Switching Tricks

The silicon-diode switch is a infinite applications. Some ones are shown

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SILICON DIODES HAVE LONG BEEN popular rectifiers for radio and TV sets. Compared to tubes and the older selenium diodes, the silicon units are much more compact for the same current and voltage ratings, and have an excellent front-to-back resistance ratio. It is this last feature that also contributes to the silicon rectifier's usefulness, because it makes an ideal switching device. Thus, digital computers use numerous silicon diodes to form logic switching circuits to gate in or out certain signals as required.

By using combinations of silicon diodes we can form a number of tricky but useful switching circuits for signalling purposes, between two or more locations, or for providing a combination-type system that can be made to work only by identifying the correct contacts. Also, diodes can be used to build *electronic keys* for opening garage doors electrically, opening locks, or turning on electric equipment such as power tools or hi-fi systems to prevent use by others.

Diode selection and testing

Remember that current and voltage ratings of silicon diodes are maximum values, and operation at lower values is not only all right, but desirable. Thus, if you have some 0.25A diodes (100V types) on hand and intend to use No. 47 pilot lights for signalling devices, you have a wide margin of safety, since the lamp is rated for 6.3 volts at 0.15 ampere. With a silicon diode rectifier in series with such a lamp, the current drawn is even lower (less than 75 mA).

If you intend to use diodes already on hand, you can use the simple tester shown in Fig. 1. While this unit will not indicate current or voltage limits, it will indicate correct wiring polarities and will also show whether the unit is open or shorted.

While the ohmmeter section of your tester could be used, you would have to make sure of the ohmmeter testing polarities. With the unit shown in Fig. 1, the diode diagram should be drawn at the test points and the battery wired into the circuit as shown. The voltage can range anywhere from 1.5 to 9; whatever is convenient.

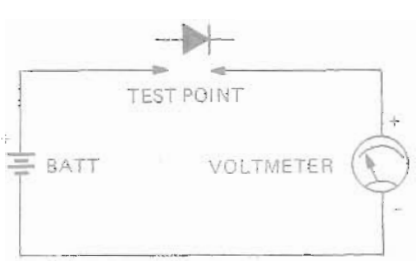

FIG. 1—SIMPLE DIODE TESTER detects opens and shorts and indicates device polarity.

To use the tester, reverse the diode at the test points until you get a reading, at which time the diode polarity is as shown. If you get a reading for both the initial position and the reversed position (for silicon diodes) the diode is shorted (or has a high leakage in the reverse direction) and should not be used. If neither the initial or reverse position at the test points gives a reading, the diode is open.

Selective calling unit

A circuit using two silicon diodes to form a selective signalling system is shown in Fig. 2. Here, one remote unit can be signalled without the other, with only two wires interconnecting the entire circuit. For 6- or 12-volt systems, bell wire, lamp cord, or twin lead can be used.

Buzzers or door bells can be used for short-signal calls. Light bulbs are useful for maintaining the signal for some time in silence. If, for instance, the person being called is not in the room, the light can be left on until he returns, at which time he can return the call with an intercom or by phone. If you use buzzers or relays, check the current consumed during operation to make sure the diode's ratings are not being exceeded. Also check the operating voltage at the buzzer to make sure the buzzer will operate reliably.

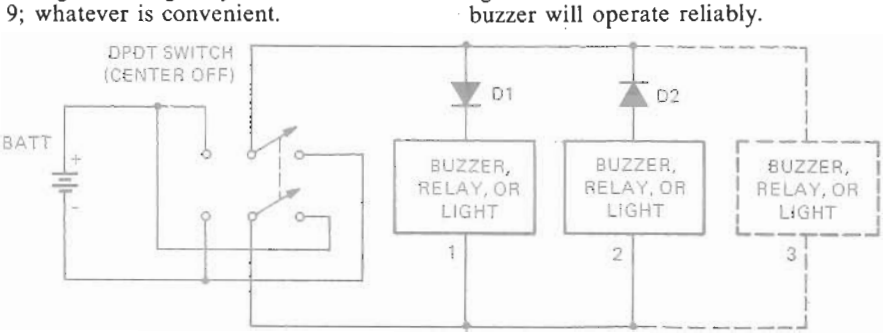

FIG. 2—SELECTIVE CALLING SYSTEM uses the polarity of the control diodes and the polarity of the applied voltage to select the signalling device at the desired remote location.

