

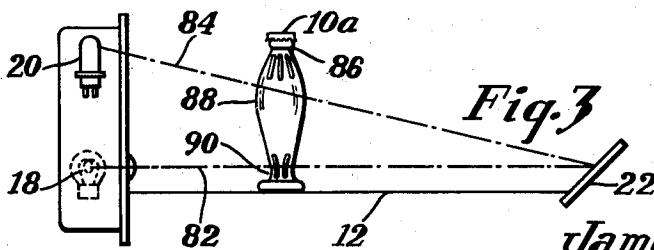
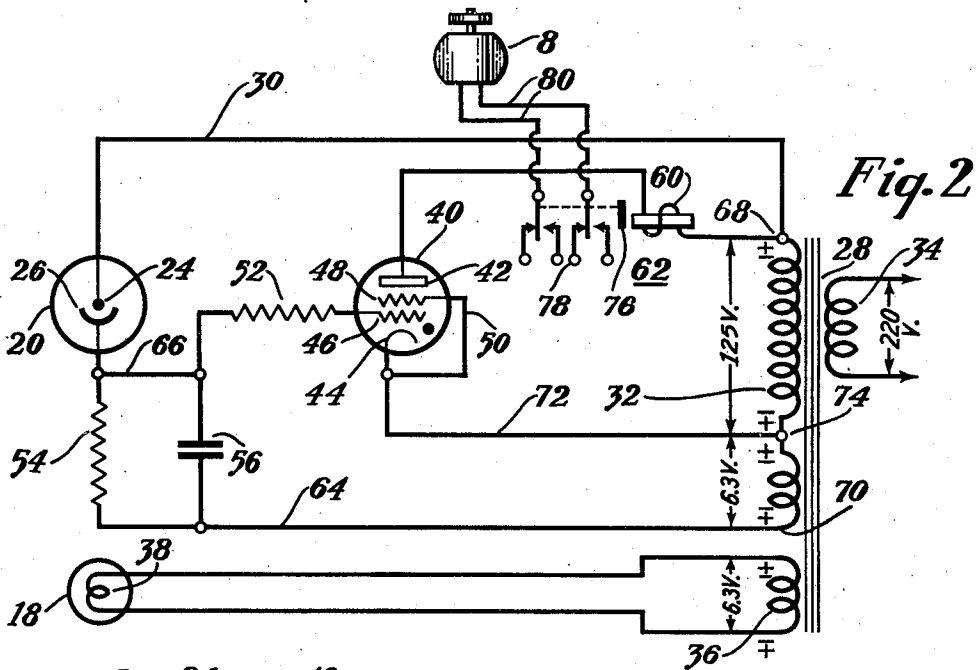
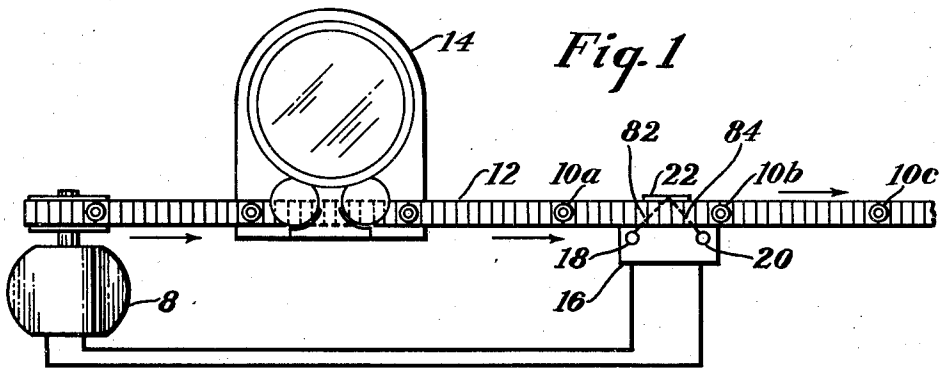
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PHOTO ELECTRIC RELAY

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PHOTOELECTRIC RELAY

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This invention relates to a photo-electric relay, and particularly to such a relay adapted to control the movement of objects in spaced relation.

In many automatic industrial processes, it frequently becomes necessary to move objects from one station to another with an interval of time and space between each object. The moving process is usually an automatic one. If the objects become jammed on the conveyor or other track along which they are being moved, the moving means will, nevertheless, continue to operate and damage may be caused to the objects and their contents and, perhaps more importantly, to the equipment. Delay may also be caused in shutting down the machinery for the repairs which may then be necessary.

It is, therefore, an object of the invention to provide an improved photo-electric relay adapted to control the movement of objects in spaced relation.

Another object is to provide means for automatically rendering inoperative means for moving objects along a path in spaced relation, when such objects become jammed together on said path.

