April 15, 1941. P. W. BLACKBURN 2,238,620

PHOTOSENSITIVE GLOW-RELAY TUBE

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Fig. 1.

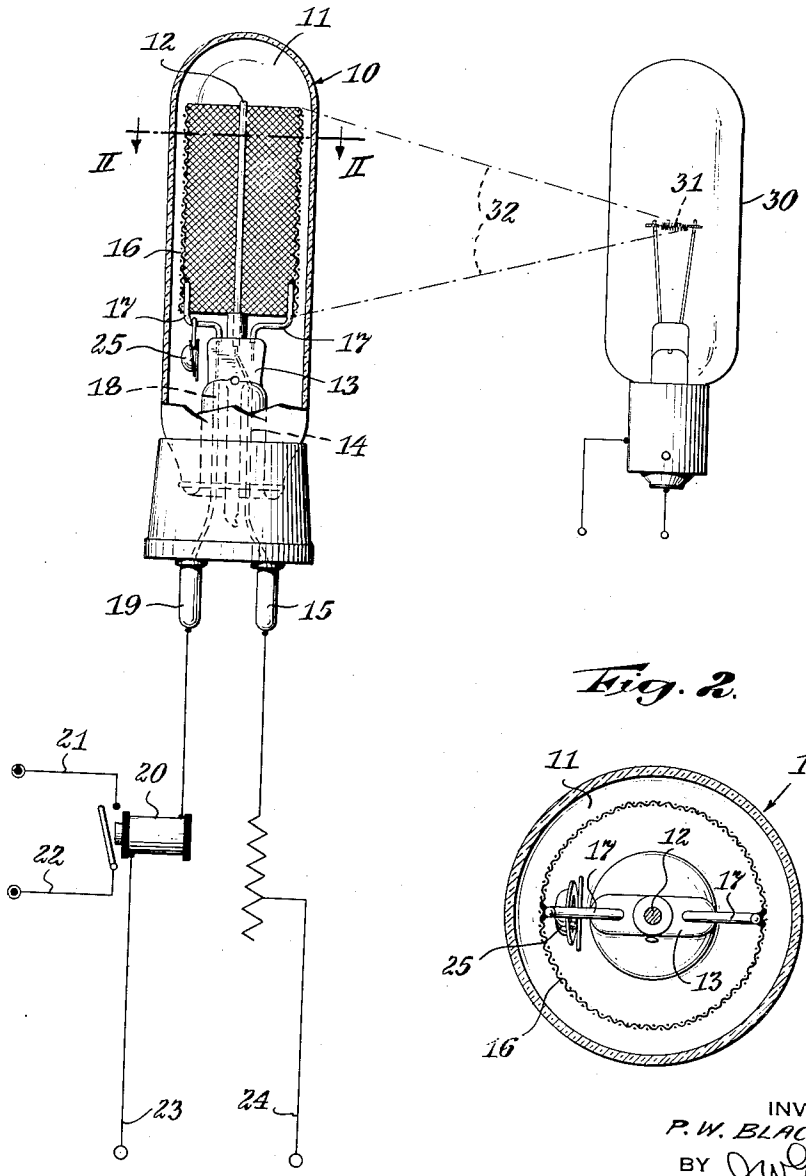


Fig. 2.

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PHOTOSENSITIVE GLOW-RELAY TUBE

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1 Claim. (Cl. 250—165)

My invention relates to discharge apparatus and particularly apparatus responsive to light signals.

An object of the invention is to provide a photosensitive tube that will directly operate a relay in response to light signals.

Another object of the invention is to provide an illuminating source in combination with a photoglow tube which will discharge on much greater voltage change than heretofore possible with photosensitive devices.

Other objects and advantages of the invention will be apparent from the following description and drawing in which Fig. 1 is a view, partly in elevation and partly diagrammatic, of a photosensitive tube and relay.

Figure 2 is a view on lines II—II of Figure 1.

The present method of operating a photosensitive apparatus to actuate a relay is to provide the usual commercial illuminating lamp directing its rays upon a phototube connected to an amplifier, usually a "thyratron," so that the photoelectric current will be sufficiently amplified to operate a relay.

Several attempts have been made in the past to make a photosensitive tube capable of carrying sufficient current to directly operate the relay. Generally, such devices were provided with a very large cathode area with the purpose of providing a current of a few milliamperes instead of micro-amperes as provided by the regular phototube. When the arc or glow discharge takes place in a tube with such a photosensitive surface, the surface is soon sputtered off, or otherwise harmed or damaged, as far as photosensitivity is concerned.

The life of such tubes has been very short as the surface is eventually sputtered or loses its photosensitivity. Also, because the surface selected is rather insensitive, a large quantity of light falling on the cathode makes only a slight change in the breakdown voltage of the tube.

