

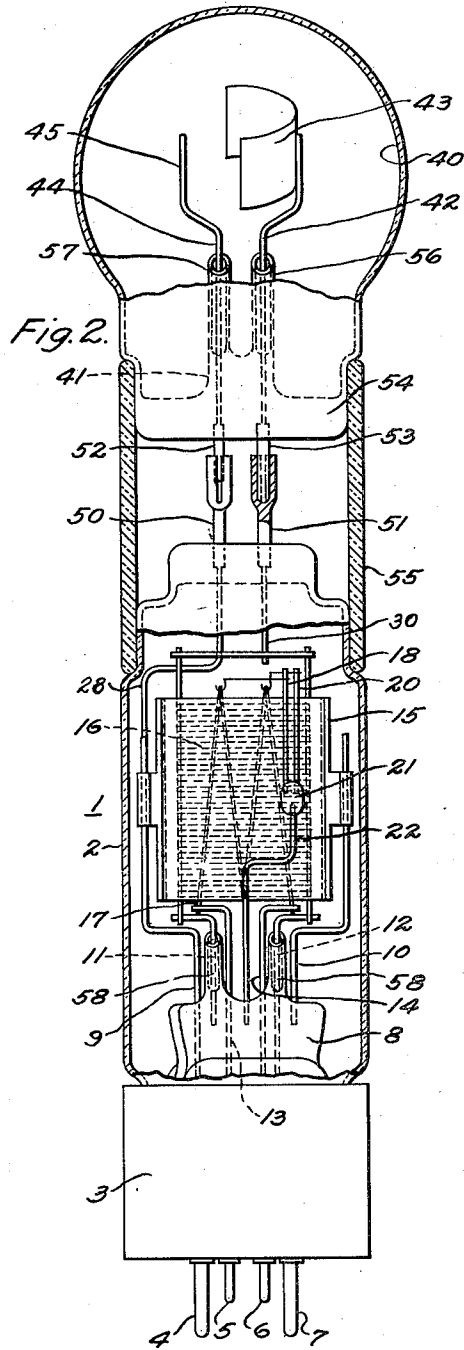
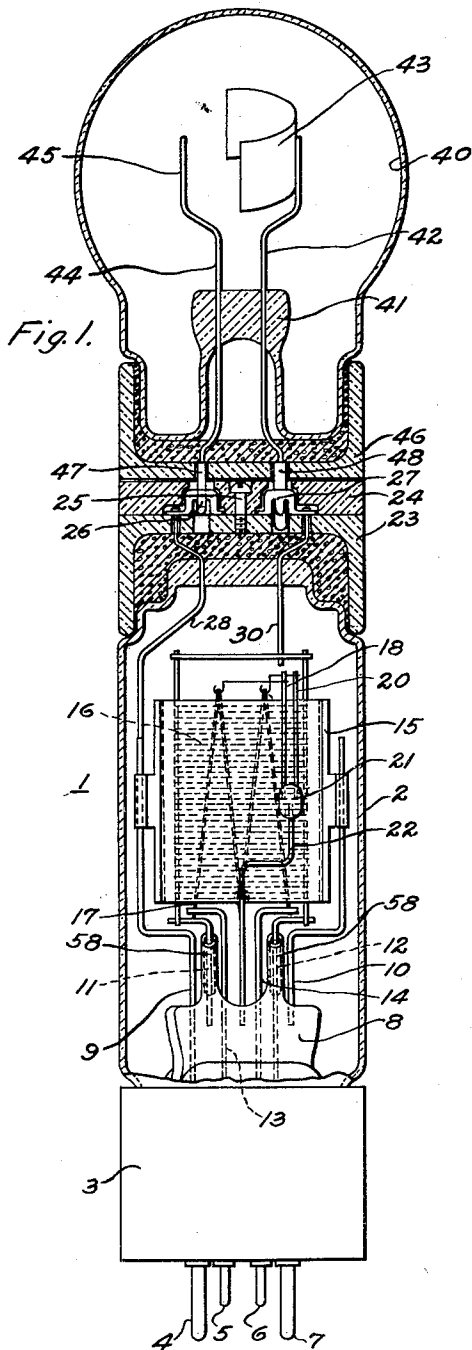
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T. R. GOLDSBOROUGH ET AL

1,645,280

PHOTOELECTRIC CELL

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UNITED STATES PATENT OFFICE.

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PHOTOELECTRIC CELL.

