March 30, 1965 F. P. DUNIGAN 3,176,196

PHOTO-ELECTRIC RELAY

Filed Aug. 9, 1961

FIG. 1.

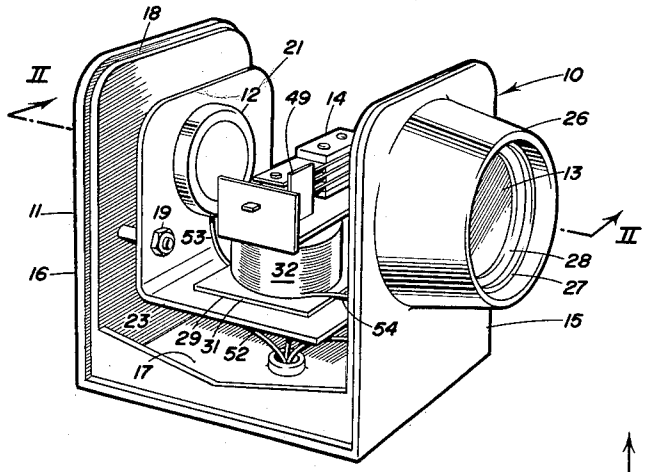
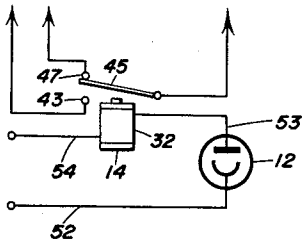


FIG. 4.



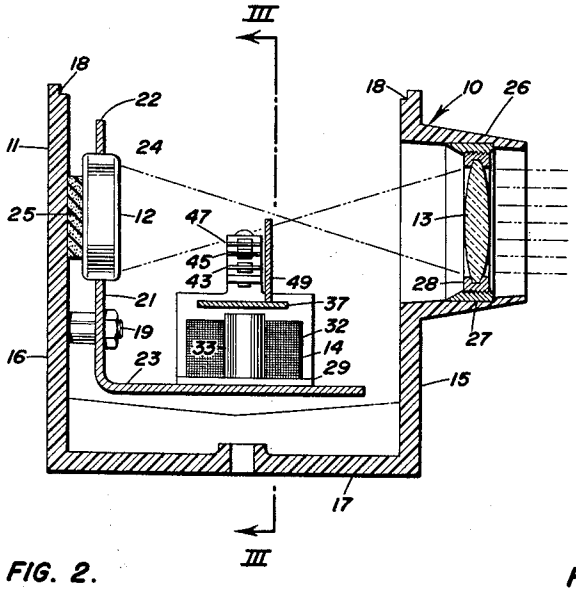


FIG. 2.

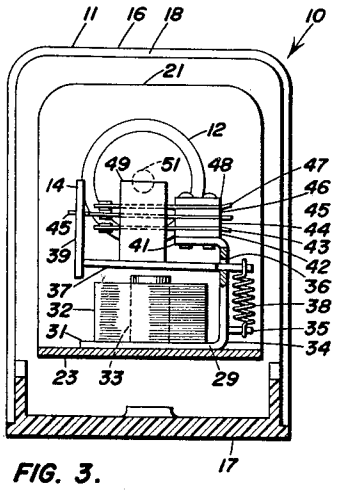


FIG. 3.

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PHOTO-ELECTRIC RELAY

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This invention relates to a photo-electric relay and more particularly to apparatus arranged to connect or disconnect an electrical circuit in response to the intensity of light.

A cadmium selenide photo resistor is capable of offering very large changes of resistance with small changes of light intensity. These resistors have been used to operate a small relay directly in series with the cell, thus eliminating the need for a vacuum tube and amplifier as has been necessary in the past with photo-electric cells. Generally speaking, such a simple relay is operated on direct current obtained from a rectifier and a capacitor as part of the assembly. However, it is possible to eliminate the rectifier and capacitor and to operate the device on 110 volts, 60 cycle power. The circuit, then, becomes a simple series circuit of the relay coil and the photo resistor. However, a problem is presented by the fact that the relay does not operate in a clean manner; instead, it "buzzes" in and out as light is alternately applied and removed. In addition to the noise, the "buzz" has another disadvantage; the fact that the relay is buzzing indicates that the contact pressure is varying in accordance with the 60 cycle current and this can cause arcing or excessive sparking of the contacts. This, of course, results in failure of the contact in a very short time. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a photo-electric relay which may be operated from alternating current electricity without rapid deterioration of the relay contacts.

Another object of this invention is the provision of a photo-electric relay to be operated from alternating current electricity which makes and breaks contact without excessive noise.