As shown, a double-pole double-throw switch is used to reverse polarity to select either one or the other of the remote call units. A toggle switch with a center-off position can be used, or knife switches can be substituted. If desired, you can add a third remote unit as shown by the broken lines. This unit, without the series diode, gets all calls received by either No. 1 or No. 2 For remote units with the series diodes, how-

with Silicon Diodes

tiny solid state device that has of the more interesting in this article

ever, current flows only when the correct battery polarity is present, so the selective feature still operates just as it did before.

If pushbutton convenience is desired, the unit shown in Fig. 3-a can be used. With this system, both remote units can be called at the same time, or either one selected individually, as before. Two voltage sources are needed, as shown. The pushbuttons should be momentary contact types, such as those used for door bells. Miniature ones can be used (Allied Radio Shack catalog No. 275-1547, or GC Electronics No. 34-000).

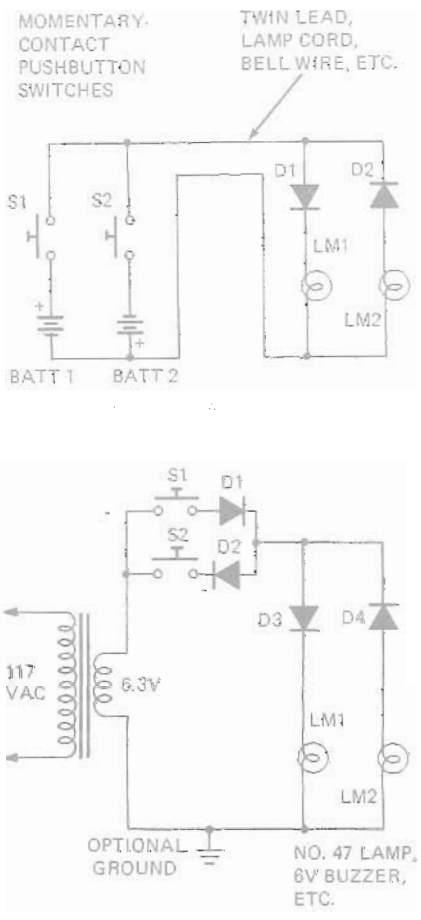

FIG. 3—PUSHBUTTON SWITCHES control the battery-operated (a) and line-powered (b) selective signalling systems.

You can eliminate the batteries by using a 6.3-volt transformer as shown in Fig. 3-b. Two additional diodes are used to create a circuit that is fairly simple but forms a sophisticated switching system. It uses only two interconnecting wires, yet permits an ac source to select either one or the other, or both remote units as desired. If, for instance S1 is closed, diodes D1 and D3 will have identical series polarities and the resulting current flow through LM1 lights the lamp (or activates a buzzer). With S1 closed, however, diode D4 is opposite in polarity to D1 and does not permit current flow through LM2. Similarly, depressing S2 puts diode D2 in polarity-coincident series with D4 and current flows through LM2. Incidentally, a lamp could be used at one location and a buzzer or bell at the other, as required.

Secret combination system

Diode switching principles can be used to create "secret combination" systems. A typical one using push buttons is in Fig. 4. In this kind of system we must prevent the system from working when all buttons are pushed down simultaneously. For Fig. 4 this is done by using a normally-closed relay in series with diode D4 as shown. The normally-open relay is the one that applies the power to the power tools, the garage-door opening mechanism, or other device when the correct combination is used.

Any combination can be formed, though for Fig. 4 push buttons Nos. 1, 3, and 7 must be depressed simultaneously for the normally-open contact relay to close. With these contacts closed, diode D2 is in series with D3 of the same polarity. Since diode D4 is of opposite polarity, the normally-closed relay does not trip.