Application filed September 28, 1926. Serial No. 138,197.

Our invention relates to photo-electric cells, and more particularly to photo-electric cells when utilized in connection with thermionic amplifiers.

One object of our invention is to provide, in one unitary device, a combined photo-electric cell and thermionic amplifier.

Another object of our invention is to provide a combined photo-electric cell and thermionic amplifier comprising readily renewable elements.

Another object of our invention is to provide a combined photo-electric cell and thermionic amplifier that may be inserted into, and removed from, a system as a unit, thus facilitating the handling thereof.

Another object of our invention is to provide a combined photo-electric cell and thermionic amplifier in which the connections between the photo-cell portion and the amplifier portion are reduced to a minimum.

Another object of our invention is to provide a combined photo-electric cell and thermionic amplifier particularly adapted for use in systems which require a minimum time-lag.

It is now well-known that the output of a photo-electric cell of the usual potassium-hydride type may be utilized to control a thermionic amplifier. It has been customary, however, in constructing photo-cell controlled amplifiers, to separate the photo-cell from the thermionic tube by an appreciable distance and to connect the two by the necessary conductors. As an example of amplifiers of this type, attention is called to the patent to Irving Langmuir, No. 1,273,627, which discloses a photo-cell connected through a plurality of conductors to a thermionic device, one of the conductors including a source of potential.

Systems of the general type of the Langmuir patent have been open to the serious objection that they are not instantaneously responsive to varying light conditions. In order to improve the speed of response, it has been proposed to enclose the cell and the thermionic tube in the same glass envelope, rigidly supporting certain of the cell elements directly from those of the thermionic tube. A device of this character, together with proposed systems for its utilization, is disclosed in a co-pending application in the name of V. K. Zworykin, Serial

No. 141,734 filed Oct. 15, 1926, and assigned to the Westinghouse Electric & Manufacturing Company.

A device of the type disclosed in the co-pending application referred to, while having exceedingly satisfactory electrical characteristics, is somewhat expensive to manufacture. It is also obvious that failure of either the photo-cell portion or the thermionic tube portion will render the entire device inoperative.

By our invention we have, therefore, so modified the upper end of the glass envelope of the usual thermionic amplifier tube, that a photo-electric cell having external contact elements may be directly mounted thereon. Our device may, accordingly, be handled and inserted into a circuit as a unit, but, upon failure of either portion thereof, it is only necessary to replace the defective part by one that is operative, thus effecting an appreciable lowering of the cost of maintenance.

The novel features which we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with further objects and advantages thereof will be best understood by reference to the following description, taken in connection with the accompanying drawing, in which

Fig. 1 is a view, partly in section and partly in elevation, of a preferred embodiment of our invention, and

Fig. 2 is a similar view of a modified form of our invention.

Referring particularly to Fig. 1, the thermionic amplifier portion 1 of our device comprises the usual and well-known elements, a glass envelope 2, a base 3 carrying a plurality of contacts 4, 5, 6 and 7 and a press 8 in which are mounted a plurality of conducting standards, 9, 10, 11, 12, 13 and 14. An anode 15 is supported from the standards 9 and 10, and a grid 16 is supported from the standards 11 and 12. The ends of a looped filament 17 are connected to the standards 13 and 14, the loops being resiliently supported from a plurality of rods 18 and 20 mounted in a non-conducting bead 21 carried by a standard 22.

The upper end of the glass envelope is so

modified as to be capable of retaining thereon a shell-element, or base, comprising a sleeve 23 and a face-plate 24 secured thereto by a retaining-screw 25. A plurality of resilient socket members 26 and 27 are firmly held between the base and the face-plate, the latter being recessed to accommodate them. The member 26 is connected to the anode by a short conductor 28, and the member 27 is connected to the grid support by a short conductor 30.

The photo-cell portion of our device, which may be made according to the method described in the patent to J. Kunz, No. 1,381,474, or according to any other well-known method, comprises a glass envelope 40 furnished with a press 41 in which are mounted a standard 42 carrying a photo-electrically sensitive cathode 43, and another standard 44 terminating in a portion 45 adapted to function as an anode. The envelope 40 is mounted in a shell-element, or base 46 which is provided with a plurality of contact elements, 47 and 48, so arranged as to be insertible into the socket elements carried by the thermionic tube. The contact element 47 is conductively connected to the anode 45, and the contact element 48 is conductively connected to the cathode 43, the latter element and the cooperating socket being made larger than those associated with the anode, or being made with a differing configuration, in order to prevent incorrect connections from being established.

