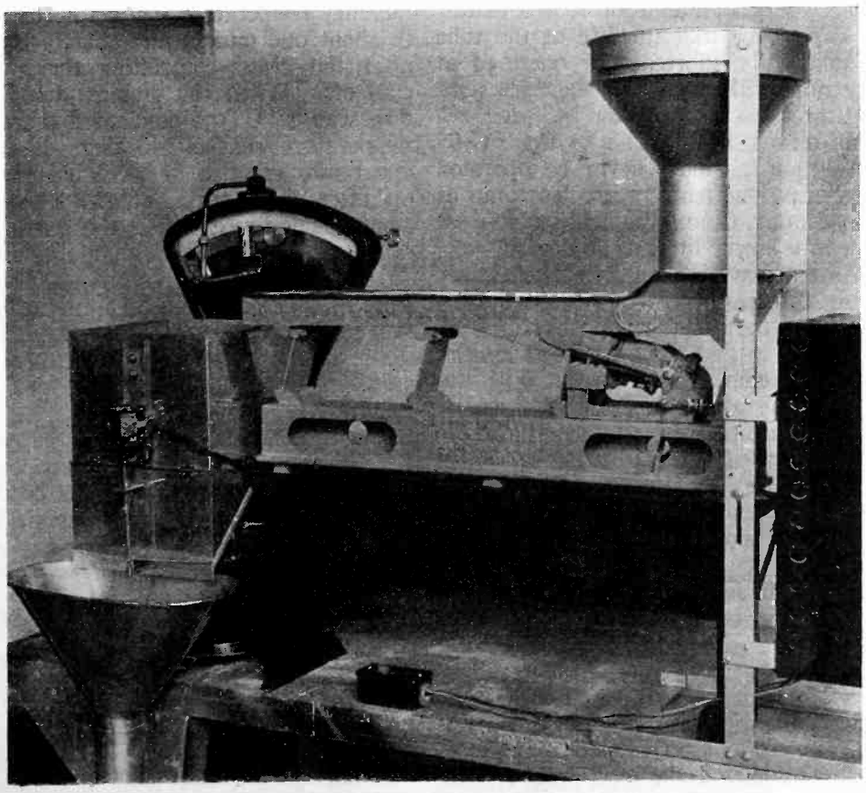
The cell automatically regulates the amount of chlorine that is liberated as a germ killer into the water supply of cities. Its action is prompted by color changes.

"The first or 'balanced bridge' arrangement," Mr. Alfriend explains, "utilizes two light sensitive photo tubes simultaneously to inspect the light transmitted through a sample of the unknown liquor and the light transmitted through a standard colorimetric sample representing the desired quantity of the variable chemical. The second or 'null' method uses a single photo tube inspecting simultaneously the light transmitted by the unknown sample and the known sample."

Similar automatic photoelectric control has been applied to maintaining the acidity of paper mill stock solutions, holding the proper amount of sand in coal washing water, and in regulating the acidity of the electrolyte in electrochemical industries.

✦ ✦ ✦

AUTOMATIC PHOTOCELL-CONTROLLED SCALES



This is the Toledo vibrator filling machine. It automatically weighs out predetermined amounts of dry materials in packaging or blending operations. The vibrator shakes the cereal or prunes onto the scale; a photocell cut-off stops the flow when the required quantity is reached

✦ ✦ ✦ ELECTRONIC NOTES

Device for temperature regulation of mercury vapor tubes

By C. Stansbury *and* G. C. Brown
Cutler-Hammer, Inc.

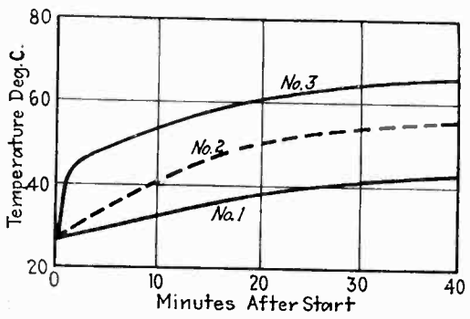
A VERY IMPORTANT POINT in the use of mercury vapor tubes is the fact that their characteristics and life are dependent on the ambient temperature at which the tube is operated. The tube contains mercury, which is partly in the form of vapor and partly in the form of liquid condensed at the lowest point of the bulb. The temperature of the liquid mercury at this point determines the vapor pressure throughout the enclosure. On the vapor pressure in turn is dependent the voltage necessary to drive a given current from anode to cathode which is a vital factor in connection with the rate of deterioration of the tube in service. Also affected is the value of anode voltage necessary to start an arc at a given grid potential which affects performance of devices dependent for proper operation on reasonable stability of this characteristic.

A thermocouple taped against the bulb just above the upper edge of the base appears to give a temperature slightly higher than the actual condensed mercury temperature but it is sufficiently accurate for most practical purposes. For reasonably stable control at least 40 deg. condensed mercury temperature is necessary. In addition it is a matter of experience that the life of the tube is materially shortened if operated at any time with condensed mercury temperature less than about 45 deg. C. This means, in the case of the FG-65 tube, that it should never be operated at an ambient temperature less than at least 15 deg. C. and the makers have set a definite lower limit of 20 deg. C.

As ambient temperatures much lower than 20 deg. C. are commonly encountered in industrial applications, it is necessary to find some way to keep the ambient temperature surrounding the tube always above this minimum.

Experiments with a small heater located near the base of the tube which, although not having anywhere near enough watts to heat up the whole enclosure, disclosed that it was possible to warm a current of air which would pass up and surround the tube and raise its ambient temperature just as effectively as if the whole enclosure were heated. The arrangement proved to be practicable, but also showed the necessity for thermostatically controlling such a heater to avoid excessive temperature under summer conditions. Curve one of the performance may be taken as the general ambient temperature inside the enclosure, curve two is the temperature on the tube side of the thermostatic strip which controls the heater, and curve three shows the approximate condensed mercury temperature. The controlling thermostat is located just as close to the bulb at the point just above the base as is practicable in order to make its temperature correspond to approximately the condensed mercury temperature. The ideal control of the heater would doubtless be by means of a device which would respond accurately to condensed mercury temperature, but the approximate correspondence here obtained is sufficiently good for the purpose.

To protect the tube until it has had time to warm up to operating temperature, a thermostatic strip timer is used, which keeps open the cathode return circuit for from one to two minutes with the FG-65 tube and for longer periods



in case of larger tubes. The condensed mercury temperature reaches 40 deg. C. in about one minute and shortly thereafter the heater-controlling thermostat cuts off. When the ambient temperature was 8° C. the condensed mercury temperature reached 40 deg. C. after about two minutes and the heater cut off after about six minutes. The ambient temperature inside the enclosure did not reach the nominal safe value of 20 deg. C. for eleven minutes, but in spite of this fact the local heater raised the condensed mercury temperature of the tube to a safe value within the permissible warming up period of two minutes.

In general, if the enclosure is not very large the ambient temperature inside the enclosure will ultimately exceed 20 deg. C. except under excessive conditions, after which there is no longer any call for the heater.

✦

Magnetostriction oscillator

INTENSE AUDIBLE SOUNDS produced by a magnetostrictive vibrator are described in *Physics 3: 209-229, 1932,* by Newton Gaines, University of Texas.

The vibrator consists of a cold-drawn nickel tube ¾ in. in diameter and about 26.4 cm. long, sticking with its upper half into a water vessel, and closed at its upper end by a thick nickel plate welded to it. The lower half is surrounded by the coils by means of which oscillations of the frequency 8,900 cycles are maintained with the aid of a UV 204-A. A cork firmly driven into one end of the nickel tube quickly becomes hot at its center owing to the absorption of sound energy. The nickel tube itself is eventually broken near the middle. Metal and glass surfaces held under water show traces of erosion. Bacteria are killed.

✦

Quartz-rod electronic precision clock

A PRECISION CLOCK HAS BEEN constructed by A. Scheibe and V. Adelsberger, German National Physical Laboratory. As described in *Zeitschrift techn. Phys. 13, 591-593, 1932,* it comprises a quartz rod 1.5 by 3 by 91 mm. in place of a slab as in Marrison's crystal clock as the mechanical vibrating system. The rod oscillates in its second harmonic (longitudinal) frequency, 60,000 cycles per sec., it is placed between grid and cathode of a commercial vacuum tube, and excites oscillations in the tuned anode circuit. These oscillations are amplified in a resistance-coupled stage and then in a tuned stage. After the frequency has been reduced to 333 cycles per sec. it is made to operate a synchronous motor. During a period of six months the quartz clock remained constant to within +0.002 second.

✦

Low voltage photoelectric colorimeter

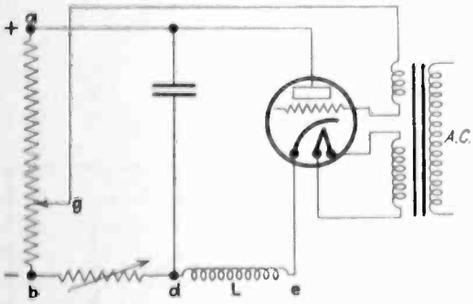
B. LANGE, OF THE K. W. INSTITUTE, Berlin, describes a very compact photoelectric colorimeter in *Die chemische fabrik 5:457-459, 1932,* and in *Zeitschrift für techn. Physik, 13:600-606, 1932.* Two detector-type photoelectric elements (cuprous oxide, selenium layer, etc.) were used in two arms of a Wheatstone bridge, a potentiometer forming the two other branches. The sliding contact on the potentiometer is connected to the shunted measuring instrument, and from there to a point between the two cells. No external source of potential is required. Light from a small lamp passes through glass cells one containing a standard solution, the other the solutions whose color or turbidity has to be measured. For ordinary purposes a microammeter is sufficient (see measuring acidity and alkalinity by photocell, *Electronics,* July, 1932).