A further object of the present invention is the provision of a relay making use of a cadmium selenide photo resistor which may be operated by alternating current electricity without noise or deterioration of the relay contacts.

It is another object of the instant invention to provide a relay operated by light falling on a photo resistor which operates on alternating current electricity to give quick and clean making or breaking of contact.

With these and other objects in view, as will be apparent to those skilled in the art, invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to one of its structural forms, as illustrated by the accompanying drawings in which:

FIG. 1 is a perspective view of a relay embodying the principles of the present invention;

FIG. 2 is a vertical sectional view of the relay taken on the line II—II of FIG. 1;

FIG. 3 is an enlarged vertical sectional view of a portion of the invention taken on the line III—III of FIG. 2; and

FIG. 4 is an electrical schematic view of the invention.

Referring first to FIG. 1, wherein are best shown the general features of the invention, the relay, indicated generally by the reference numeral **10**, is shown as consisting

of a housing **11** in which is mounted a cadmium selenide photo resistor **12**, a lens **13**, and a relay element **14**. The housing is formed of plastic material and was provided with a front wall **15**, a rear wall **16** joined by a bottom **17**. A groove **18** extends around the edges of the housing and is adapted to receive the edges of a U-shaped light-tight closure (not shown) but which serves to enclose all of the apparatus with the exception of the lens **13**. Fastened to the rear wall **16** by means of bolts **19** is an L-shaped support **21** having a vertical portion **22** parallel to and slightly spaced from the rear wall **16** of the housing and a horizontal portion **23** which is parallel to and spaced from the bottom **17** of the housing. The vertical portion **22** is formed with a circular aperture **24** in which the cadmium selenide photo resistor **12** is mounted, there being a rubber pad **25** cemented to the surface of the wall **16** and to the resistor **12**, so that the resistor floats and yet is restrained by the edges of the aperture **24**. The front wall **15** of the housing is formed with a tubular hood **26** in which is molded an aluminum threaded sleeve **27**. This sleeve is threadedly engaged with a ring **28** in which the lens **13** is mounted.

The cadmium selenide photo resistor **12** is of the well-known type which has a low resistance when light falls on it and a high resistance when light does not fall on it. Mounted on the horizontal portion **23** of the support **21** is a sheet metal bracket **29**, best shown in FIG. 3. The bracket is provided with a base portion **31** which is fastened to the upper surface of the horizontal portion **23** of the support **21**. On this base portion is mounted a relay coil **32** having an iron core **33**. The bracket **29** is provided with a vertical portion **34** having in the lower portion a lug **35** and in the upper portion an aperture **36**. Through the aperture extends a movable element **37** of the relay. A portion of the movable element extends through the aperture **36** and overlies the lug **35**; a coil spring **38** extends in tension between the two to bias the movable element **37** in an upward direction. The outer end of the movable element is provided with a vertical insulated plate **39** formed of a non-electrically conducting material. At the top of the vertical portion **34** the bracket **29** is provided with a short table portion **41** having mounted on its upper surface an insulating plate **42**, a contact finger **43** having an apertured electrical attachment, lugs extending rearwardly therefrom, another insulating plate **44**, a contact finger **45** having an electrical attachment lug extending rearwardly therefrom, an insulating plate **46**, a contact finger **47** with a rearwardly-extending lug, and lastly another insulating plate **48**. The central contacting finger **45** extends at its forward end through the plate **39** and moves upwardly and downwardly with the plate and with the movable element **37** of the relay element. The plates and fingers are fastened to the table portion **41** by means of screws in the usual way. In its normal position with the coil **32** unenergized the spring **38** biases the movable element **37** upwardly; this causes the plate **39** to carry the central contact finger **45** into electrical contact with the upper contact finger **47**; when the coil **32** is energized, however, the movable element **37** moves downwardly into contact with the core **33**. This movement carries the plate **39** and the central contact finger **45** so that the last-named finger contacts the lower contact finger **43**.

Mounted on the movable element **37** between the lens **13** and the reeds or contact fingers **43**, **45** and **47** is a shield **49** formed of a generally opaque material. The shield has a height such that, when the coil **32** is unenergized and the movable element **37** is in its upper position, it cuts approximately in two the rays of light extending between the lens **13** and the photo resistor **12**. The section of the ray of light in the area of the shield is

shown by the dotted line circle 51 in FIG. 3 and when the coil 32 is energized and the movable element 37 is in its downward position against the core 33, however, the shield 49 has moved entirely out of the circle.

