HOW-TO BOOKLET #3003

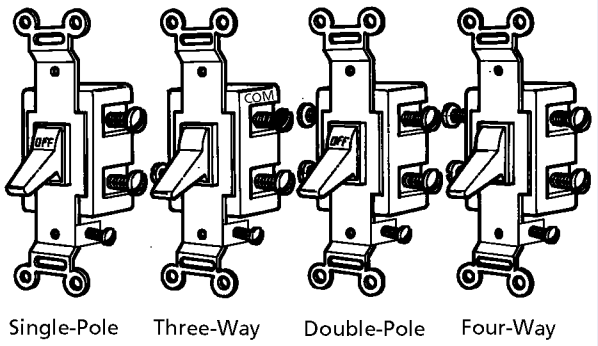
SWITCHES & OUTLETS

TOOL & MATERIAL CHECKLIST

- ❑ Screwdriver
- ❑ Needlenose Pliers
- ❑ Electrician's Tape
- ❑ Neon Voltage Tester
- ❑ Ground Clips
- ❑ Wire Strippers
- ❑ Utility Knife
- ❑ Continuity Tester
- ❑ Bare or Green-Insulated Copper Wire
- ❑ New Switches and Outlets as Needed

Read This Entire How-To Booklet for Specific Tools and Materials Not Noted in the Basics Listed Above.

Fig. 1



Single-Pole Three-Way Double-Pole Four-Way

Common types of switches include this basic selection for residential housing. Note the difference between four-way and double-pole, which has OFF/ON stamped on the toggle.

Switches and outlets are essential in modern living. They are not indestructible, though they sometimes seem that way. When you must replace one or the other, the task is fairly simple. Always follow established safety procedures: be sure the current in the circuit is shut off at the service panel, and double-check with a voltage tester. Do not work in a wet or damp environment. Always practice safety as you work.

SWITCHES

A switch controls the flow of power in an electrical circuit. When the switch is on, electricity flows through the circuit from its source to a point of use. Most residential electrical switches are one of several toggle (or snap) types. To determine the exact type, turn off the circuit to the switch before you begin. Then remove the faceplate and the mounting strap screws to release the switch. Pull it out toward you. The switch will be attached to the cable wires by either screw terminals or, less often, spring clamps like those in back-wired outlets. Most commonly, they have both side terminals and back-wiring holes. The number of connections tell you which of the following types of toggle switches you have (**Fig. 1**).

Single-Pole Switch. A switch with two terminals is called a single-pole switch; it alone controls the circuit. The incoming hot wire is hooked to one terminal screw, and the outgoing hot wire is connected to the other screw.

Three-Way Switch. A switch with three terminal screws is called a three-way switch. One terminal is marked COM, or "common"; the hot wire is connected to this terminal. The other terminals are switch leads. Two three-way switches are used to control a circuit from two places. Complete information on the wiring of three-way switches is given in How-To Booklet #3004: 3-Way Switches.

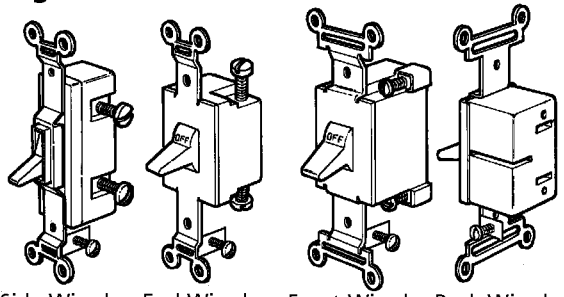
Double-Pole and Four-Way Switches. A double-pole switch has four terminals. It is normally used to control 240-volt appliances. A four-way switch also has four terminals. Three four-way switches are used in a circuit to control one outlet or fixture from three separate places. Both switches look the same, but a double-pole switch has ON/OFF markings.

In addition to the terminals mentioned, most switches will have a green terminal for a ground wire.

POSITIONS OF TERMINAL SCREWS

The position of terminal screws varies to let you select a switch that permits the most convenient placement of wires in the switch box (**Fig. 2**). No matter which switch you select, it will fit into a standard-size box.

Fig. 2



Switches come with different terminal positions for wiring convenience. All those shown here are single-pole. Back-wired switches have terminal holes instead of screws.

