

LIGHT OPERATED SWITCHES

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LIGHT operated switches are extremely useful devices which have a number of uses in burglar alarms, automatic parking lights, etc. Most designs for these switches work along the lines of the circuit shown in Fig. 1. The ORP12 photo-resistor is a device which in total darkness has a very high resistance (usually a few megohms), but when light falls upon it, the resistance will fall to a very low level (usually a few hundred ohms).

It will be seen that in the circuit shown in Fig. 1, when there is no light falling on the ORP12, there will be very little base current flowing. In consequence very little collector current will flow and so the relay will not operate. However, when a small amount of light falls on the photocell, its resistance will drop, and a larger base current will flow, causing a larger flow in collector current, which will operate the relay.

Latch on circuit

The relay will only remain on for as long as light is falling on the photocell. This renders this type of circuit unsuitable for many applications. For example, if a burglar alarm which is meant to be triggered by the light from the torch of an intruder is required, if the circuit of Fig. 1 is used, the alarm will only sound for the period the torch is aimed at the photocell. This is of course of no use. A circuit which will remain operative once it is triggered is required.

A suitable circuit is shown in Fig. 2, based on a bistable multivibrator. When the circuit is turned on, as there is a far lower resistance to the base of Tr1 through the relay and R2 than there is through R1 and R3 to the base of Tr2, Tr1 is switched hard

on. This causes the voltage at the collector of Tr1 to be at a very low level, and Tr2 receives only a very small amount of base current through R3. This means that Tr2 is turned off, and the relay will not operate.

When light falls on the ORP12, its resistance will decrease and it will have an earthing effect on the base of Tr1. This will cause a decrease in the current flowing through Tr1, and the voltage at the collector will swing to a high level. Tr2 can now obtain quite a heavy base current and will turn on, operating the relay. The voltage at the collector of Tr2 will now be at a low level, and it is Tr1 that is unable to obtain any appreciable base current, and will thus be turned off. Even if the light is now taken off the photocell, the circuit will still remain in the same state, as Tr1 will still be unable to draw sufficient base current due to the low voltage at the collector of Tr2.

The circuit may be reset by two methods. A push-button switch may be connected between Tr2 base and earth. When this is operated it will have the same effect as when light fell upon the photocell, except it will have the opposite result. Alternatively the unit may be turned off, and then turned on again.

A protective diode is connected across the relay in all the circuits shown. This is to prevent the high reverse voltage, which is induced into the relay coil by the collapsing magnetic field as the relay is turned off, from damaging the transistor. Almost any diode will work in this position.

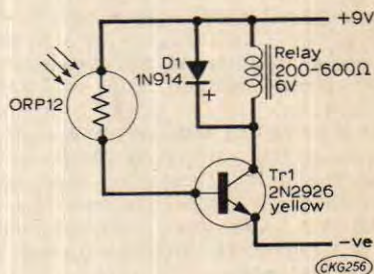


Fig. 1: Typical photoelectric switch.

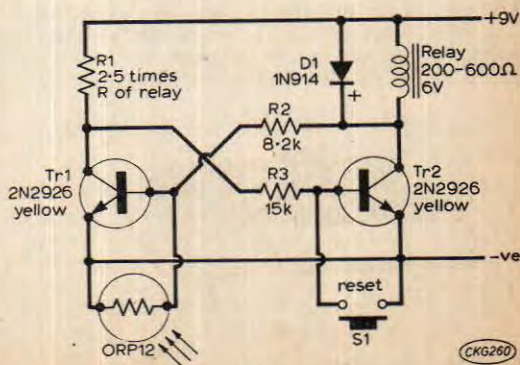


Fig. 2: Circuit suitable for applications where the relay must remain on once operated.

Higher sensitivity

The circuit of Fig. 2 does lack sensitivity and the ORP12 has to be almost fully illuminated before the relay is triggered. A more sensitive circuit is shown in Fig. 3. This circuit requires an extra transistor, and although BC183L is specified, the circuit should work equally well with any high gain, silicon, n.p.n. transistor.

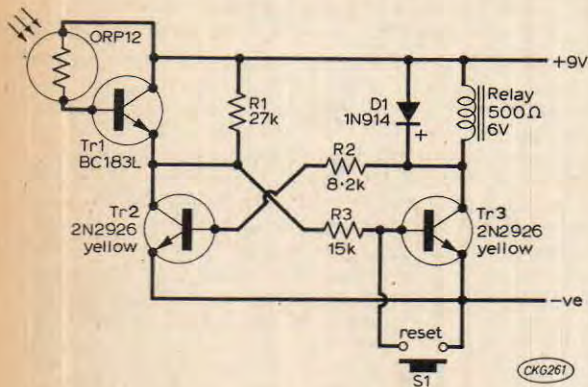


Fig. 3: Sensitive circuit using three transistors. A 25kΩ potentiometer may be placed in series with the ORP12 to control sensitivity.

With no light falling on the photocell it will have a high resistance. Tr1 will receive very little base current, and will have a high resistance between the collector and emitter. R1 also has a fairly high resistance and this will prevent much current flowing to the base of Tr3. This transistor will cut off while Tr2 is turned on, as occurred in the circuit of Fig. 2 when a small amount of light falls on the photocell, its resistance will fall, causing the resistance of Tr1 to fall by a far greater amount.

When this resistance reaches a low enough value, the voltage at the collector of Tr2 will be at a fairly high level. A large base current will now flow, turning on Tr3, and operating the relay. The voltage at the collector of Tr3 will drop, turning off Tr2. If the light is now taken away from the photocell, the resistance between the collector and the emitter of Tr1 will again be very high. The resistance of Tr1 and R1 will be just sufficient to give enough base current to Tr3 to hold the relay on.

Broken light beam alarm

Another type of alarm sometimes used is one in which a beam of light is aimed from one side of a room, or a doorway, to a photocell on the opposite side. If anyone then passes between the two, breaking the beam, the alarm is sounded. A suitable circuit for an alarm such as this is shown in Fig. 4.

This works in very much the same way as the two previous circuits. When light is falling on the photocell it will have a resistance very similar to that of R2 in Fig. 2, and the circuit will behave in the same way initially. When the light to the photocell is

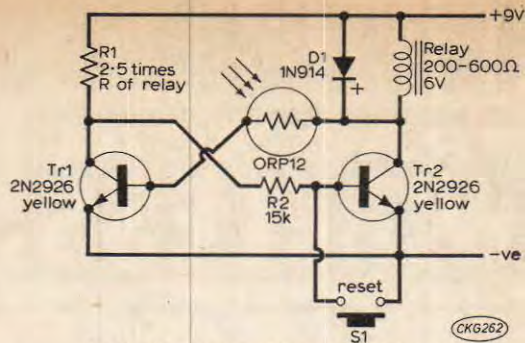


Fig. 4: Circuit for operating in a dark room.

interrupted, it will exhibit a high resistance. Tr1 will receive very little base current, the voltage at its collector will rise, Tr2 will be able to obtain a large base current, and will turn on. The voltage at the collector of Tr2 will drop and, even if light is now restored to the photocell, Tr1 will be unable to draw any appreciable base current. Thus Tr2 is able to draw a heavy base current and the relay remains on.

The circuit may be reset in the same way as the two previous circuits. For the circuit to function correctly, the room in which the photocell is situated has to be fairly dark, of course, or the light in the room will keep the relay off, regardless of the light beam.

These circuits are all fairly simple, and inexpensive, but should prove useful and interesting. With a little imagination a number of uses, other than those mentioned, may be found for the circuits. ■

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