Referring particularly to FIG. 4, which shows the electrical connections, a line 52 is connected to one side of a source of alternating current electricity (not shown). The other end of the line 52 is connected to one side of the photo resistor 12. The other side of the photo resistor is connected by a line 53 to one side of the coil 32 of the relay element 14. The other side of this coil is connected by a line 54 to the other side of the alternating current source. As is usual in most relays, there are binding posts to which a circuit may be connected for use as a normally-closed circuit and others which may be used as a normally-open circuit. The finger 45 and the finger 47 serve as a normally-closed portion of the relay while the finger 45 and the finger 43 serve as a normally-open portion. These fingers may be inserted in an electrical circuit to perform switching operations as desired.

The operation of the invention will now be readily understood in view of the above description. With the apparatus connected to the alternating current circuit, with the closure over the housing 11, and with no light coming through the lens 13, the photo resistor 12 has a very high resistance. For that reason, no current flows through the coil 32 and the movable element 37 is in its upper position, thus closing the circuit between the finger 45 and the finger 47 and keeping open the circuit between the finger 45 and the finger 43. When light is admitted to the lens 13, however, it falls on the photo resistor 12 and causes its resistance to drop very rapidly. When this happens, current passes through the line 54, the coil 32, the line 53, the photo resistor 12, and the line 52. The energization of the coil 32 in this way causes an electromagnetic field to be set up around the iron core 33 and draws the movable element 37 downwardly into contact with the core. The movement of the member 37 causes a similar downward movement of the plate 39 which carries the finger 45 with it and into contact with the finger 43, thus closing that circuit and opening the circuit between the finger 45 and the finger 47. The current which passes through the relay coil 32, however, is alternating current and for that reason the electromagnetic field set up around the core 33 is built up and falls off 60 times per second; this normally would cause a vibratory movement of the movable element 37 downwardly and cause a buzzing noise in the contact fingers. Actually, if the movable element 37 moves up and down or vibrates slightly as it moves in its downward direction, clean breaking and making of the electrical contact is prevented. The result would be not only a noisy operation and an operation which would be poor from an electrical switching point of view, but also result in rapid deterioration of the silver contact discs on the fingers. This is the type of undesirable operation that would take place were it not for the shield 49. However, in the present case, when the light passes through the lens 13, approximately one-half the light is cut off by the shield 49. When the movable element 37 starts downwardly, it carries the shield with it and the slightest movement of the shield downwardly exposes a very much larger part of the light in the circle 51 of the light ray which is falling on the photo resistor 12, so that the movement downwardly is greatly accelerated the moment it has started. The greater exposure of light to the photo resistor causes even greater energization of the coil 32 and the movable member 37 moves downwardly into position rapidly without giving the alternating current an opportunity to draw it up and down or to vibrate it during its movement.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired, to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A photo-electric relay for use with a source of alternating current electricity, comprising a photo resistor, a relay coil, the resistor and the coil being connected in series for connection across the source, means causing the light to pass in a defined path to the resistor, a movable element associated with the coil and adapted on movement to bring about a switching function, a shield actuated by the movable element from a first position in the said path when the coil is non-energized to a second position at least partly removed from the said path when the coil is energized.

2. A photo-electric relay for use with a source of alternating current electricity, comprising a photo resistor which has a high resistance when light falls on it and a low resistance when no light falls on it, a relay coil, the resistor and the coil being connected in series for connection across the source, means causing light to pass in a defined path to the resistor, a movable element associated with the coil and adapted on movement to bring about a switching function, a shield actuated by the movable element from a first position in the said path when the coil is unenergized to a second position at least partly removed from the said path when the coil is energized.

3. A photo-electric relay for use with a source of alternating current electricity, comprising a photo resistor, a relay coil, the resistor and the coil being connected in series for connection across the source, a lens causing light to pass in a defined ray to the resistor, a movable element associated with the coil and adapted on movement to bring about a switching function, a shield actuated by the movable element from a first position interrupting a substantial area of the said ray when the coil is unenergized to a second position when the coil is energized, the shield interrupting considerably less area of the said ray when in the second position than when in the first position.

4. A relay adapted to be energized by a source of alternating current electricity, comprising a cadmium selenide photo resistor which has a high resistance when light falls on it and a low resistance when no light falls on it, a relay coil, the resistor and the coil being joined in series for connection across the source, a lens causing light to pass in a defined ray to the resistor, a movable element associated with the coil and adapted on movement to bring about a switching function, an opaque shield mounted on the movable element and movable with it from a first position interrupting a substantial area of the said ray when the coil is unenergized to a second position when the coil is energized, the shield interrupting considerably less area of the said ray when in the second position than when in the first position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,788,111	Knowles	Jan. 6, 1931
2,913,637	Bayley	Nov. 17, 1959