FROM THE LABORATORY +++

A new electronic tool—the discharging condenser

APPLICATION OF grid-controlled rectifiers to welding calls attention to the use of a condenser-resistor combination to control the rate at which a phenomenon is permitted to take place. The discharging condenser has been used frequently in the laboratory; practical uses have been the control of street traffic lights, and this new application brings added importance to a natural electrical phenomenon.

In the welding equipment, the grid-controlled tube is used to effectively short circuit the secondary of a series transformer. When this occurs the reactance of the transformer becomes very low and nearly full current is passed to the welding circuit. The



number of cycles during which the tube shall pass current, and the period of each cycle during which the tube shall be non-conducting or conducting are of importance.

Some sort of timer, therefore, is necessary. Again the grid-controlled rectifier comes into service. In the figure when d.c. voltage is impressed across a-b the voltage across the condenser is at first zero and therefore the anode and cathode are at the same potential. The grid is negative with respect to the cathode. As the condenser charges the anode becomes positive, and the grid somewhat less negative. At some critical value of these two voltages the tube will pass current discharging the condenser whence the cycle can begin again.

The voltage between *g* and *d* is constantly varying between the voltage determined by the position of the slider *g* and the charge and discharge of the condenser and this cyclically varying voltage can be put to varied uses. The rate at which the condenser charges is controlled by the value of the resistor *b-d*. The adjustment of the oscillating circuit controls the time the tube is on or off in cycles, the position of the slider *g* determines the relative portion of the cycle the tube is on or off.

In practice a small a-c voltage is put on the grid of the timer control tube to aid in maintaining synchronous timing.

Velocity of sound in paper

MEASUREMENTS ON THE velocity of sound in paper were made by D. A. Oliver, Northampton Polytechnic, by fixing a strip of paper in a vibrating clamp and noting the resonant frequencies for various length of overhang. The velocity was found from these paper cantilevers is 2.1×10^4 cm. for white Bristol board paper, 0.017 cm. thick and 1.8×10^5 cm. for brown corrugated paper 0.047 cm. thick. The measurements are reported in *Philosophical Magazine* and *Journal of Science*, August 1932, and seem to be in good agreement with those assumed in loud speaker work.

✦

Gas-filled photocell inertia

IN EXPERIMENTS CONDUCTED BY F. Ollendorff of the Institute of Technology, Berlin, light from a point arc was allowed to fall upon gas-filled commercial photocells (General Electric type) after having passed through a rotating scanning disk which caused up to 60,000 interruptions per second. The photo current as measured by the potential drop across a moderate resistance decreased as the frequency was increased from zero to the point where 30,000 interruptions were produced, but it began to increase again between 30,000 and 60,000 complete cycles. The theory *(Zeitschrift für techn. Physik B:606-611, 1932)* of the ionization currents produced in the cell shows that the current assumes high values when the frequency of the modulated light beam is a multiple of v/d (v = velocity of positive ions, d = distance between electrodes), that is when the positive ions produced near the plate arrive at the cathode during the peak of the illumination. Low values are obtained when the arrival coincides with the darkened period.

✦

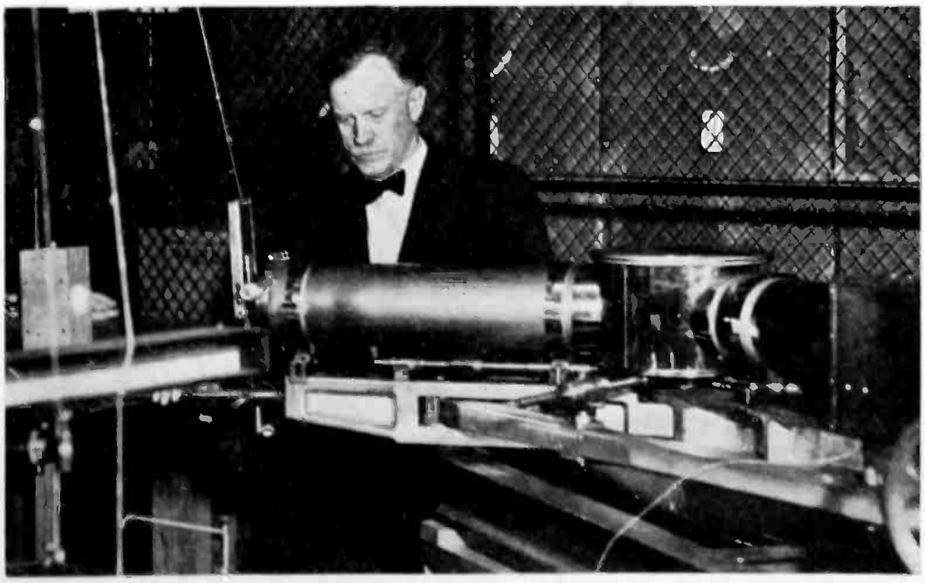
Photoelectric U-V photometers

CONSIDERABLE WORK has been done to adapt the photocell to the photometry of sources of ultra violet light. In regions where the eye is not sensitive or where the eye would suffer from exposure to the energy, some means such as a light-sensitive surface forms an elegant method of making comparisons or quantitative measurements. In addition to the list of ultra violet photometers listed below, an instrument using photocells for application to photomicrography has been put into service at the Mt. Sinai Hospital, New York City.

Ultraviolet photometers utilizing the photocell are in use at the Bureau of Standards, the Department of Public Health, and the Department of Agriculture in Washington. Other units are owned by the American Medical Association, and several photometers are in use in hospitals in Cleveland and Pittsburgh. These units have been manufactured by Westinghouse after the research work of Dr. H. C. Rentschler. The Mt. Sinai installation was made by Dr. E. E. Free.

✦ ✦ ✦

TO AID RESEARCH IN THE ULTRAVIOLET



By means of this monochromater recently completed at the Nela Park laboratories by Dr. W. E. Forsythe it is possible to select one wave-length of light from the spectrum and measure its characteristics fully. This device is used to study the ultraviolet, visible and infra-red radiation from various light sources

BACK TO QUALITY

An Editorial

NEARLY one million dollars a week is spent on bringing to the radio listening public the best program features and talent that money can buy. Additional millions are being invested in broadcast-transmitter equipment, so that broadcasting of the uttermost fidelity and tone-quality may drench our principal centers of population.

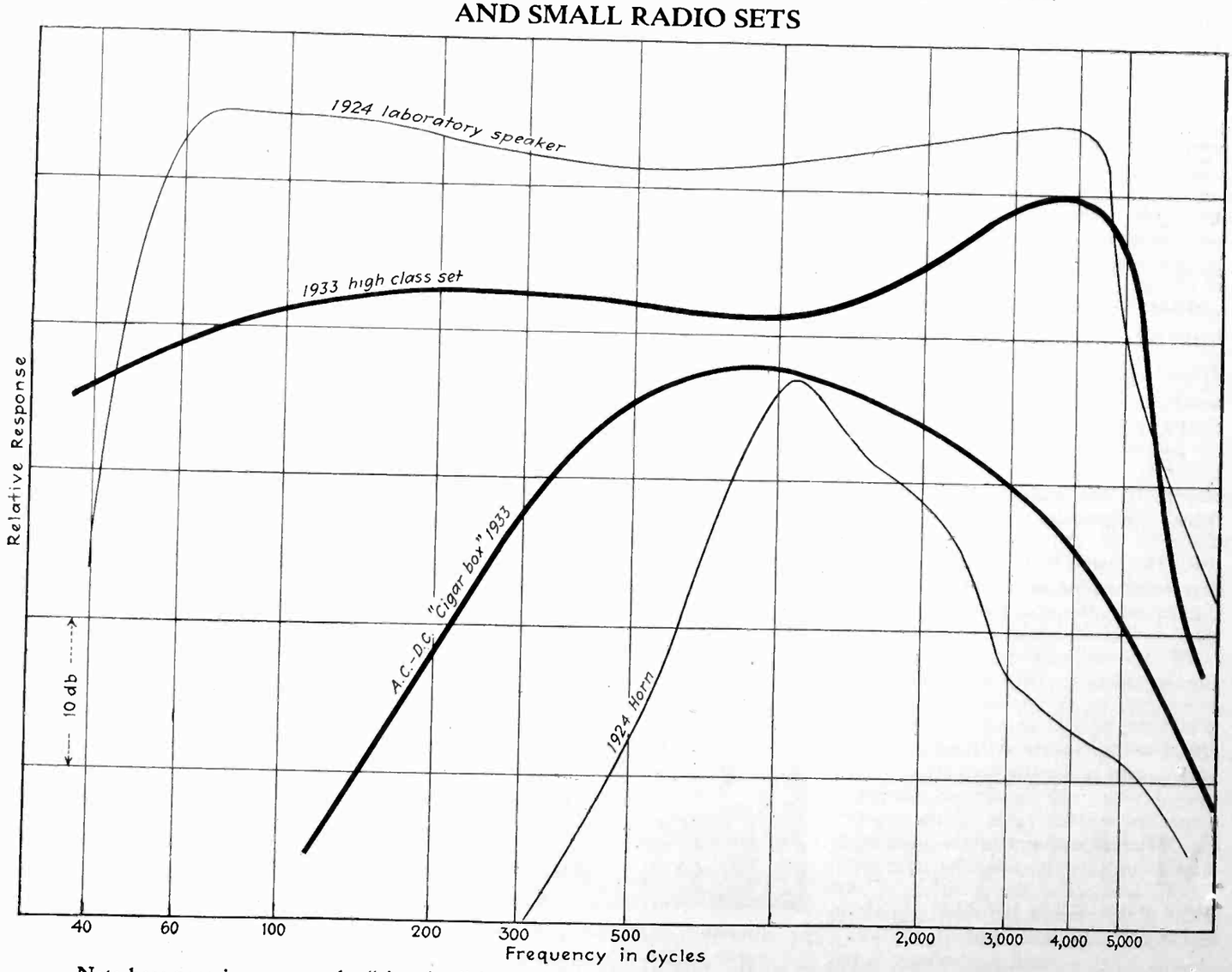
Yet steadily the average of our *receiving sets* grows worse and worse,—more and more deficient in quality of reproduction, inadequate in material equipment and durability.