In order that current leakage between the electrodes may be very materially reduced, we have found it preferable to utilize the modified form of our device illustrated in Fig. 2. In this form, the base member carried by the upper end of the thermionic tube is dispensed with, a plurality of socket members 50 and 51 being imbedded in the glass itself. The base-member 46 of the photo-cell is also omitted, a plurality of pins 52 and 53 being imbedded in, and carried by, the lower end 54 of the glass envelope 40. A cylindrical element 55, into the open ends of which the photo-cell and the thermionic tube fit, is provided to act as a supporting device and to also prevent damage to the connecting elements 50, 51, 52 and 53.

Leakage between the electrodes is also lessened by providing certain of the electrode-supporting standards with an encircling tube-like extension of the tube walls, in the manner disclosed in a copending application in the name of V. K. Zworykin, Serial No. 140,485 filed Oct. 9, 1926 and assigned to the Westinghouse Electric & Manufacturing Co.

In the drawing, a tube-like extension 56 is shown around the cathode support, and an extension 57 around the anode support in

the photo-cell, and extensions 58 are shown around each of the standards which support the grid of the thermionic tube. The illustration is merely suggestive of the manner in which the extensions may be applied, it being obvious that all of the electrode supports may be so equipped if necessary.

In the operation of our device, it has been found advantageous, as pointed out in the Zworykin application, Serial No. 141,734 to apply to the grid-photo-electric-cathode assembly a negative bias sufficient to reduce the thermionic current to a negligible amount during such time as the photo-cell is in darkness. A resistor of from two to fifty megohms is included between the grid-bias source and the grid proper, through which the photo-electric current flows when the photo-cell is illuminated. The drop of potential across this resistor is sufficient to lower the grid potential to a value which permits the flow of thermionic current in the anode circuit of the tube, which current may be utilized to operate an indicating device of any appropriate type.

Our improved photo-electric amplifier is principally advantageous from the standpoint of economy. If the filament of the thermionic tube portion fails, it is not necessary to discard the entire device, nor is it necessary to install a complete device should the photo-cell portion become inoperative from any cause. Obviously, the maintenance expense of a system equipped with our device is less than when the photo-cell and the thermionic tube are both enclosed in the same glass envelope, yet the advantages resulting from the extremely short connections of the unitary device are all retained.

Although we have illustrated and described certain specific embodiments of our invention, many obvious modifications thereof will be apparent to those skilled in the art. Our invention is accordingly not to be limited except in so far as is necessitated by the prior art, and by the spirit of the appended claims.

We claim as our invention:

1. In combination, a thermionic device and a photo-electric device separably mounted thereon.
2. In combination, a thermionic device and a photo-electric device separably mounted thereon and carried thereby.
3. In combination, a thermionic device having an envelope, and a photo-electric device exteriorly mounted on said envelope and supported thereby.
4. In combination, a thermionic device having an envelope, a photo-electric device removably mounted on the exterior of said envelope, and conductive connections between said devices.
5. In combination, a thermionic device provided with exteriorly supported termi-

nal connectors, and a photo-electric device provided with terminal connectors adapted to engage the connectors carried by the thermionic device.

5 6. In combination, a thermionic device comprising a container, asymmetrical terminal connectors supported by said container exteriorly thereof, and a photo-electric device provided with exterior terminal connectors adapted to engage said asymmetrical connectors.

10 7. In combination, a thermionic device comprising a container, a grid and an anode within said container, terminal connectors exteriorly supported by said container, a connection between one of said connectors and one of said electrodes, a photo-electric device comprising a container, a photo-electric cathode and cooperating anode within said container, external terminal connectors carried by said photo-electric device con-

tainer, and a connection between one of said photo-electric device electrodes and one of said terminal connectors, the terminal connectors of the photo-electric device being adapted to make contact with the terminal connectors carried by the thermionic device. 25

8. In combination, a photo-electric device comprising a plurality of electrodes, a thermionic device comprising a plurality of electrodes, means for so removably connecting the photo-electric device with the thermionic device as to constitute a combined device insertable as a unit into a cooperating socket, and means for preventing electric leakage between contiguous electrodes. 30 35

In testimony whereof, we have hereunto subscribed our names this 22nd day of September, 1926.

THADDEUS R. GOLDSBOROUGH.
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