To overcome these difficulties I have provided a phototube in which the gaseous atmosphere will always be very readily ionized when a light signal illuminates the cathode surface, and I have also selected an illuminating device for the light signal that will most easily provide the ionization of the path between the cathode and anode. In particular, I utilize a caesium cathode and a gaseous atmosphere of one or more noble gases in which there is an excess of caesium vapor from the cathode.

Furthermore, I provide an illumination device that is strong in the blue portion of the spectrum so that the caesium will be quickly and highly ionized. The result of this combination is that the device will break down at a voltage much lower than that of the usual photosensitive apparatus and will be capable of supplying the few milliamperes necessary to directly operate the relay.

In Figure 1 I have illustrated the photosensitive tube 10 having the interior space 11 therein filled with a gaseous atmosphere of one or more of the noble gases. This atmosphere may be of argon, or argon and neon, or any one or combination of the noble gases. I prefer to utilize a pressure of from 2 to 10 millimeters of mercury pressure.

The anode 12 may be a cylindrical rod arising from the center of a press 13 through which passes the anode connection 14 to the contact pin 15. The cathode 16 I prefer to construct as a wire mesh and to make it in the cylindrical form disclosed in Figure 2. Two standards 17 support this mesh from the press 13 and a connection 18 to one of these standards extends to the cathode pin 19.

A relay 20 to make or break the circuit 21, 22 to any desired actuating mechanism is connected in the leads from the electrode pins 15 and 19 to a suitable voltage line source 23 and 24 to provide the voltage drop for breakdown of the phototube 10 when a proper light signal is received. A container 25, which may be of the helmet type, is placed in the tube and preferably connected to one of the cathode leads, as disclosed. This helmet has a caesium pellet therein and preferably has an excess amount of caesium therein over that utilized for the usual phototube.

This caesium is flashed after the tube has been formed and the caesium coats the mesh of the cathode 16. The excess caesium acts as a vapor to mingle with the gaseous atmosphere of the noble gas or gases. The caesium may have a pressure of $\frac{1}{1000}$ of a micron to one micron, depending upon the temperature of the device. In this respect my tube differs from the tubes of the prior art using similar helmets of caesium, because the caesium in these tubes is just sufficient to coat the cathode and if there should chance to be any excess vapor, it is removed by pumping, baking or chemical action prior to inserting the gaseous atmosphere. The prior art tubes do not have, even by chance, my deliberate pressure of caesium vapor in excess of $\frac{1}{1000}$ micron.

For the illuminating signal I have provided a special lamp 30 which is more particularly de-

scribed in the application of Gjon Mili, Serial No. 125,548, filed February 13, 1939, for Incandescent filament and lamp. In particular, this lamp is very strong in the blue and ultraviolet portion of the spectrum. This lamp has a container of ultraviolet transmitting glass and has a very short tungsten filament **31** that operates at the order of 7½ amperes on a 10 volt circuit.

The result is that the filament operates at an excess of temperature such as about 2800 or 2900 Kelvin, instead of the usual 2400 Kelvin with the ordinary lamp. The reason for providing this lamp that is very strong in the blue portion of the spectrum is, that the caesium has its highest ionizing rate in this portion of the spectrum at a wave length of 3183 Å. The lamp signal from the filament **31** illustrated by the dotted lines **32** will very quickly and highly ionize the caesium vapor within the phototube **10**. The result will be that the voltage range between operation at light and dark will be greater in my tube than in the usual photoglow tube. In my photoglow tube the difference in breakdown between light and dark is 40 volts or greater, while other photoglow tubes, with which I am familiar, operate at 5 or 10 volts difference. The gas will be ionized and as a result the discharge will not be destructive to the cathode as in tubes not constructed in accordance with my invention, when these tubes are attempted to be operated to supply current of the order of milliamperes to actuate a relay. If some caesium should be sputtered off from my cathode, it will be replaced from the excess caesium in the tube.

I prefer to utilize a mesh for the cathode, first, because it holds more caesium than a cathode formed of solid material and, second, because light will pass through to the opposite caesium surface. The tube as described operated satisfactorily with 15 milliamperes in the circuit. If the tube is operated on alternating current, then the discharge will stop when the light is withdrawn.

My photoglow tube is not to be confused with the usual gaseous phototube that cannot be operated with a glow-discharge and which only produces microampere output.

Although a preferred embodiment of my invention has been disclosed, it will be understood that many modifications may be made within the spirit and scope of the appended claim.

I claim:

A photosensitive device comprising a container, an anode and a cathode therein, said cathode having caesium thereon, a gaseous atmosphere including one of the noble gases in said container, said gaseous atmosphere including caesium vapor having a pressure in excess of $\frac{1}{1000}$ micron.

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