Of course there are still citadels of radio quality. There are still organizations where skimping and chiseling of material and tone will not be permitted.

But the great volume of the receiving sets poured out upon the market are limited in their tone quality, and whittled to the breaking point in their necessary skimping of materials.

And this sinister chiseling of quality is felt all the way back along the line of supply of parts and constituents. Parts manufacturers have learned that their sales depend upon their skimping in turn, until the last vestige of working load is wrung from the shrieking metal; that they must chisel and then chisel again.

THE WIDE DIFFERENCE IN TONE FIDELITY BETWEEN LARGE AND SMALL RADIO SETS



Note how poor in response the "cigar-box" is and how w ell the high-class console with its large baffle reproduces the low tones. The relative flatness of these curves is important. The comparative loudness of the sets is not indicated

IN RADIO RECEIVERS!

THE quality of broadcasting stations, of wire lines and repeaters, has steadily improved. In fact, it is almost impossible to sell a transmitter nowadays that is not guaranteed to go up to 7000 cycles or beyond. But on that part of the public that buys the little two and three-octave sets, all this expense is wasted.

The curves shown here demonstrate clearly that the cigar-box sets of today are poorer in quality than receivers of 1928, or even of many built in 1926 and 1927. As long ago as 1925 loudspeakers were available which transmitted to the listener the deep bass which gives power and grandeur to the world's great music. The curves of the small 1933 set shown were recorded in a well known laboratory under standard conditions on a receiver with the following dimensions 24 cm. by 17 cm. by 11 cm., clearly a cigar-box set. The engineers who made the test selected it as being "one of the best of today's ultra-small sets."

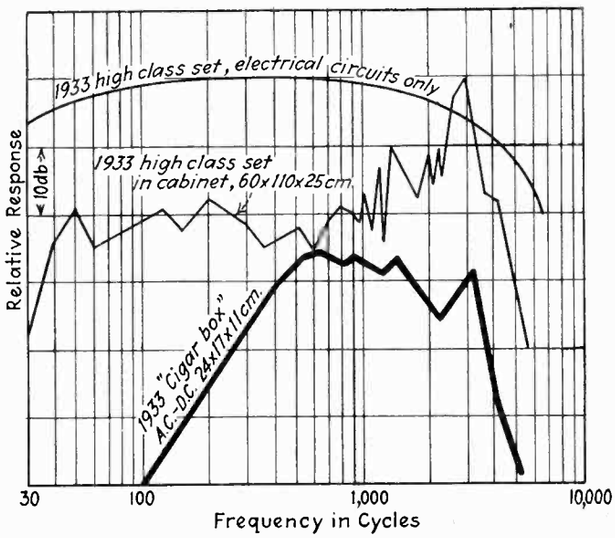
Fidelity of reception is not the only characteristic that has gone by the board in the craze for lower and lower prices. Sensitivity has decreased, selection of receivers in the factory has become so superficial that anything that plays is shipped.

What can be done about this progressive degradation of the radio receiver until the entire broadcast system invites competition from other means of getting high quality entertainment into the home?

There are several steps that can be taken.

The industry must recognize, as it has during the past year, the public demand for small sets. The public, however, must be taught that high fidelity of tone cannot be secured from the cigar-box type of receiver. It is simply a case of insufficient baffle area for the loudspeaker. Clearly then the loudspeaker must be separated from the set, equipped with sufficient baffle area and placed, inconspicuously perhaps, in some other part of the room. This will enable the listener to have his small set and to get high quality to boot.

MORE experimenting along the line of remote control or "lazy man's" radios will determine what form the new type of radio and external loudspeaker will take. Perhaps it will be a single model of chassis but a number of models of loudspeakers sold on the accessory plan.



The dimensions of the two sets are given; only the flatness of the curves count, not the fact that one has been plotted above the other

At any rate the very advantage of tuning and adjusting volume and tone from the point in the room where the listener will sit is of great importance. As soon as the idea is firmly planted that the speaker and the tuning mechanism need not be in the same box, the idea of two speakers will not be difficult to sell. The virtues of two speakers, rather widely separated in the room, is as yet untried commercially, but experimentally has shown itself to be of vast importance in improving tone value and realism. These extra speakers can be inconspicuous and inexpensive and can go in doors, behind sofas, in end tables, behind screens and other places where the tuning part of the radio could not go.

Such removal of the speaker from the set will bring back the bass notes. There will remain the task to improve the high frequencies. Present day sets are remarkably dead above 4000 cycles, despite the fact that the broadcast transmitters are pumping into the ether all frequencies up to and including 6000 and 7000 cycles. To get these frequencies into the home receiver will call for an industry war waged on man-made static. It will call for industry demand that field strength of broadcast stations be improved.

All this is possible. The demand for small inexpensive sets can be turned to advantage. Quality can again become a talking point. It can sell countless thousands of radios still.

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

The manufacture of photoelectric cells

[G. DEJARDIN, University of Lyons.] The article describes the parts used for the electrodes and the materials used for the bulb, insisting upon the property of thin glass walls to let pass a considerable amount of ultraviolet (French patent 692,007), methods for depositing the sensitive layers either upon the wall, particularly easy in the case of magnesium, or upon silver or copper disks, which are then treated according to the method described in *Electronics* 5:255, 1932, and describes a few typical cells. The second part of the article is devoted to the methods of preparing the photosensitive layers including the cells for measuring ultra-violet radiations (cadmium, thorium, uranium, cerium). Many articles and over 50 French patents are mentioned.—*Revue gen. El. 33:3-13 and 37-53, 1933.*

✦

Grid-controlled discharge tubes

[E. LUEBCKE, Siemens Research Laboratory] The use of grid-controlled electron tubes (ordinary half-wave, and grid-controlled rectifiers) for control and regulation work is examined in the case where the external load is an ohmic resistance. In contrast to vacuum tubes with their high plate potential, grid-controlled rectifiers have a low internal resistance (10 to 30 volts on the plate). Starting requires a positive grid potential which except for very low values decreases linearly with the plate voltage between 400 and about 30 volts so that as in the case of vacuum tubes controlling amplification factors can be defined for different tubes. They vary between zero and eight. The starting points obtained with d.c. can be used to construct the starting curves when a.c. is applied to one plate. Sinusoidal curves result, raised or lowered more or less with respect to one another and nearly flat when the amplification is small. In this latter case the tube can only be used for switching current on or off. If a.c. is applied to the grid, the strength of the average rectified current can be varied in any ratio between 1 and 10,000. A still more flexible control is to be had when a.c. and d.c. are applied at the same time to the grid.—*Zeits. techn. Physik 14: 61-64, 1933.*

✦

Fight against radio interference

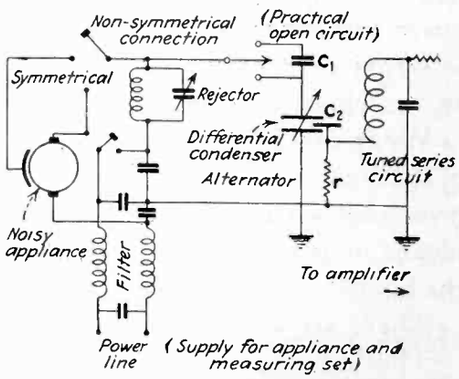
[MICHEL ADAM] It is desirable that the strength of the local stations exceed 2 mv/m, that of the distant stations 1 mv/m, whereas any appliance producing more than $\frac{1}{8}$ mv/m at the receiver is to be considered as a source of interference. Progress in the fight against man-made static has been made in 1932 with regard to discharge tubes (rejector circuit in secondary of transformer), screened lead-ins (0.0001 to 0.001 uf per meter length), street-car noises (aluminum contacts being replaced by zinc and carbon; if necessary choke-coils inserted, 24 in. in height and 5 in. in diameter), high frequency medical appliances, elevators, oil-burners.

Out of 300,000 complaints forwarded during 1931 to German radio-inspectors, 35 per cent were due to motors and domestic appliances, 3 per cent to medical apparatus used by physicians and 23 per cent due to those used in the homes, 8 per cent were due to regeneration, 5 per cent to power stations, 6 per cent to street cars, 13 per cent to defective sets, etc. At a recent radio show 44 firms exhibited interference eliminators. Out of 49,000 complaints received by the English authorities in 1932, 37 per cent were caused by high frequency medical devices, 8 per cent by power stations, 15 per cent by other receiving sets.—*Revue gen. Electricite, 33: 247-253, 1933.*

✦

Measuring man-made static

[W. WILD, Committee on man-made static of the Society of German Engineers] Practically all the appliances which become a nuisance owing to sparking emit waves which cover continuously the entire broadcast band, the strength being inversely proportional to the frequency. The measured effective voltage level varies with the square root of the band width. The instrument designed measures the intensity of bands of definite width in the region from 150 to 1,500 kc. and allows the load to be varied from open to short circuit conditions. It consists of connectors to be



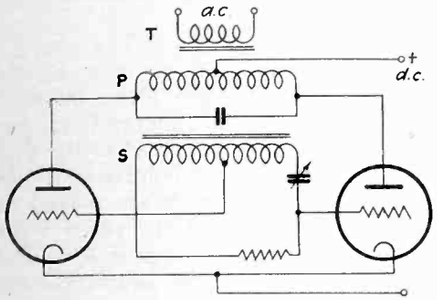
attached to the terminals of the appliance (symmetrical connection) or to one terminal and the body (housing, support) of the noisy machine (unsymmetrical connection). Then follow a rejector circuit, an attenuator 1:1,000 by means of which the load can be varied, a tuned circuit, an aperiodic r-f amplifier (4 stages), the main band-pass filter with a dynatron for introducing negative resistance, a second aperiodic r-f amplifier (2 stages), then either an r-f vacuum-tube bridge voltmeter for measuring steady disturbers or an impulse meter for intermittent noises. The damping due to the instrument varies very little between 200 and 1,500 kc. Curves show the complex resistance of a vacuum tube cleaner spark and a warm air drier at different r-f—*Elektrotechn. Zeits. 54: 149-152, 172-175, 1933.*

