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COMBINATION OF A PHOTOTUBE AND AN AMPLIFIER

Filed May 1, 1930

Fig. 1.

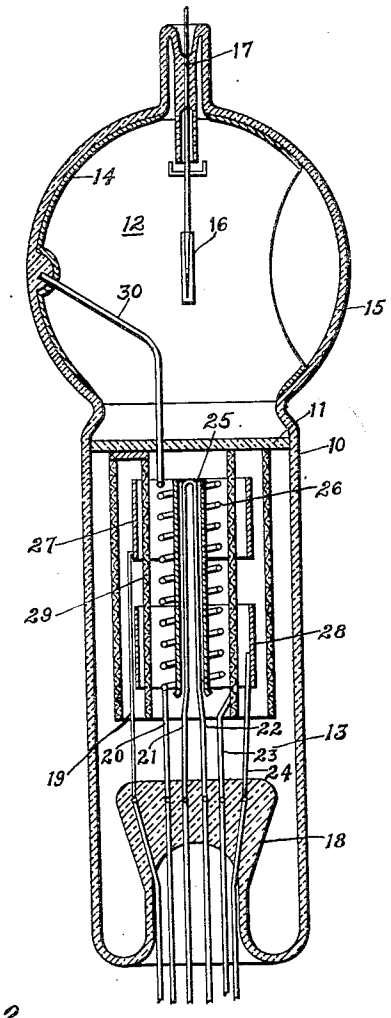
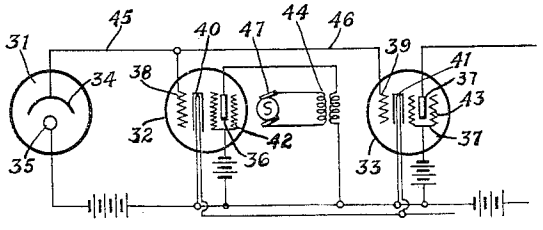


Fig. 2.



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COMBINATION OF A PHOTOTUBE AND AN AMPLIFIER

Application filed May 1, 1930. Serial No. 448,866.

This invention relates to light-sensitive devices and has particular relation to light-sensitive systems in which photo-electric tubes are utilized to control the output of thermionic amplifiers.

One object of our invention is to provide a relay system in which the time lag is inappreciable.

Another object of our invention is to provide, in one unitary device, a structure equivalent to the combination of a photo-electric tube, a tube acting as a varying resistance and an amplifying tube.

In our copending application, Serial No. 305,682, filed September 13, 1928, for phototube amplifiers is disclosed a circuit containing tubes and a photo-tube for controlling their output. It is desired, by this invention, to cut down the interval of time between the actuation of the photo-tube and its resulting controlling effect on the tube elements as much as possible by incorporating the many elements of these three devices into one unitary structure. This combination of elements into a unitary structure cuts down the capacity that was formerly present between the various elements of the three tubes. By reducing the capacity, the time lag of the system is also reduced, with the result that the system operates more quickly than that disclosed in our prior application. Furthermore, by use of a common cathode and a common grid, the number of elements is reduced.

Another purpose of the invention is to change the direct-current pulses produced by the activated photo-tube into pulsations that can be amplified by alternating-current amplifiers. An equivalent of a screen-grid tube is utilized as a varying resistance and has its plate supplied with an alternating current of a frequency of shorter duration than the shortest light flash upon the photo-tube. The screening grid prevents the alternating current from being directly coupled to the grid. The result is that the impulses of current due to the activation of the photo-tube are broken up into still smaller pulses of the frequency of the alternating current. These latter pulses may be amplified by any of the well known amplifiers.

Figure 1 is a cross section of a preferred form of tube embodying our invention.

Fig. 2 is a diagram of the circuit in which the elements are used, some in double capacities.

As disclosed in Fig. 1, the tube 10 has preferably a rather elongated shape with a partition 11 dividing the tube into an upper portion 12 and a lower portion 13. The upper portion 12 of the tube is preferably of the rounded shape disclosed in the drawing and is coated, on the major portion of its interior surface, with a photo-sensitive substance 14, preferably cæsium oxide. The cæsium oxide may be deposited upon the surface in any well-known manner but it is preferred to coat the surface of the glass first with magnesium and then with cæsium.

A window 15 is left at any suitable place for an entrance of light to actuate the cæsium oxide surface. An anode 16 for this photo-sensitive surface or cathode 14 is also located in the upper portion 12 of the tube. The anode 16 preferably depends from the upper tip of the tube to the approximate center of the portion 12 in such manner that there will be no possibility of short-circuiting the cathode and anode by over-lapping the cæsium oxide coating upon the connection 17 to the anode.

The lower portion 13 of the tube has, preferably, a seal or press 18 having a plurality of conductors 19, 20, 21, 22, 23 and 24 extending into the interior of the tube. In the lower portion 13 is a thermionic cathode 25, preferably heated by the current in the conductors 21 and 22 to an electronic-emissive state when the device is in operation.