An additional object is to provide an improved photoelectric circuit which will be energized when light passing to an element therein is interrupted for more than a predetermined period.

A further object is to provide an improved photoelectric relay adapted to be operated by alternating currents only, and including a time delay circuit.

A still further object is to provide an improved and compact photo-electric relay for the purposes aforesaid from which connections need be made only to a source of alternating currents and to the means for moving such objects.

These objects are achieved in accordance with the invention by providing a photo-electric device connected to a gas tube and a relay, the latter being connected to a circuit which controls the movement of objects along the conveyor or other path in spaced relation. Both the photo-electric device and the tube are operated by alternating current. A beam of light is directed to the photo-electric device in such manner that each object cuts the beam in its passage along the conveyor. Light passing to the cathode of the photo-electric device causes current to flow therefrom to the grid of the gas tube, fires the latter and keeps the relay closed. A time delay circuit connected to the grid of the gas tube keeps that grid at its firing potential for a period dependent on the time constant of the time delay

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circuit, although the passage of light to the photo-electric device is intermittently interrupted by the normal passage of the objects along the conveyor. If, however, the passage of light to the photo-electric device should be interrupted for a period greater than the delay caused by the time delay circuit (for example, because the objects have become jammed against each other on the conveyor), the gas tube is extinguished; this opens the relay which in turn stops further movement of the objects along the conveyor.

From time to time in this specification reference will be made to automatic apparatus for the processing of bottles containing beverages. In such apparatus, filled bottles are moved automatically in an upright position, and in spaced relation to each other along a conveyor from a machine at which they are inspected for the detection of foreign particles which may be contained in the beverage, to another machine at which the bottles are capped. The references to such apparatus are inserted for purpose of illustration only, since the invention is applicable to any apparatus in which any light-impeding objects are moved in spaced relation, and no limitation of the scope of the invention is intended by such references.

The invention may be better understood from a consideration of the following description thereof when read in conjunction with the accompanying drawings in which:

Figure 1 is a plan view of apparatus embodying the invention, showing the relation of the photo-electric control of the invention to objects moving along a conveyor,

Figure 2 is a circuit diagram of apparatus in one embodiment of the invention, and

Figure 3 is a view in elevation along the conveyor illustrating adjustment of the path of the light from its source to the photo-tube.

Figure 1 shows apparatus 14 which may be the inspection machine before referred to, and a conveyor 12. Objects 10a, 10b, etc. (for example, bottles) are moved by any appropriate means, such as the electric motor 8, from the machine 14 along the conveyor 12 in the direction of the arrow. Adjacent to the conveyor 12 is the photo-electric control 16 of the invention. The control includes a source of light such as the exciter lamp 18; in a preferred embodiment, a 21 candlepower, single contact, 6 to 8 volt auto bulb has been used as the source of light. Light from the lamp 18 is directed to a photo-tube 20. Light from the lamp 18 passes to a mirror 22 and is reflected therefrom, as indicated by the

dash lines 82, 84, respectively, to the photo-tube. If desired, the light source may be on one side of the conveyor and the photo-tube on the other, so that the objects 19a, 19b, etc., moving along the conveyor 12 cut the beam of light passing to the photo-tube. A special method of adjustment of the transmitted and reflected beams is described hereinafter.

Referring now to Figure 2, the photo-tube 20 (which may be an RCA type 868) has an anode 24 and a cathode 26, connected by conductor 30 and by resistor 54 and conductor 64, respectively, to the respective ends 68 and 70 of a secondary winding 32 of a transformer 28. The primary winding 34 of this transformer is connected to a source of alternating current (not shown) which may have an R. M. S. value of, for example, 220 volts. An auxiliary secondary winding 36 of the same transformer provides voltage to heat the filament 38 of the lamp 18; alternatively, the secondary winding 32 may be tapped for this purpose.

The photo-tube is connected to a gas tube 40, having an anode 42, a cathode 44 and a control grid 46. In a preferred embodiment, a tetrode RCA type 2051, having a screen grid 48 connected to the cathode 44 by a conductor 50, has been used. The cathode 26 of the photo-tube 20 is connected to the control grid 46 of the gas tube by a conductor 66 and resistor 52; the latter may have a value of 5.6 megohms.

The anode 42 of the gas tube is connected through an energizing coil 60 of a relay 62 to the end 68 of the secondary winding 32; a conductor 72 extends from a tap 74 on the secondary winding to the cathode 44 of the gas tube. A capacitor 56 is connected across the resistor 54 in the cathode lead of the photo-tube 26.

The secondary winding 32 between its end 68 and tap 74 provides an alternating potential, which may have a value of 125 volts, between the anode and cathode of the gas tube. Similarly, the smaller portion of the secondary winding between the tap 74 and 70 provides an alternating-current bias (through resistor 54, condenser 56 and resistor 52) for the control grid 46.