✦ ✦ ✦

Radio set for locating source of man-made static (Tobe Deutschmann)

Inversion by means of grid-controlled rectifiers

[H. FRUEHAUF, General Electric Co., Berlin] The inversion d.c. interests the radio engineer because it offers a simple means of obtaining a.c. for the batteryless set in districts where only 110 volt d.c. is available. The transformation is based upon the sudden drop in voltage which occurs when the discharge starts in one of the two thyratrons mounted in parallel with (between the plates) a center-tapped transformer shunted by a condenser (center-tap positive, cathodes negative). The impulse produced in the



transformer sends a reverse current through the tube which is operating and interrupts the discharge, the sudden discharge of the condenser provides the voltage necessary for controlling the grid (transformer secondary) and the desired a-c power (tertiary). It is possible to draw 100 watts from a glass tube of ordinary rectifier size, but the shape of the wave leaves much to be desired (see also *Electronics, April, 1931.)—Radio-Helios 10: 9-12, 1933; also A. W. Hull in Physics 4: 66-75, 1933.*

✦

High-powered transmitters system

[LORENZ.] A typical feature of the Lorenz transmitters (Leipzig 120 to 150 kw., the largest German transmitter, Munich 60 kw.) is the complete separation of the different r-f amplifier stages. Leipzig has seven stages, all housed in metal cabinets several meters apart; the two last stages being in duplicate with the sixth stage consisting of two 40 kw. tubes, the last stage of four 140 kw. tubes. Munich has the same circuit, but the last stage contains only two tubes in all. Both transmitters have wooden towers, and the antenna is suspended 200 m. from the transmitter building.

During spring and summer of 1932 the number of German listeners began to decrease, but the whole year showed a gain compared to 1931, and the high powered stations seem to revive the interest.—*Radio-Helios 10:3-4, 1933.*

Photocells for the ultra-violet

[A. H. TAYLOR, General Electric Company, Cleveland.] Although many diseases are caused by germs little affected by ultra-violet light, interest in this field continues unabated. Sodium cells in quartz or in Corex D bulbs are frequently used for measuring intensities. In addition the variation of the photoelectric sensitivity (combined with the effect of the glass or quartz wall) of cadmium and titanium cells is shown. Only the cadmium cell is practically insensitive to light waves longer than those producing sunburn, and while it gives a small photoelectric effect a gas-filled cell with a Leeds and Northrup galvanometer is satisfactory in the measurement of the ultraviolet energy in sunlight and sunlamps. — *Journal Optical Society 23:60-66, 1933.*

✦

Vapor pressure in oxide-coated tubes

[A. CLAASSEN, C. F. VEENEMANS and W. G. BURGERS, Philips' Research Lab.] The vapor pressure of barium oxide is given (in mm. mercury) by log p=8.87 — 19,700/T between 1,200 and 1,500° abs., that of strontium oxide by log p=13.12—30,700/T between 1,500 and 1,650° abs. In mixtures the vapor pressure depends only on the percentage of the components. Layers of oxide 100 to 200 microns thick deposited upon platinum (30 sq.cm.) were used in this investigation. At a temperature of 1,500° abs., one molecular layer of strontium oxide and 42 layers of barium oxide are evaporated per minute; at 1,100 it takes 120 minutes before a molecular layer of barium oxide is boiled off.—*Zeits. Physik 80: 324-352, 1933.*

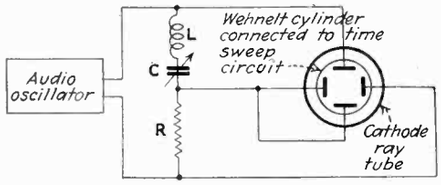
✦

Calibration of microphones

[W. GEFFCKEN and L. KEIBS, Breslau Institute of Technology] Report that although the theory of the thermophone commonly used for calibrating microphones (E. J. Abbott, Journal Acoustical Society 4:235-244, 1933) has been corrected on several occasions, it is found that the formula for calculating the sound pressure produced by the electrically heated wire or foil ceases to be valid when the temperature of the conductor is distinctly above room temperature. In Annalen d. Physik 16:404-430, 1933, they deduce a new formula which is in complete agreement with experimental results when applied to the wire thermophone. This type of thermophone, which has cylindrical symmetry, is useful on account of its constancy. The formula was checked by studying the threefold intensity of hearing.

Modulated deflection of cathode-ray beam

[H. E. HOLLMANN and W. SARAGA, Heinrich Hertz Institute] When a-c curves are studied with the aid of the cathode-ray tube, an alternating analyzing voltage being applied to the deflection plates, the shape of the figure obtained is independent of the sign of the phase difference between the two voltages. The direction in which the figure is written changes with the sign, but it is difficult to follow the beam even at fairly low frequencies. The sense in which the curve is described may be



deduced with the aid of the stroboscope or more simply, by applying an auxiliary voltage (time deflection) to the plate. The figure obtained now presents dark and light portions which seem to be wandering along the curve,, and the angular velocity of a given spot has the same sign as the phase difference mentioned above, provided that the number of times the curve is written per second divided by the modulating auxiliary frequency is larger than 1 or ½ or ⅓. The properties of series resonant circuits of grid and plate voltage opposition in a tube and of phase differences at different distance from a loudspeaker are readily shown.—*Hochfr. Techn. & El. Ak. 41: 53-56, 1933.*

✦

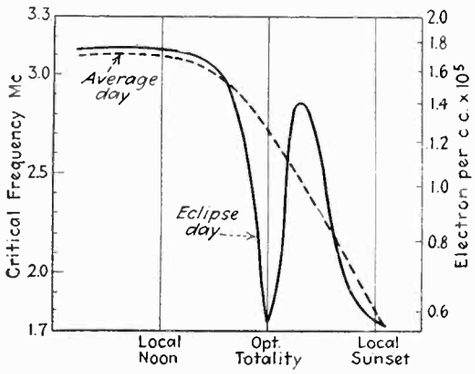
Speed regulation grid-controlled rectifiers

DIRECT CURRENT IS USED as a rule for equipment which has to run under a great variety of conditions. The direct current can be produced from a.c. and regulated at the same time by means of grid-controlled mercury arc rectifiers which are now made in glass containers for all sizes up to 200 amps. 3,000 volts. As shown by the French engineer Toulon the simplest way of varying the output is to apply an a-c voltage to the grid; if it is in phase with the plate voltage, the current passes freely; if it is in phase opposition no current passes; if the phase difference is reduced, the current can be set to have any desired value. The proper phase difference can be applied through a governor. An installation of such a rectifier with motor for hauling coal to the furnace of a power station is briefly described. Thyratrons and grid-glow tubes have also proved to be reliable for electric railways when protected against short circuits and overloading. — *Elektrot. Zeits, 54: 13, 1933.*

Solar eclipse and radio waves

NEWS OF THE BEHAVIOR OF radio waves at the time of the solar eclipse, August 31, 1932, is now making its way to the light. (See *Electronics*, August, 1932.) According to *Science* (76:444-446, 1932), tests on 2,398 kc., 3,493 kc. and 4,798 kc. (or 125 m., 86 m. and 62.5 m.) made at Deal, N. J., by Schafer and Goodall, gave minimum ionization ten minutes after the optical totality. The two shorter waves were invariably returned by the upper layer.

The method used by the Canadian expeditions (J. T. Henderson, McGill University, Canadian *Journal of Research*, 8:1-14, 1933) was to have trans-



mitters (one near Ottawa, the other near Kingston) send signals of half a millisecond duration each. These signals reach the receiver by two distinct paths, one wave traveling along the surface of the ground, the other rising to the reflecting region and descending to the receiver placed about two miles from the transmitter. The lag of the second signal behind the first is a measure of the equivalent height to which the sky wave has traveled assuming a straight path. To measure the electron concentration (N per cu.cm.) the frequency of the transmitter is increased until at a certain critical value the sky signal is no longer sent back by the layer E, but comes from the upper or Appleton layer. $N = 0.184/10^7 f^2$. The change in N shown by the curves leaves no doubt that the ionizing agent producing the lower layer disappears with the shutting off of the sun's rays by the moon. Minimum ionization (60,000 electrons per cu.cm.) coincides with totality to within three minutes for the upper as well as the lower layer (as against 170,000 at noon). The frequencies used varied between 1,500 and 6,000 kc. Unfortunately, a magnetic disturbance began several days before August 31 and was still in progress during the day of the eclipse. It may explain the queer observations on 35-meter waves which Alexanderson reported in *Radio Engineering* for October, 1932, but which have little to do with the main question studied this year.

Measuring the moisture content of wheat, electrically

[H. E. HARTIG, University of Minnesota, and B. SULLIVAN, Russell-Miller Mining Co.] A parallel plate condenser, between which a thin, hard rubber cell could be inserted, was connected in one arm of a General Radio shielded capacity bridge. In the measuring arm of the bridge was connected a precision variable air condenser and an 11,000-ohm decade resistance box. In shunt with the parallel plate condenser a 100 uuf. fixed air condenser was connected for the purpose of increasing the current through the bridge and thereby the sensitivity of adjustment. To indicate balance a Western Electric four-stage vacuum-tube amplifier-voltmeter was used. Current was supplied by a vacuum tube oscillator.—*Industrial and Engineering Chemistry Anal. Edition, 5: 107-110, 1933.*

✦

Grid and plate currents in a grid-controlled mercury vapor tube

[A. C. SELECTZKY and S. T. SHEVKI, Case School of Applied Science, Cleveland] About 10 oscillograms are given and discussed, each showing for chosen operating points plate and grid voltage, plate and grid current of a commercial thyratron (60 cycles, 1,100 volts r.m.s. on plate, 4 amp.) The grid current lags somewhat behind the grid coltage and its direction depends not only upon the sign, but also upon the magnitude of the grid voltage. An increase of one volt in the grid potential may modify the shape of the grid current wave quite considerably. When the grid voltage is in phase with the plate voltage, the grid current curve may assume a variety of shapes depending upon the grid voltage. When the grid voltage leads the plate voltage, positive grid current flows as long as the plate is negative, and the reverse is true when the grid voltage lags the plate voltage. During this time the plate current is negative. An inverse plate current of the order of milliamperes always flows when grid current is delivered during the negative half cycle of the plate voltage.—*Journal of the Franklin Institute 215:299-326, 1933.*

✦

Everyday photometry with photo cells

[J. W. T. WALSH, National Physical Laboratory] The different characteristics and limitations of the three main types of photo cells, based on the external photo-electric effect (Elster-Geitel) the internal effect (selenium) and the combined photo electric and detector cell (barrier layer cell), are reviewed. The applications of the cells to the measurement of candlepower, luminous flux and illumination, the determination of polar curves, and the preparation of records of illumination are then described in some detail. For ranges of illumination below the Elster-Geitel cell must be used in combination with an amplifier.—Illuminating Engineer 26:64-72, 1933. Photo effects in semi-conductors are also described by B. Lange in a preprint (63-8 of the Electrochemical Society, p. 69 to 81).