Side-Wired Switch. This type of terminal arrangement has screws on one side of a single-pole switch or on both sides of three-and four-way switches.

End-Wired Switch. Another type has screws on the top and bottom of the switch housing with screw heads pointing up and down, respectively.

Front-Wired Switch. A third type of terminal arrangement has screws facing the front of the switch, with one screw at the top of the switch and the other at the bottom of the switch. This type is very rare.

Back-Wired Switch. This type doesn't have terminal screws. It has holes in the rear of the switch into which wires are pushed. Below each hole is a slot. To release a conductor, use the end of a paper clip, screwdriver, or similar tool to press the tang in the slot (**Fig. 3**). To insert a conductor, press the tang in the slot and insert the wire. The wires must be perfectly straight and exactly the length indicated on the side of the device.

TESTING A SWITCH

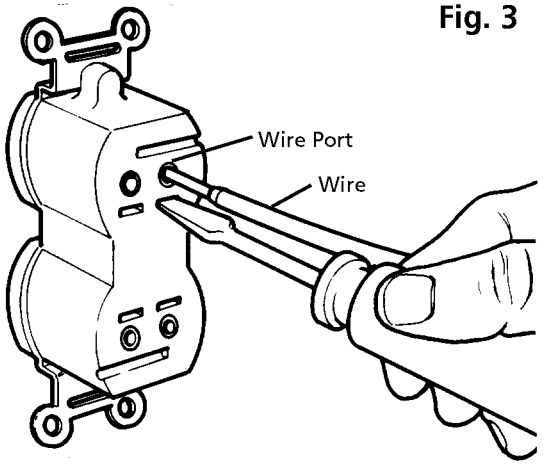
When electricity fails to reach an outlet or fixture, a switch may be faulty or the defect may be with an outlet, fixture, appliance, or lamp. To determine if a single-pole switch is causing a circuit to fail, use the continuity tester to test the switch. If the switch proves faulty, replace it. Do not try to repair a faulty switch.

1. Turn off the power to the switch by deactivating the appropriate fuse or circuit breaker.
2. Remove the faceplate screws and the faceplate.
3. Use a voltmeter to make sure the power is off. Pull the switch out of the switch box after removing the screws that hold it in the box.
4. Loosen the terminal screws and remove the wire connections from the switch. Do not do anything to any other wires present in the box.
5. Fasten an alligator clip on, or touch a probe to, one wire of the tester to either terminal screw and then touch the other probe or alligator clip to the other terminal screw (**Fig. 4**). Have a helper flip the toggle switch. When the switch is in the ON position, the light will go on in the tester. When the switch is in the OFF position, the tester light will be off. This indicates that the switch is in good working order and the trouble is in the light or appliance that the switch controls.

ABOUT OUTLETS (RECEPTACLES)

A receptacle is frequently called a wall receptacle. It is the point of electrical service into which you insert the plug of a lamp, appliance, clock, or other electricity-using equipment. There are several varieties of receptacles. Some are designed for outdoor use, some to handle the heavy-duty requirements of major appliances, some are integrated into light fixtures, and some are combined with switches. The most common home receptacle is the duplex receptacle that is rated at 15 or 20 amperes and 120 volts (**Fig. 5**). A duplex receptacle has two outlets and accommodates two pieces of electrical equipment.

Fig. 3



Back-wired switches (and outlets) have a tiny slot under wire port to release the wire from the switch/outlet. Push screwdriver tip into the slot.

Although many homes have two-hole outlets, three-hole grounding outlets are required in all new houses and should be used for all replacements where a ground is available. Such outlets include one hot wire, one neutral wire, and one ground wire. Most people recognize the hole for the grounding prong, but many do not realize that the other two slots are different sizes. The shorter slot is connected to the hot wire and the longer slot to the neutral wire. This distinction is important with the increased use of electronic equipment in the home. Many of the plugs for this type of equipment are polarized, meaning that one prong is wider than the other because internal switches and other components must connect to the current in proper sequence.