The respective polarity of the various windings at a given instant is shown by the drawing, so that the anode of the gas tube is most positive when its control grid is most negative, and vice versa. The parallel combination of resistor 54 and condenser 56 constitutes a time delay circuit, tending to oppose any change in the potential of the grid, as will appear more fully hereinafter. The whole of the secondary winding provides an alternating potential between the anode and cathode of the photo-tube, but the voltage drop through the resistor 54 serves to limit the value of this potential.

The relay 62 contains the energizing coil 60 and an armature 76, which cooperates with a switch 78 in a circuit 80 connected to the electric motor 8.

The operation of the circuit is as follows: The bias on the control grid 46 is of such a value as to prevent the gas tube from firing. Light from the lamp 18 passes to the cathode 26 of the photo-tube 20; current flows therefrom to the control grid 46 and raises its potential sufficiently to fire the gas tube. Current then flows in the anode circuit of the gas tube, energizes the coil 60 and therefore closes the switch 78 and the circuit 80. As each object moves along the conveyor 12, it interrupts the beam of light passing to the photo-tube; and this, but for the time delay circuit, would extinguish current in the gas

tube, open the relay 62 and, therefore, prevent the continued movement of the objects. The time delay circuit, however, is able to maintain the grid 46 above its extinguishing potential for a period dependent on its time constant. If the time which it takes an object to cross the light beam passing to the photo-tube is less than the period corresponding to the time constant of the delay circuit, light again passes to the cathode of the photo-tube and causes the grid 46 to remain at a sufficiently positive potential to maintain the gas tube in a conductive condition.

If, however, light is prevented from passing to the photo-tube for a period greater than that before referred to (due, for example, to the jamming of the bottles one against the other), the potential of the grid 46 will fall and extinguish current in the gas tube, thereby opening the relay and preventing further movement of the objects along the conveyor. Removal of the impediment to the passage of light to the photo-tube automatically makes the control operative again, closes the relay and sets the objects in motion along the conveyor. Other circuits which have been proposed for this purpose require resetting by hand.

The period, therefore, during which light passing to the photo-tube may be interrupted without extinguishing the current in the gas tube, is dependent on the values of the elements in the time delay circuit. In a preferred embodiment of the invention, the resistor 54 and capacitor 56 had values of 1.2 megohms and .5 microfarad, respectively, for an effective time delay of approximately .5 second; the time may be doubled or quadrupled by increasing the value of the capacitor to 1 microfarad, or to the 2 microfarads, respectively.

Ordinarily, the values of the elements of the time delay circuit will be chosen to provide for continued firing of the gas tube during a period equal to the interruption of light by the passage of an object across it, but longer delays may be obtained if necessary. Thus, it may not be desired to shut down the conveyor during the occurrence of short jams which automatically clear themselves, and values of the resistor 54 and capacitor 56 will then be selected to provide for the delay desired. In the three examples just given, the value of the resistor was 1.2 megohms in each case; it is not desirable to increase the value of the resistor above 5 megohms, because in electronic circuits the charge on the condenser may then tend to leak off through other channels.

The resistor 52 matches the low impedance of the gas tube when conducting, with the comparatively high impedance of the resistor-capacitor combination 54-56, which would otherwise be ineffective for delaying the extinguishment of the anode current of the tube.

It has been proposed to provide a photo-electric relay operated by alternating current with means for maintaining a positive voltage on the grid of an electron discharge amplifier during part of the negative half-cycle of the supply voltage. The present invention differs from that proposal in that the grid is held positive over a large number of complete cycles.

Certain variations in the embodiment described will suggest themselves to those skilled in the art. For example, the objects moving along the conveyor have been described as interrupting completely the passage of light to the cathode of the photo-tube, but a similar control effect may

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be obtained by a reduction or other variation in the intensity of light passing to the tube, or a refraction of light by the objects, it being necessary only that the objects should in some way impede or vary the passage of light to the tube.

In the embodiment described, current in the anode circuit of the gas tube has been employed to control the movement of objects along the conveyor; but, in some cases, it may be desirable to use this current to sound an alarm, or flash a warning light, or otherwise to indicate that the passage of objects along the conveyor is abnormal. The current may also be used to actuate a combination of the movement-terminating and indicating means.

When the objects passing along the conveyor are of irregular outline, the use of a beam passing to a mirror and reflected therefrom to the photo-tube, as before described, has special advantages. For example, in Figure 3 the object is shown as a bottle 10a of the type which is ordinarily used for carbonated beverages, and which has a neck 86, a wide portion 88, and below that a narrower waist-like portion 90. The transmitted beam 82 may then be made substantially horizontal, and adjusted to such a height that if the bottles are jammed against each other in a horizontal position, the neck 86 of a bottle will be bound to interrupt the passage of light to the mirror, and thence to the tube. The beam may also be reflected upwards (for example, by inclining the mirror 22 at an angle to the vertical) so that it passes through the wide portion 88 of the bottle; if the bottles become jammed in a vertical position, the reflected beam 84 will be bound to be interrupted.