✦

The Ninth French Radio Exhibition

[MICHEL ADAM.] A common feature is the use of band-pass filters in tuned receivers, either as intermediate elements or directly connected to the first tube (so-called super-inductance). In this latter case the coils are wound on glass supports so that the phase angle does not exceed half a degree as against ten times this value for ordinary coils. This leads to frequency response curves which are considered satisfactory. In superheterodyne sets band filters comprising as many as seven circuits are in use. The speaker with permanent magnets has staged a comeback, the strength of the field being increased by the use of cobalt steel. Indirectly heated cathode-tubes are much in use, and the variable mu tube has assumed the name "selectode"in France. —*Revue gen. de l'Electricité. 32: 845-851. 1932.*

✦

Transmission lines for meter-waves

[F. BAHNEMANN, University of Jena] —The telegraph equation continues to apply at these high frequencies provided that all the components of the equipment be arranged as symmetrically as possible. The potential distribution along the wires was measured directly (wavelength 2.6 m.) by means of a detector tube having two filaments in series, each facing a separate plate, the plate terminals being used to support and shift the tube. The potential produced by the rectified wave is compensated by d.c. When the generator is not symmetrically coupled to the wires, potential differences exist between opposite points and the line loses energy by radiation. With ohmic losses along the amplitude decreased about 5 per cent along copper wires 1 mm. thick and 40 m. long. For matching surge impedance and output, two parallel wires side by side are used when the load resistance is large, and two concentric wires for light loads (see in this connection *Proc. I.R.E. 20: 1163-1202. 1932.—Hochfr. u. El. Ak. 40: 189-198. 1932.*

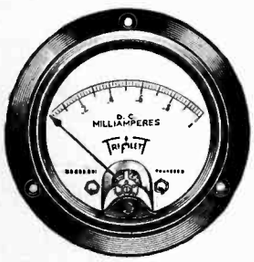
+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Moving-coil instruments

THE TRIPLETT ELECTRICAL INSTRUMENT COMPANY of Bluffton, Ohio, has just announced a new line of D'Arsonval moving-coil instruments, designed to register accurately, under severe service conditions. Two sizes of these instruments are made—in three case models. They are furnished in low-reading micro-ammeters, milli-ammeters, voltmeters up to 2,000-volts, milli-voltmeters, and ammeters.

The new instrument fits around a moulded Bakelite plate in which the terminals and assembly studs are firmly anchored. This construction combines accuracy and high insulating qualities. The metal dials are enameled permanently white with black lithographing. . .



resulting in a most durable and attractive finish. Fine sapphire jewel bearings are used. The aluminum needle and other parts are ribbed and made unusually strong throughout. The moving coil is light in weight. The scales are extra long, uniform, and easy to read.—*Electronics, April, 1933.*

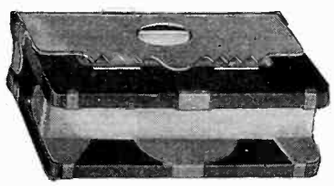
✦

Neon lightning arrester

L. S. BRACH MANUFACTURING CORPORATION, 55 Dickerson St., Newark, N. J., has developed a new neon lighting arrester for the protection of telephone, fire and police signaling, railway signaling, telegraph, radio broadcasting and other low-voltage circuits. These arresters can also be used in protection of cable wires and coil shunting, by being placed across the terminals of relays, resistors, etc.

An important feature of this type arrester is its very small and compact size ($\frac{3}{8}$ in. wide by $1\frac{1}{4}$ in. long) arranged to mount on $\frac{1}{2}$-in. centers. It will fit in standard telephone-arrester spring mountings and is interchangeable with carbon mica or carbon porcelain units.

The arrester consists essentially of a small glass tube containing two specially chemically-treated metal electrodes in neon-argon gas. The electrodes are separated approximately $\frac{3}{32}$ in. The glass tube is encased in a metal and bakelite holder so as to form a very rigid unit capable of withstanding considerable rough handling, thoroughly protecting the glass tube from injury.



Notwithstanding the wide spacing of the electrodes this arrester can be made to function at any predetermined voltage and below this operating voltage the insulation of the circuit remains constantly high. The arrester functions as a safety valve with great speed and while functioning has a very low impedance resistance.

These arresters may be easily tested either by placing across the terminal of an induction coil or placing across the spark plug of an automobile.—*Electronics, April, 1933.*

✦

A-C remote-control amplifier

THE REMLER COMPANY, 2101 Bryant St., San Francisco, Calif., announces two new pieces of broadcast equipment to supplement the Remler condenser microphone. These consist of an all a-c operated remote control amplifier and microphone power supply and an a-c power supply for condenser microphones. The first is a three-stage amplifier of improved design, together with power supply. The amplifier brings the microphone output to a maximum of plus 10 decibels input into the telephone line to operate normally at a plus 2 db. level. Output is flat within plus and minus 1 decibel, over the audio

range of 40 to 10,000 cycles. Equipped with level indicator and attenuator calibrated in decibels, both units are housed in a single attractive duco-finished metal cabinet 21 in. by 9 in. by 10. The weight is 40 lbs. The other device is an a-c power supply for both studio and remote installations.—*Electronics, April, 1933.*

Paper-dielectric condensers

"THERE IS NO SUBSTITUTE FOR quality" is the motto that has been adopted as the maxim of Wego Condensers, Inc., 729 Seventh Ave., New York City, for its paper dielectric condensers. Applying careful attention to minute details of design, construction and practicability, the windings are compact and non-inductive. They are impregnated in several special-process vacuum vats and the containers are small, well-insulated and light in weight yet very strong and durable. The capacity tolerance has been brought down to within five per cent plus or minus, as closely as the most advanced engineering skill will

permit. The ratings are conservative and are in strict accord with recognized advanced engineering practice, and wholly borne out by the remarkably fine record of results enjoyed by all types of users everywhere—broadcast and amateur stations, airplane, short-wave and television stations, service technicians, experimenters and public address amplifier constructors, and manufacturers of radio and electrical equipment and devices.—*Electronics, April, 1933.*

✦

Special coils

THE GENERAL MANUFACTURING COMPANY, 8066 South Chicago Ave., Chicago, Ill., announces the development of an additional coil combination to be used in conjunction with the very recently developed miniature type variable condenser now being produced by the leading condenser manufacturers with special oscillator section ranging between 450 and 465 kilocycles for use in five-tube superheterodyne two-gang receivers.

Blueprints of lug positions on standard coils are available at the present time, and on request a blueprint for the five-tube superheterodyne circuit can be supplied.—*Electronics, April, 1933.*

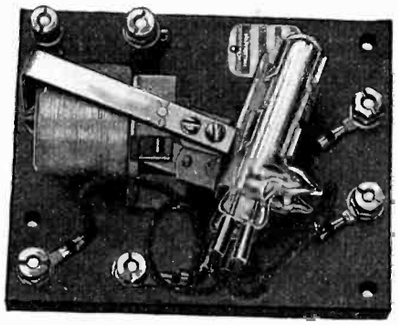
Electrostatic voltmeters

THE SENSITIVE RESEARCH INSTRUMENT CORPORATION, 4545 Bronx Boulevard, New York City, announces a new line of direct reading electrostatic voltmeters. These operate on the principle of the attraction and repulsion of electrified surfaces. The ranges obtainable run from 20 volts full scale in the type ES, reading down to 5 volts, and in the type EWC up to 40,000 volts full scale. The average scale length is 6 inches. The instruments are shielded from extraneous charges and fields are so designed that there is a minimum of danger to the operator in the high-voltage types.—*Electronics, April, 1933.*

✦

Mercury swing-type relay

STRUTHERS DUNN, INC., manufacturers of "Dunco" products, 139 N. Juniper St., Philadelphia, Pa., has just brought out a new type of Dunco mercury swing-type relay in which the designers have attempted, as far as possible, to move the glass around the mercury



rather than the mercury in the glass. These relays have proved themselves useful in many applications where silent, sure and sparkless operation is essential. The new Struthers-Dunn P-32 sheet describes this unit, which is representative of the mercury-tube relays.—*Electronics, April, 1933.*

✦

Reflection meter

THIS NEW PHOTOELECTRIC reflection meter provides an extremely sensitive means of comparing and measuring the total reflection factors of *similar* opaque materials. The instrument is designed to illuminate an area of approximately three square inches of the material under test, and to measure on a comparative basis the total illumination reflected from this area of the material. The standard for comparison may be another similar sample, the surface of a block of magnesium carbonate, or any other desirable standard. The sample whose total reflection factor is to be measured is illuminated by a parallel beam of light normal to the surface under test. It is "viewed" by two Photronic cells placed at an angle of 30 degrees from this surface. The combined output from these Photronic cells is applied to a Weston model 440, zero-center galvanometer and balanced by the steady output of a third Photronic cell applied to the galvanometer through a slide wire bridge contained within the instrument.