Grounding Outlets. Grounding outlets have a green grounding terminal. If the metal box is mounted on the surface of the wall so that the projecting metal tabs on the outlet make firm contact with the box, no wires need be connected to this grounding terminal. Otherwise, the terminal should be wired to the ground wires entering the box. If there are no ground wires entering the box, test for the presence of ground before installing a three-pronged receptacle. Having confirmed the presence of ground, attach a bare or green wire to the grounding terminal and attach it to a grounding clip. Follow directions from the grounding clip package. Alternately, you may secure ground wire to a screw threaded into the back of the metal box. Older boxes may have to be hole drilled and tapped so that machine screws can be driven in to secure the grounding wire. Using sheet metal screws is illegal. Don't install a grounding outlet that is not actually grounded, unless you use a GFCI receptacle.

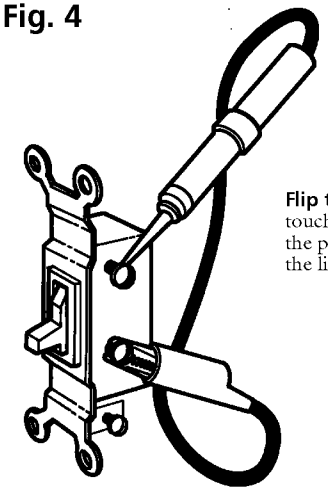
Testing Outlets. Although a receptacle has no moving parts, it eventually wears out. However, if you have trouble with a circuit, test it carefully to determine whether or not it is faulty. In time, plastic parts may become brittle and break off. Metal parts inside the receptacle loosen and fail to make secure contact with plug prongs. If a receptacle shows physical damage, or if it seems to have an internal failure, it should be replaced. A bad receptacle cannot be repaired.

The best outlet-testing procedure is to use an inexpensive neon voltage tester. It has no internal power, and the test light glows only if the probes connect points where voltage is present (**Fig. 6**).

Reading Switch/Outlet Markings. When you buy a replacement switch or outlet, be sure you get the one that matches the circuit. The markings and ratings on old and new equipment must match.

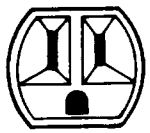
UL (Underwriter's Laboratories) and CSA (Canadian Standards Association) monograms indicate that the switch/outlet has been tested and listed by these organizations. Make sure the replacement has markings appropriate to your country. AC ONLY means that the switch/outlet will handle only alternating current. CO/ALR is a wire code indicating that the switch will handle copper, copper-clad, and aluminum wire. 15A-120V means that the switch/outlet will handle 15 amperes and 120 volts of power. A new switch/outlet must have the same volt rating as the switch/outlet it replaces. It can have a greater ampere rating, provided that the rating does not exceed the fuse or circuit breaker feeding it.

Fig. 4



Flip the toggle to OFF. Again touch both of the terminals with the probes. If the wiring is right, the light should not light up.

Fig. 5



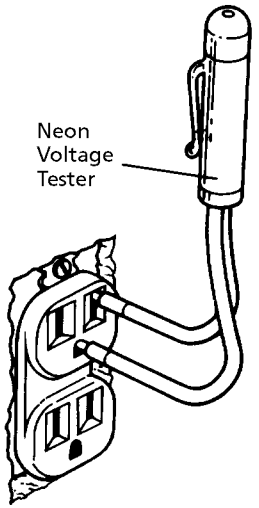
Grounded Three-Prong
(120 Volts-15 Amps)

Ungrounded Two-Prong
(120 Volts)

Grounded Three-Prong
(120 Volts-20 Amps)

Buy the right replacement receptacle. Replacement outlets should have the same voltage and amperage ratings as the original outlet.

Fig. 6



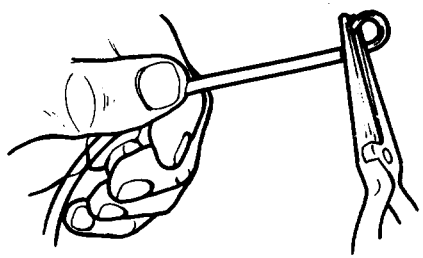
Insert one prong in the hot side of an outlet, the other in the ground and then the neutral side. If the wiring is right, the bulb will light both times. If there is no ground hole, touch one prong to the receptacle top or to the metal box itself and insert the other into the hot side of the outlet.