There has thus been described a control system for the movement of objects along a path in spaced relation, including a photo-tube and a gas tube operated by alternating current, and in which a time delay circuit is employed to prevent the operation of the control on a variation in the energizing light for a predetermined period.

I claim as my invention:

1. A control system for apparatus adapted to move light-impeding objects along a path in spaced relation, including in combination a light-sensitive device, terminal means for applying alternating currents to said device, a source of light passing to said device across said path, and means responsive to the flow of current through said device and including a time delay circuit and a gas tube for terminating the movement of said objects on a variation of said light passing to said device for a period dependent on the time constant of said circuit.

2. In combination, means for moving light-impeding objects along a path in spaced relation, a light-sensitive device, terminal means for applying alternating currents to said device, a source of light passing to said device across said path, and means responsive to the flow of current through said device and including a time delay circuit for rendering said moving means inoperative on a variation of said light passing to said device for a period dependent on the time constant of said circuit.

3. In combination, a circuit including a normally closed relay and means for moving light-impeding objects along a path in spaced relation, a control system for said circuit including a light-sensitive device, terminal means for applying alternating currents to said device, a source of light passing to said device across said path, and

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a connection between said device and said relay, said connection including a time delay circuit and means responsive to the flow of current through said device for opening said relay on a variation of said light passing to said device for a period dependent on the time constant of said time delay circuit.

4. In combination, a circuit for moving light-impeding objects along a path in spaced relation, a light-sensitive device having at least an anode and a cathode, a source of light passing to said cathode across said path, a gas tube having at least an anode, a cathode and a grid and a normally closed relay with its energizing winding connecting the anode and cathode of said gas tube, a connection including a time delay circuit and a resistor in series between the cathode of said device and said grid and, a connection for applying alternating currents to said device and said tube, said relay being operatively connected with said first-mentioned circuit, whereby said first-mentioned circuit is rendered inoperative on a variation of said light passing to the cathode of said device for a period dependent on the time constant of said time delay circuit.

5. A control system for apparatus adapted to move light-impeding objects along a path in spaced relation, including in combination a light-sensitive device, terminal means for applying alternating currents to said device, a source of light passing to said device across said path, and means responsive to the flow of current through said device and including a time delay circuit, for indicating a variation of said light passing to said device for a period dependent on the time constant of said circuit.

6. A control system for apparatus adapted to move light-impeding objects along a path in spaced relation, including in combination a light-sensitive device, terminal means for applying alternating currents to said device, a source of light passing to said device across said path, an instrument having at least two conditions, means for maintaining said instrument in one of said conditions, and means responsive to the flow of current through said device and including a time delay circuit, for conditioning said instrument to another of said conditions on a variation of said light passing to said device for a period dependent on the time constant of said time delay circuit.

7. A control system for apparatus adapted to move light-impeding objects along a path in spaced relation, including in combination a light-sensitive device, terminal means for applying alternating currents to said device, a source of light, means defining a transmitted and a reflected path for said light from said source to said device, the path of said objects intersecting both said transmitted and said reflected paths, an instrument having two different indicating conditions, means initiated by the passage of light to said device for maintaining said instrument in one of said indicating conditions, and means responsive to the flow of current through said device and including a time delay circuit, for conditioning said instrument to another of said indicating conditions on a variation of said light passing to said device for a period dependent on the time constant of said time delay circuit.

8. In combination, a light-sensitive device having at least an anode and a cathode, a source of light passing to said cathode, a gas tube having at least an anode, a cathode and a grid, a connection for applying alternating currents to said

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device and said tube to maintain the anode of said device and the anode and cathode of said tube at at least their respective operating potentials and to maintain said grid at below its firing potential, an electro-responsive instrument connected to the anode of said tube and having at least two indicating conditions, a connection between the cathode of said device and said grid whereby said light passing to said cathode causes current to flow to said grid to fire said tube, and thereby to maintain said instrument in one of said indicating conditions, and a time delay circuit and a resistor in series therewith in the circuit of said grid for maintaining said grid at above its extinguishing potential for a period

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dependent on the time constant of said time delay circuit, notwithstanding interruption of said light passing to said cathode.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,150,467	Stain	Mar. 14, 1939
1,998,132	Geffcken	Apr. 16, 1935
1,972,682	Fitzgerald	Sept. 4, 1934
1,992,055	Cockrell	Feb. 19, 1935