The device was developed by Elmer Lyford and Monroe Barnard, of the American Photo Electric Corporation, 215 Third Ave., New York City.—*Electronics, April, 1933.*

✦

Core material for coils

THE MANUFACTURERS OF Inca coils at Ft. Wayne, Ind., have introduced a new rigid core which they have named Tru-Form, because it holds its shape and does not bulge or buckle as paper cores of the square type often do.

These new cores are manufactured under a patented process from a treated and re-inforced wood with corners perfectly mitred by special machinery.

The manufacturers who have been using these new Tru-Form coils over a period of time claim that much labor and material is saved which heretofore has been wasted, due to the difficulty of inserting the core laminations in coils where core tubes have buckled.

Information and samples may be secured from the Inca Manufacturing Division of Phelps-Dodge Copper Products Corporation, Ft. Wayne, Ind.—*Electronics, April, 1933.*

✦

Magnetic speaker

THE NEW "HYFLUX TRUMPET" is a very powerful magnetic-type speaker which has exceptional carrying capacity for this type of horn. It is light enough to be easily handled, and therefore is adaptable to all kinds of temporary sound installations. Strong metal reinforcement at the throat and in the middle of the horn insures it against damage from rough handling. The double magnet in the unit of the Hyflux Trumpet allows it to handle a great deal of power without reducing its efficiency.

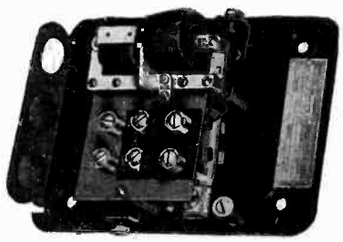
The Hyflux Trumpet unit will stand considerable power, in fact, the guarantee holds good for three watts, but one and one-half watts is recommended because it is the correct input to secure the maximum efficiency. Technically, the armature saturates at approximately one and one-half watts, therefore, any added power does not increase the sound proportionately. This small wattage makes it possible to cover a great area, by the use of a number of horns, without the necessity of a large powerful amplifier.

Finished in black weather-proof duco, the Hyflux Trumpet will stand any kind of weather. Total length—3 ft. 9½ in. Opening at bell 20 in. Weight 15 lbs., boxed for shipment. Normal operating input 1½ watts. Price, $60.—*Electronics, April, 1933.*

Mercury contact

THE MERCOID TYPE V TRANSFORMER relay meets the severe service conditions encountered with frequently operating automatic equipment, such as oil burners, stokers, air conditioners, electric heaters, traffic signals, etc. It is also adaptable for many other applications requiring a thoroughly dependable remote control.

This very simple and compact device is in principle a low voltage transformer, but also operates as a repulsion relay. It meets the demand for a



positive and reliable low voltage relay by incorporating the Mercoid sealed mercury contact switch, and also by overcoming many inherent weaknesses heretofore characteristic of low voltage relay equipment.

The hermetically sealed Mercoid switch completely eliminates possibilities of open arcing, oxidation, corrosion or pitting of contacts.

As this transformer-relay does not employ the conventional clapper type iron armature, noises due to uneven, dirty or rusty armature faces cannot occur. Furthermore, there can be no residual magnetism to affect the operation as there are no metal contacting surfaces.

This relay acting as its own transformer, induces low voltage (24 volts) on the pilot circuit, thus eliminating the necessity of an externally connected low voltage transformer. It is made by the Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.—*Electronics, April, 1933.*

✦

Radio dials, controls and escutcheons

THE CROWE NAMEPLATE AND MANUFACTURING COMPANY, 1749 Grace St., Chicago, Ill., makes a complete line of direct-drive dials, tuning units, controls, nameplates, embossed escutcheons and similar radio products for equipping radio receivers. All of the tuning units have the Crowe wedge drive, except when otherwise noted. This is a smooth and powerful mechanism which gives satisfactory control. The brackets or frames in the regular output of the Crowe Company are standard for 90 per cent of the concern's production, but the company announces that it is equipped to form special bends to fit manufacturers' chasses or condensers.—*Electronics, April, 1933.*

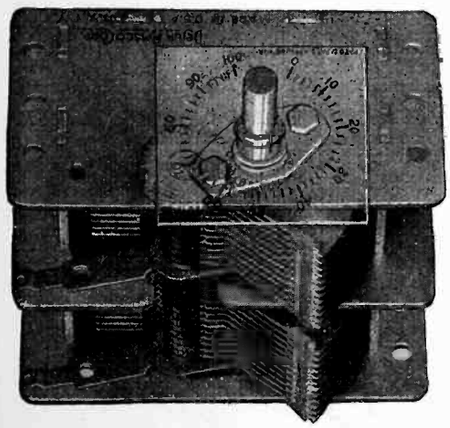
Mobile a-c supply sources

RADIO CHASSIS, 116 West 18th St., New York City, now offers a complete line of readily-attached automobile generators with outputs of 32 volts and 110 volts, and powers of 50, 100, 150, 200, and 300 watts. These units provide close voltage regulation and can be easily installed in the car. They are particularly adapted for sound equipment, also for aircraft radio (special wind-driven type), police radio, and emergency alternating-current supply for any standard 110-volt device. List prices range from $38.50 to $139.50.—*Electronics, April, 1933.*

✦

Tuning condensers and accessories

THE DEJUR-AMSCO CORPORATION, 95 Morton St., New York City, has developed its midget variable condenser with special reduction drive for use on universal a.c.-d.c. radio receivers, automobile radios, and short-wave receivers. This new unit is especially applicable to superheterodyne receivers to improve tuning facility. No mechanical changes



are necessary in cabinet or chassis. The knob rotates through 320 degrees. Variable condensers are also available with or without reduction drive for tuned-radio-frequency, 175 and 456 kilocycle receivers.

Other tuning accessories manufactured by the DeJur-Amsco organization include 90-degree full-vision friction-drive dials, 180-degree dials, direct-drive dials, sector-vision dials, bevel traveling drives, and dial-light sockets.—*Electronics, April, 1933.*

✦

Cathode-ray screen material

A NEW SCREEN MATERIAL developed by the Allen B. Du Mont Laboratories, Upper Montclair, N. J., for use on cathode-ray tubes produces a spot intensity five times as brilliant as any screen previously used. This is particularly valuable for photographic recording. A unique feature of this screen is the ability to retain for well over a minute any wave or figure applied to it when used in a darkened room or hood. This feature however in no way affects the use of the tube for ordinary oscillograph use or for photographic recording, because of the large difference between the spot intensity and the afterglow. Any of the various styles of cathode-ray tubes made by this laboratory can be supplied with this new screen at slight additional cost.—*Electronics, April, 1933.*

✦

Coils for small radio sets

THE GENERAL MANUFACTURING COMPANY, 8066 South Chicago Ave., Chicago, Ill., offers to the radio industry an entirely new winding never before provided for broadcast purposes. Such a winding has been offered for commercial long-wave use, but its adaption to the broadcast band for mass production of radio receivers is an entry into a new field of coils.

Until the present time lattice-wound coils have been the only available type of winding to meet the pressing demands for extremely small coils for the present day miniature sets, which type of winding, although answering this purpose, has not proved entirely satisfactory, in view of the extremely low gain and distributive capacity.

The new four-bank winding, although extremely small in physical dimensions, involves no sacrifice of efficiency. At 600 kc. the interstage coil, when measured in a single stage gain test with a number 58 tube, proved a gain of 110 times input, and at 1,500 kc., a gain of 65 times input. Although the above figures are given for the limits of the broadcast band only, this coil when properly balanced with any of the present standard low minimum variable condensers has an extended frequency coverage between 540 and 1,700 kc.—*Electronics, April, 1933.*

✦

Radio modulator

SHURE BROTHERS COMPANY, 337 West Madison St., Chicago, announces its new radio modulator which employs a modulated oscillator circuit.

It is thoroughly shielded and carefully designed to prevent radiation. A two-button microphone of the professional type is used, and consequently the quality of reproduction that comes out of the radio loudspeaker is comparable to the finest broadcasting stations. Some of the modern sets have such excellent tone quality and enormous reserve of power that the combination makes an ideal public-address system—and at a very low price. The list price is $33.50, complete with three tubes, microphone, and 50 ft. of cable subject to usual dealer and distributor discounts.—*Electronics, April, 1933.*

Choke coils

IN HIGH GAIN CIRCUITS circulating currents must be kept at a minimum. Efficient filtering requires the use of adequately designed choke coils. Such a choke coil is the Type 6A, manufactured by the General Communications Laboratories, Ridgefield Park, N. J. In the development of this choke a new method of measurement has been devised, whereby actual performance characteristics in the working frequency range are determined. The present general practice is to make such measurements at 1,000 cycles. Choke coils, for which distributed capacitance values of 3–4 $\mu\mu t$ are claimed, actually measure 22–19 $\mu\mu f$ respectively, at radio frequencies. The important performance index of an r-f choke coil is not the inductance but the distributed capacitance.

The r-f characteristics of the 6A choke coil are as follows:

Apparent inductance	39 mh
Real inductance	24.5 mh
Distributed capacitance	12.5 $\mu\mu t$
Fundamental anti-resonant frequency	276 kc.
D.C. resistance	145 ohms
Current carrying capacity	80 ma.
Actual suppression with 0.1 μt by-pass	59 db.
Working range	500—20,000 kc.

The list price of the 6A choke coil is $1.—*Electronics, April, 1933.*

✦

Manufacturers' bulletins and catalogues

Short-wave antennas—Installation diagrams of the Lynch antenna system. Arthur H. Lynch, 1775 Broadway, New York City.

Antenna materials—Aerial kits, arresters, shielded lead-in wire, cables, magnet wire. Belden Manufacturing Company, Chicago, Ill.

Instrument fuses—Low-range and high-speed fuses, radio fuses, high-voltage fuses. Circuit diagrams. Catalog No. 5, 1933. Littelfuse Laboratories, 1772 Wilson Ave., Chicago, Ill.