REPLACING SWITCHES/OUTLETS

Here are the steps necessary to change either a switch or outlet with only two wires attached plus a ground wire

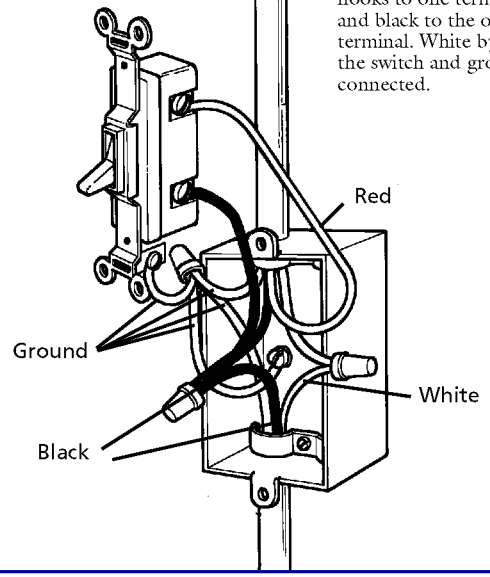
1. Remove the faceplate and turn off the power, if applicable. Test the switch/outlet, as already detailed.
2. Pull the switch/outlet fully from the box so you can work easily with the wires. With a screwdriver, turn the terminal screws counterclockwise to remove the wires or insert a narrow screwdriver blade into the back-wire release slots. Do not disturb other wires in the box — just those attached to the switch/outlet.
3. If you're not sure of replacing the wires properly on the new switch/outlet, label them with a piece of tape as they are removed from the old switch/outlet.
4. Straighten and reform the loops on the ends of the wire with needlenose pliers (**Fig. 7**).
5. There should be approximately 3/4" of insulation stripped from the ends of the wires. If more insulation has been removed, cut the wire to the 3/4" length. Then reform the loops.
6. Replace the wires on the terminal screws (**Figs. 8 and 9**). The loops you formed should go onto the screws in the direction the screws turn down — clockwise. This way, the wire is tightened under the screw as the screw is tightened.
7. At this point as an option, wrap the sides of the switch/outlet with several layers of electrician's tape. This makes a neat package and protects the wires inside the box.
8. Carefully bend the wires in an accordion configuration and press the wires and the switch/outlet carefully into the box (**Fig. 10**). Don't force the wires, just press easily or you will loosen the wires on the terminal or even crack the switch or outlet.
9. Attach the switch/outlet to the box and fasten on the faceplate. After restoring power, test the switch/outlet. It should work perfectly.

Fig. 7



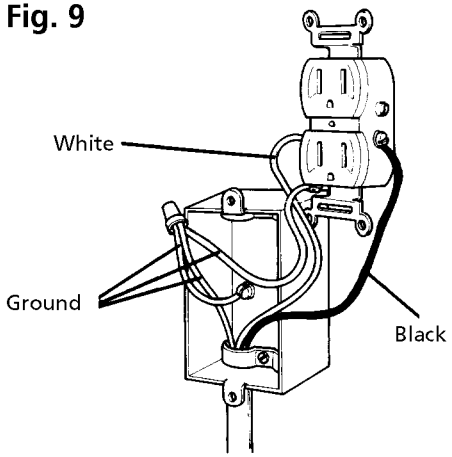
Reshape wire loops with needlenose pliers so they hug terminal screws when screws are set.

Fig. 8



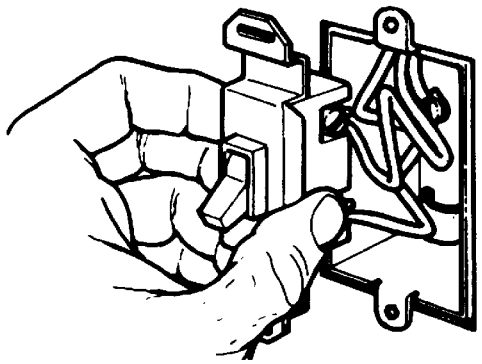
To wire a switch, red hooks to one terminal and black to the other terminal. White bypasses the switch and ground is connected.

Fig. 9



To wire the outlet, connect the black to the brass terminal, and white to silver at the outlet.

Fig. 10



Accordion-fold the wires, and then push the switch back into the switch box gently, but firmly.