Surrounding the cathode is a grid 26, preferably in spiral convolutions. Surrounding the grid are a plurality of anodes 27 and 28 preferably axially spaced from one another along the cathode 25 and grid 26. The anodes 27 and 28 are connected, respectively, to the conductors 19 and 24. It is also preferred to have the anodes screened on both sides by the double screen 29 connected to the conductor 23.

The partition 11 may be made opaque in any desired manner to prevent light from the

thermionic cathode from affecting the photo-sensitive elements in the upper portion 12 of the tube. A connection 30 from the photo-sensitive cathode 14 extends through the partition to the grid 26 of the tube elements in the lower portion 13 of the tube.

Fig. 2 illustrates the circuit functions and connections of the composite tube with the various elements of Fig. 1 expanded into a three-tube circuit to illustrate the efficiency of the invention. The elements of Fig. 1 are equivalent, in respect to function, to the elements of the tubes 31, 32 and 33 of Fig. 2.

In these tubes, the photo-sensitive cathode 34 and anode 35 represent the photo-sensitive cathode 14 and the anode 16 of Fig. 1. Likewise, plate 36 of tube 32 and plate 37 of tube 33 represent the plates or anodes 27 and 28. The grid 38 of tube 32 and the grid 39 of tube 33 represent the double function of the single grid 26 of Fig. 1. Likewise, the thermionic cathode 40 of tube 32 and the thermionic cathode 41 of tube 33 represent the double function of the single thermionic cathode 25 of Fig. 1. Similarly, the two screening grids 42 and 43 of tubes 32 and 33, respectively, represent the double function of the screening grid 29 in Fig. 1.

The operation of the elements in Fig. 2 is as follows. The light from any source to be indicated by the system, falls on the photo-sensitive cathode 34 and actuates the photo-tube to produce signals. These signals are amplified by the tube 33. Instead of the usual resistance shunting the photo-tube, there is inserted a screen-grid thermionic tube 32. The filament-grid impedance of this tube is varied according to an alternating-current transformer 44 connected to the plate of the tube. The light signals from the photo-tube are transformed into alternating current and can be further amplified by alternating-current amplifiers connected to the tube 33. In order to prevent alternating-current impulses from the transformer 44 from transmitting directly to the amplifying tube 33, a screening grid structure 42 is used in the tube 32. The wave length of the alternating current supplied from the alternator 47 through the transformer 44 is preferably shorter than the shortest period of illumination, so that the direct-current impulses from the photo-tube may be accurately transformed into alternating-current waves of equal duration.

An examination of Figs. 1 and 2 will disclose that the number of tube elements in Fig. 2 have been reduced in the composite tube structure of Fig. 1. An important change, however, is the elimination of the outside connections 45 and 46 in Fig. 2 between the photo-sensitive cathode 34 and the two grids 38 and 39. In Fig. 1, a very short inside connection 30 extends from the photo-sensitive cathode 14 to the single grid 26 performing in place of the two grids 38 and 39. The capacity between the photo-sensitive cathode 14 and the grid 26 is, accordingly, very much less than that between the photo-sensitive cathode 34 and the grids 38 and 39. This lesser capacity results in there being very little, if any, time lag between the actuation of the cathode 14 and its controlling effect on the thermionic elements in the lower portion of the tube. Hence, the response to the light rays is much quicker in Fig. 1 than in Fig. 2 and this reduction in time is important in television application of the invention.

Although we have shown and described certain embodiments of our invention, we are fully aware that many modifications are possible. Our invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

We claim as our invention:

1. A light-sensitive device comprising a container, a photo-sensitive surface and an anode therefor in said container, a thermionic cathode in said container, a plurality of anodes for said cathode also in said container, and means for controlling the electron emission from said thermionic cathode to said anodes, said means being connected to said photo-sensitive surface.

2. A light-sensitive device comprising a container, a photo-sensitive surface and an anode therefor in said container, a thermionic cathode in said container, a plurality of anodes for said cathode also in said container, and a grid connected to said photo-sensitive surface for controlling the electron emission from said thermionic cathode to said anodes.

3. A light-sensitive device comprising a container, a photo-sensitive surface and an anode therefor in said container, a thermionic cathode in said container, a plurality of anodes for said thermionic cathode also in said container, and a grid connected to said photo-sensitive surface for controlling the electron emission from said thermionic cathode to said anodes, and means screening said anodes from said grid and said thermionic cathode.

4. A container having a partition dividing said container into two portions, a photo-sensitive cathode and an anode therefor in one of said portions, a thermionic cathode, a grid and a plurality of shielded anodes in said other portion, said grid being connected to said photo-sensitive cathode.

In testimony whereof, we have hereunto subscribed our names the 14th and 24th days of April, 1930.

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