Condenser Microphones—Remote control amplifier and a.c. microphone power supply. Accessories. Remler Company, Ltd., 2101 Bryant St., San Francisco, Cal.

Resistor units—Vitrohm radio products, resistors, rheostats, magnetic relays, voltage reducers. Circular 507. Ward Leonard Electric Company, Mount Vernon, N. Y.

Microphones—Demountable models, hand microphones, etc. Ellis Electrical Laboratory, Inc., 189 West Madison St., Chicago, Ill.

Self-tapping screws—Hex-head hardened self-tapping screws for radio-set assembly. List of stock sizes. Parker-Kalon Corporation, 200 Varick St., New York City.

Rheostats—Air-cooled, water-cooled, non-inductive, precision-adjustment, high-voltage and other special rheostats. Bulletin No. 4, Central Scientific Company, 460 E. Ohio St., Chicago, Ill.

Condensers—Electrolytic units, oil-filled capacitors, by-pass condensers, paper condensers, automobile-ignition suppressors, light-socket antennas, transmitting condensers, etc. Catalog No. 123. Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City.

Photo-electric relays—Foto-switch units for commercial and experimental use. Illumination controls, counters, filters, etc. Bulletin 156-A. G-M Laboratories, Inc., 1731 Belmont Ave., Chicago, Ill.

Solder—Flux-filled solder. Gardiner acid-core solder. Gardiner Metal Company, 4820 South Campbell Ave., Chicago, Ill.

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Electronic Applications

Train control. A series of patents Nos. 1,900,403 to 1,900,412 inclusive using electron tubes for the control of trains, etc. L. O. Grondahl, assigned to the Union Switch and Signal Co.

Power circuits. A series of patents on electrical control and transmission of power from one circuit to another using electron tubes. All assigned to the G. E. Co. by various patentees. No. 1,902,462, No. 1,902,460, No. 1,901,694, No. 1,900,538, No. 1,902,495, No. 1,902,468.

Moisture measuring device. Moisture in the material to be tested changes the grid potential of an amplifier. Therefore the moisture can be measured on a plate-current meter. C. B. Limbrick, Fort William, Ontario. Filed Aug. 23, 1930. No. 1,890,545.

Measuring percentage of modulation. A modulator and an oscillator coupled by a potential transformer and a watt-meter. J. D. Wallace, Washington, D. C. Filed March 12, 1931. No. 1,884,934.

Automatic oscillograph. A method of recording both conditions leading up to a circuit disturbance and the disturbance itself consisting in temporarily magnetically storing the effect of the condition, recording a predetermined portion of the circuit condition preceding the disturbance and recording the disturbance. C. M. Hathaway, assigned to G. E. Co. Filed June 5, 1931. No. 1,883,907.

Gas-tube amplifier. Method of using a tube provided with an external control electrode, an atmosphere of gas within the tube, the relation between its geometry and the gas pressure being such that at radio frequencies amplification takes place more efficiently than audio frequencies. G. Jobst, J. Richter and W. Wehnert, Berlin, Germany. Filed Jan. 24, 1931. No. 1,889,749.

Television system. Apparatus using a Braun tube or cathode-ray tube for television purposes. August Karolus, assigned to R.C.A. Filed Nov. 30, 1928. No. 1,889,990.

Testing apparatus. Method of testing dielectric material by maintaining the material for a predetermined length of time between a potential difference of a value sufficient in that length of time to cause breakdown if the dielectric strength falls below a certain value. D. M. McBean, assigned to Beech-Nut Packing Company. Filed Nov. 7, 1930. No. 1,890,063.

Vibration recorders. Two patents to Frank Rieber, San Francisco. No. 1,902,183 and No. 1,902,184. Method of using electron tubes for measuring and recording earth vibrations, one using a piezo-electric device.

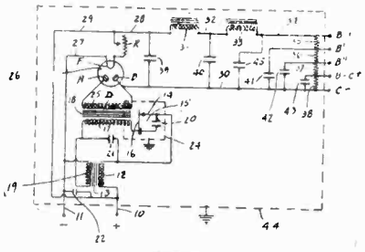
Position determination. System for controlling an electric circuit in response to a change in the position of a body with respect to a wire or other conductor connected to the grid of a vacuum tube. The circuit is a bridge system in which the grid is connected to the anode through a condenser so that the tube is normally non-conducting. Relatively small changes in the capacity of this condenser produced by change of any position of the body causes it to conduct. C. F. Whitney assigned to G. E. Co. No. 1,900,596.

Electric heating apparatus. Method of high frequency heating by means of an electrostatic field. E. P. McArthur assigned to G. E. Co. No. 1,900,573.

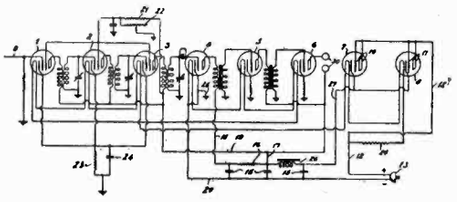
Picture transmission. Three electrode valves connected to a light sensitive cell and a means for periodically charging a condenser to interrupt the flow of current from the valve, so that the series of interruptions in the flow of current from the valve is in inverse proportion to the intensity of illumination from the cell. Otho Fulton, Bromley, England. No. 1,902,552.

Radio Circuits

D.C.-A.C. circuit. Method of using a vibrator and a transformer plus a rectifier and filter for obtaining a-c power from a d-c source. C. C. Wilson, Alexandria, Indiana. Filed April 25, 1930. No. 1,900,215.



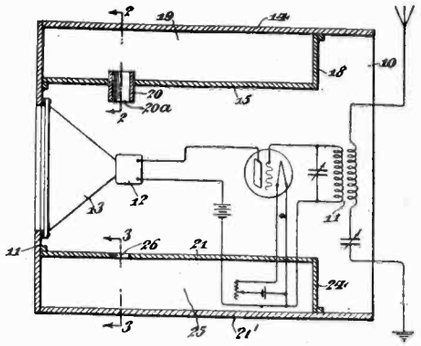
A.C.-D.C. system. Circuit in which the filaments or heaters of the tubes are connected in series and other means whereby the entire system can be energized by direct or alternating current. R. P. Wuerfel, Ann Arbor, Mich. Filed Oct. 19, 1932. No. 1,900,629.



Shield grid tube. Combination of cathode, anode, control grid and shielding means for intercepting the electrostatic lines of force extending between the electrodes. A. W. Hull assigned to G. E. Co. Filed March 3, 1924. No. 1,900,559.

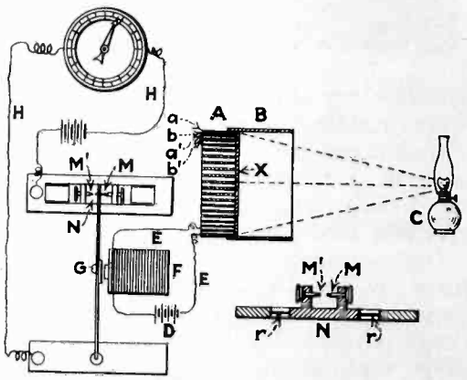
Frequency changer. Four electrode tube in which an auxiliary cathode is placed at the opposite side of the conventional cathode from the plate and nearer to this cathode than the plate. Lucien Levy, Paris, France. Filed Oct. 29, 1928. No. 1,899,622.

Elimination of cabinet resonance. During the operation of the loud speaker a relatively low pressure region is developed at a region about the diaphragm within the cabinet where a relatively high pressure region would otherwise develop. This is done by a vibratory member associated with the cabinet and means within the cabinet providing a resonator to compensate for acoustic action of the cabinet. Irving Wolff assigned to R.C.A. Filed April 18, 1930. No. 1,901,388.



Piezo-crystal receiver. Method of eliminating the heterodyne note resulting from interference between two signals of closely adjacent frequencies comprising selecting from the received signal energy, the energy which is mainly of the frequency of one of said signals; separating a relatively small amount of the total received signal energy and combining said small amount of energy in phase opposition with the said selected signal energy. James Robinson, assigned to British Radiostat Corp. Filed June 9, 1930. No. 1,898,895.

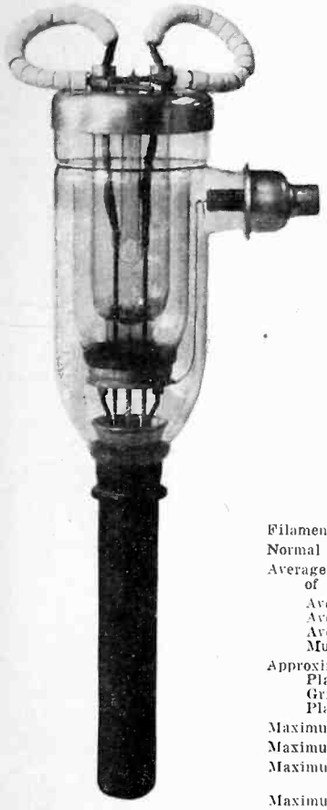
Light-Sensitive Counter—1885



Through the courtesy of Mr. Samuel Wein the above circuit is reproduced from the patent papers of C. W. Weiss. It indicates a source of light, a light-sensitive surface (selenium) operating a relay and a counter. The patent was applied for in 1884 and granted June 10, 1885. The patent claims, "the method of actuating a registering device which consists in causing each person or object passing a given point to intercept rays of light falling upon a selenium surface included in an electric circuit whereby another circuit is closed and a registering device therein actuated."

Federal Telegraph Company

offers to tube users



F-307-A **20 KW**

Typical Water Cooled Tube

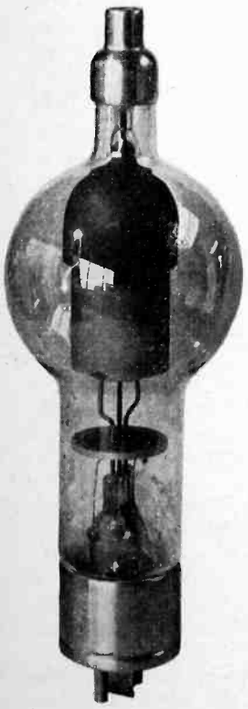
Exclusive Constructional Features

Sturdy Tripod grid support combining unique heat dissipation features.