If all buttons are depressed at one time, or button No. 7 is depressed in combination with No. 2, or No. 4, etc., diode D1 is placed in series with D4, and since their polarities are identical, the normally-closed relay opens, thus

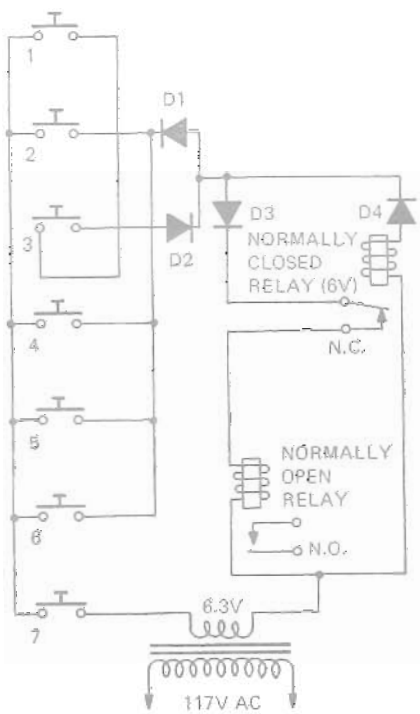

FIG. 4—COMBINATION LOCK requires closing three correct switches simultaneously.

preventing the other relay from operating.

If desired, an alarm buzzer or bell can be connected so it will ring if an incorrect combination is tried. Instead of spst contacts on the normally-closed relay, a spdt arrangement can be used so

that current flow through this relay not only opens the line to the other relay, but also closes contacts to a bell or buzzer circuit.

If the relays in Fig. 4 are ac types, they will function satisfactorily, even though pulsating dc is obtained from the series diodes. If dc relays are used, shunt them with 100-μF capacitors for smoother operation. The shunting capacitors filter the ripple component and provide a smoother operating voltage. Be sure to observe the correct polarity for the electrolytic shunting capacitors.

Electronic keys

As shown in Fig. 5 a phone plug can be used as an electronic key, with the jack acting as the keyhole. Wire a single diode across the two contacts of the phone plug to form the electronic key element. Use a normally-open relay to apply power to the desired device when the proper key is inserted. I recommend a dc relay with two 100-μF electrolytic capacitors (35wV or higher) wired back-to-back as shown. If a solid metal rod is inserted into the phono jack in an effort to trip the mechanism, only ac is applied across the relay. Since it is a dc type, it will not operate.

The shunting capacitors also act as a low reactance and have a bypass effect on some of the ac signal energy. When the phono plug (with its internal diode) is inserted, the ac is rectified by the diode and filtered by the capacitors, thus applying the required dc to the relay for proper operation. A higher-voltage transformer can, of course, be used if higher-voltage relays are employed.

Again check the current flowing through the relay winding so the proper ampere rating is found for the diode. If 0.5 ampere flows, use a 1-amp diode (or higher). Also, remember polarized capacitors used back-to-back do not double the voltage rating. So use a capacitor voltage rating high enough to be on the safe side, particularly since some back emf is developed by the collapsing fields of the relay coil when current flow stops through it. If bulk is no factor, use 50-volt units (or higher).

A more elaborate electronic-key version is shown in Fig. 6. Here a stereo plug is used, with two internal diodes instead of the single one used for the key in Fig. 5. Another relay like the one that was used in Fig. 4 is included as an additional precaution against use of a false key or shorting wires.

The two relays are also dc types with shunting back-to-back capacitors as in Fig. 5. A 12-volt transformer with center-tap is used to obtain two 6-volt sources. As opposed to the relay combination of Fig. 4, the two used in Fig. 6 are *both normally-open* types as shown.

The stereo-plug key places a diode in series with each 6.3-volt section of the circuit and thus converts the alternating current to dc which is also filtered by the capacitors shunting the relays. Thus, both relays are energized. There is a slight delay for RY1, since the normally-open contacts of RY2 must close to complete the circuit for RY1. When RY1 is energized, its contacts close and apply power to whatever system is turned on by this electronic key circuitry.