Tipless stem insuring perfect alignment of internal elements. Rugged grid seal exclusive in Federal tubes making them capable of carrying higher radio frequency grid currents than most other tubes on the market.

CHARACTERISTICS

Filament Voltage	22 Volts
Normal Filament Current	52 Amperes
Average Characteristics with Plate Voltage of 7,000 volts and zero grid bias:—	
Average Plate Current	1.9 Amperes
Average Plate Resistance	3,500 Ohms
Average Amplification Factor	20
Mutual Conductance	5700 Micromhos
Approximate Direct Interelectrode Capacities:	
Plate to Grid	27 Mmf.
Grid to Filament	18 Mmf.
Plate to Filament	2 Mmf.
Maximum Operating Plate Voltage	15,000 Volts
Maximum Plate Current	2 Amperes
Maximum Continuous Plate Dissipation	10,000 Watts
Maximum Overall Length	20¼ inches
Maximum Diameter	4 3/16 inches



F-369-A

Typical Mercury Vapor Rectifier

Latest Constructional Features

Complete shielding of arc discharge:—

- Giving higher arc back voltages.
- Decreasing effective bulb blacking.
- Diminishing effect of radio frequency fields.

Special cathode construction insuring the permanency of the oxide coated filament and consequent longer life.

CHARACTERISTICS

Filament Potential	5 Volts
Filament Current	20 Amperes
Approximate anode cathode potential drop when conducting	15 Volts
Maximum Peak Plate Current	5 Amperes
Maximum Peak Inverse Potential	20,000 Volts
Maximum Overall Length	14⅜ inches
Maximum Diameter	5 3/16 inches

A Research and Manufacturing Organization — Federal Telegraph Company experience in Radio dates back to the early Poulsen Arc era. It maintains an engineering staff associated with Dr. Frederick Kolster. Its specific tube manufacturing experience includes tubes of such wide varieties as are used by telegraph, telephone and wireless communication companies.

A Line of Standard Tubes — Federal Transmitting Tubes are built for service and proven by years of successful operation in exacting communication services, such as point-to-point and ship transmitters. Federal tubes include oscillators and amplifiers at all frequencies and all rectifier types and sizes. Rigid manufacturing and testing requirements insure tubes of uniform quality and long life. Ideal for radio and industrial uses. *Federal offers equal or greater efficiency in terms of better performance and life per unit cost.*

A Special Tube Manufacturing Service — Because of extensive research facilities, Federal is able to undertake the design and manufacture of any special tubes as may be required in radio or industrial applications. The development of the 18 cm. ultra-high frequency oscillator is typical. Problems in providing tube types such as amplifiers, measurement devices, etc., are especially in Federal's scope. CONSULT US ON YOUR SPECIAL TUBE PROBLEMS.

Engineering Data on Standard Radio and Industrial Tubes on request.

FEDERAL TELEGRAPH COMPANY

200 Mt. Pleasant Avenue

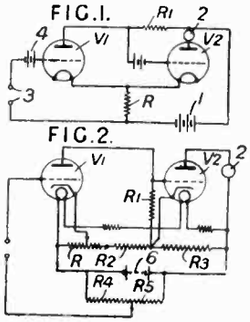
Newark, N. J.

BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tube Applications

Temperature control. Automatic control system comprising a temperature responsive device and a galvanometer operated thereby, controlling the exposure of a photoelectric cell to a source of light, the current traversing the cell being applied to the grid circuit of a grid-controlled rectifier which controls a heating circuit. H. R. Kelly, British Thomson-Houston Co., No. 372,007.



Automatic volume control. By means of rectified voltage derived from a "double diode" rectifier which may be a standard triode in which the cathode and grid act as one pair of rectifying electrodes for the modulation frequency, while the cathode and anode act as a second pair of rectifying electrodes, automatic gain control is secured. P. O. Farnham, assigned to Marconi Company, No. 381,847.

Automatic tone control. To prevent undue background noise in an automatic volume control radio receiver the higher audio-frequency signals are by-passed when the received signal is weak or absent. W. S. Barden, Marconi Company, No. 381,868.

Superregenerative receiver. Quenching or pendulum frequency is obtained from a relaxation or spill-over oscillation circuit which includes a glow discharge lamp. Telefunken, No. 381,902.

Audio compensation. Signals are arranged to produce shock excitation of a resonant circuit in order to re-introduce overtones which have been deliberately suppressed at the transmitter by passing them through a tube biased to produce considerable distortion. Telefunken, No. 382,020.

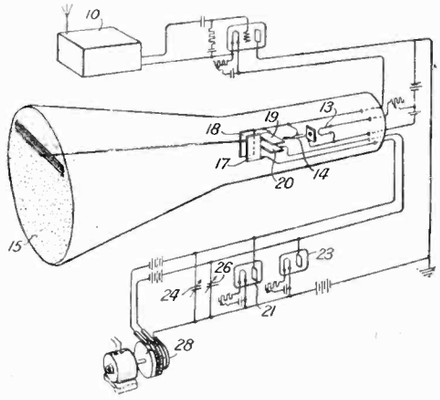
Oscillator circuit. In a superheterodyne the received frequency is supplied directly to the grid of an oscillator-detector and is prevented from neutralizing itself across the grid circuit or leaking away from the grid to the cathode by inserting one or more elements of high a-c resistance or an oscillatory circuit tuned to the received signal. O. Wullenweber, Denmark, No. 382,057.

Electron-coupled oscillator. Circuit in which the oscillations occur between the control grid and a second grid, a third grid being used to shield the output or plate circuit from the electrodes which generate the oscillation. Such a circuit is inherently stable with respect to variations in the impedance of the load circuit. J. B. Dow, Wired Radio, Inc., No. 382,316.

Inverter circuits. In a parallel type inverter comprising tubes fed from a d-c circuit and supplying a.c. to a transformer, a time delay is introduced between the closing of the switch and the commencement of discharge in either of the tubes by means of a resistor-condenser combination connected to the grid circuit of the tubes. International G. E. Company, No. 381,910.

Time delay circuits. Circuits for limiting the anode current of a tube for a period after switching on of cathode current comprising a gas discharge tube, a condenser, a resistor and an electromagnetic relay. G. E. Company, Ltd., No. 382,434.

Television. Beam of cathode rays traverses a fluorescent screen by charged electrodes. A system designed to cooperate with a transmitter employing a rotating scanning disc. R. D. Kell, British Thompson-Houston Co. No. 366,477.



Automatic volume control. Use of two valves having different operating characteristics, so that for weak signals one valve has little effect, while for strong signals it opposes the amplifying action of the other valve to give practically constant output. L. L. Kramolin, Berlin. No. 375,273.

Frequency stabilizer. The frequency of the generator is stabilized by producing unreflected waves in a mechanical oscillator from the output energy, transforming these waves back into electrical oscillation and feeding the latter to the input circuit of the generator. C. W. Hansell, assigned to Marconi Co. No. 375,568.

Superregenerator. Periodic quenching is secured by rhythmically varying the capacity of the condenser in a tuned circuit by means of a separate oscillator. Siemens & Halske, Berlin. No. 375,620.

Television system. The combined telephone and two-way television system. R. D. Parker, assigned to E.R.P.I. No. 375,785.

Navigation control. To facilitate the navigation of aircraft or other vessels advantage is taken of the characteristic periodicity of the local electric light supply to enable the nevigator to distinguish between the diffused light above a town and beacon lights or other sources of modulated devices from an airport or landing field. Two cells are used connected to push-pull amplifiers through condensers which pass only the a.c. component due to the electric light, as distinct from the steady content of natural light in the sky. The amplifier is connected to vibrating reeds, one tuned to the normal frequency of the electric light supply and the other to a special modulation from the beacon or signal light at the aerodrome. In a modified arrangement a single cell is arranged in the tail of the aircraft and is illuminated successively from alternate sides by means of a revolving mirror driven by a wind turbine. Code messages may be sent to the pilot and infra red or ultra violet lights may be used instead of visible lights. I. Langmuir, British Thomson-Houston Co., No. 371,-824.

Electron Tubes

Cathode construction. A wire or tip of gold silver, a metal of the platinum group or an alloy thereof coated with an oxide or hydroxide of an alkaline earth, rare earth, or earth metal by passage through a highly concentrated solution of a suitable compound where it is treated by electrolysis with such a high current density that sparking or firing effects are produced, the purpose being to anneal to the surface of the conductor the deposit as it is formed. The foundation wire or strip may be of a base metal such as tungsten or a chromium-nickel-iron alloy coated with a thin layer of one of the specified precious metals. The electrolyzing current may be periodically broken to provide uncoated lengths of wire or strips in alternation with coated lengths. L. Hansbirg, Carinthia, Austria, No. 381,964.

Cathode construction. A heater of refractory metal wire of diameter less than 0.06 mm. arranged in zigzag formation with two or more sections and surrounded by a solid coherent insulation which is inclosed by a tubular cathode spaced slightly from the insulation over at least a greater portion of its length. The heater operates on 50 volts as a minimum. The clearance between cathode and insulation may be less than 0.5 mm. For economic current consumption the ratio of heater surface and cathode surface should be at least 0.35. For example an insulator had a diameter of 1.8 mm. and length 30 mm. The cathode is spaced 0.5 mm. from the insulator and has a thickness of 0.1 mm. The heater is a tungsten filament of 0.023 mm. in diameter and 1,900 mm. long, wound into a helix and arranged in the cathode in four parallel sections. The heater operates from 110 volts. B. Erber, Vienna, No. 382,230.

Grid construction. Prevention of secondary emission from the grid by a coating of tantalum oxide. E. A. Giard, Igranic Electric Co., Ltd. No. 382,605.