If the stereo jack contacts are shorted in an attempt to cheat the system, only ac is applied to RY2 and it doesn't close. Consequently, an open circuit is maintained for RY1. The back-to-back capacitors across the relay prevents ac damage to the polarized (dc) electrolytics. Even if a diode is placed in series with the RY2 circuitry, RY1 will not be energized if its contacts are shorted, since dc is necessary.

The two rectifiers within the stereo plug key can be polarized in either direction and the circuit still functions. These diodes rectify the ac and so long as current flows through the relays in a single direction they will be energized, regardless of the particular direction of such direct-current flow.

The transformer used should be a good one so it will not warm up appreciably when the primary is left connected to the 117-volt ac lines. As an added safety precaution, fuses can be placed in series with each of the relays. As an alternative, a single fuse can be used between the transformer center tap and ground. **R-E**

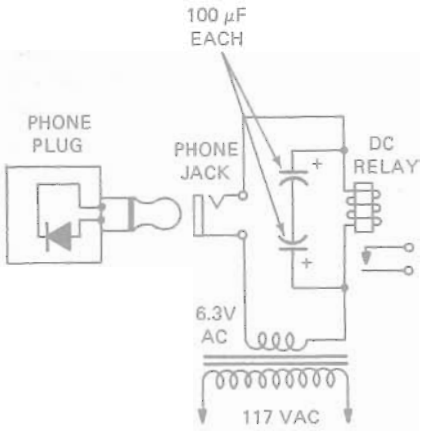

FIG. 5 (above)—SIMPLE KEY FOR ELECTRIC LOCK is diode in phone plug to rectify applied ac and provide dc for the relay.

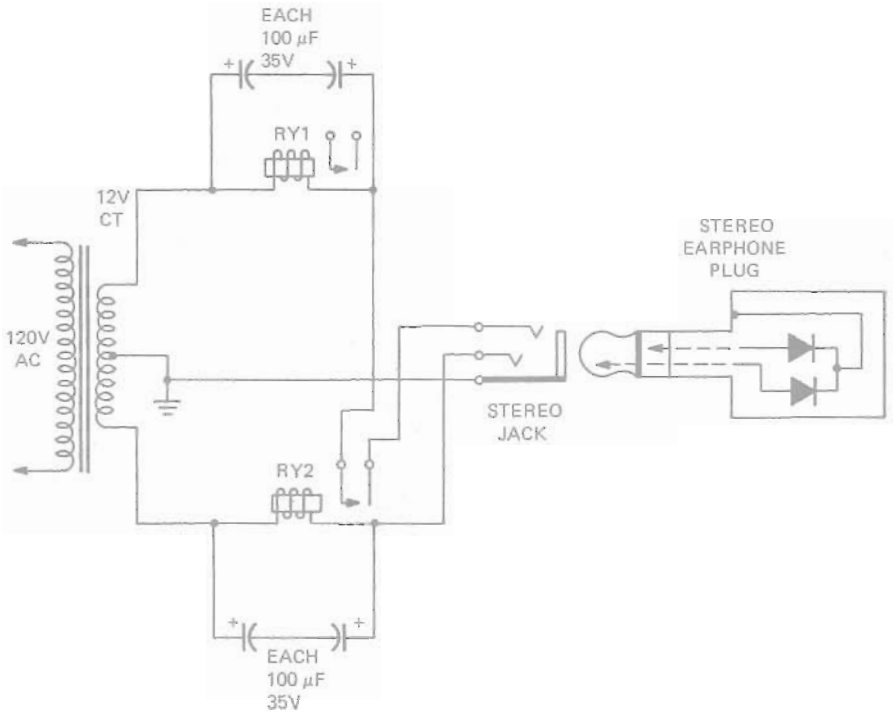

FIG. 6 (right)—ELABORATE LOCK has a simple key consisting of a pair of silicon diodes inside a stereo phone plug.