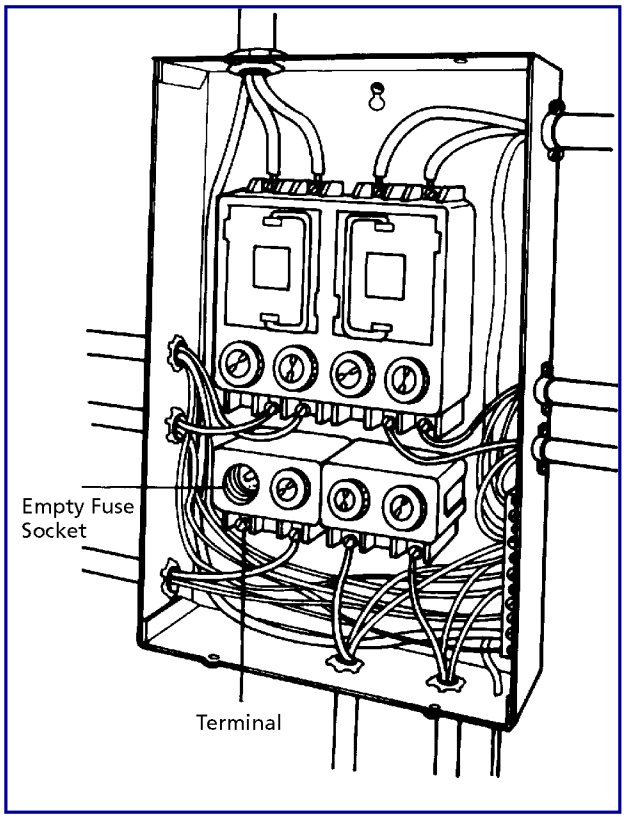
HOW-TO BOOKLET #3130

EXTENDING ELECTRIC SERVICE

TOOL & MATERIAL CHECKLIST

- ❑ Hammer
- ❑ Screwdriver
- ❑ Cable Slitter
- ❑ Long-Nose Pliers
- ❑ Lineman's Pliers
- ❑ Wire
- ❑ Safety Glasses
- ❑ Circuit Tester
- ❑ Subpanel
- ❑ Oxide-Inhibiting Compound



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

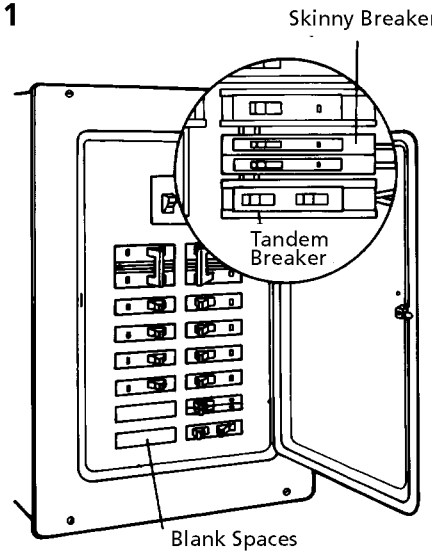
There are several good reasons for extending your electric service. Does your circuit breaker trip or fuse blow often? Do your lights flicker when large appliances are turned on? Do you use too many extension cords? Or do you wish to add a new branch circuit to provide electric power in a newly finished attic or garage, or to an outdoor lighting system or newly converted workshop? To resolve any of these situations, you most likely have to extend your electrical service.

WIRING IN AN EXISTING SERVICE PANEL BOX

The first step in extending your electric service is to determine if there are any blank spaces in your service panel. If not, it may be possible to double up by replacing an existing breaker with a pair of skinnies or a tandem device (**Fig. 1**). In a fuse box you might be lucky enough to find an unused terminal and socket that could be put to work (**Fig. 2**). To wire a circuit breaker or fuse block into an existing service panel, proceed as follows:

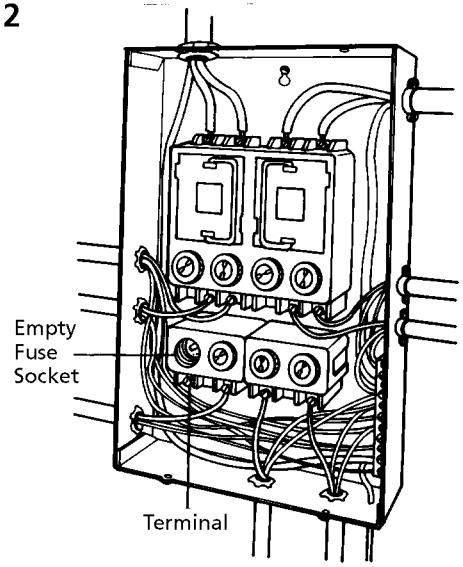
1. Turn off the power at the service panel by turning off all main circuit breaker disconnects or removing all main fuses.
2. Remove the screws that hold the panel cover on. Remove the cover.
3. Strip off the outer covering to let the wire reach through a spare knockout and inside the panel to the proper point of hook-up (allow a foot or more of wiring).
4. Run the cable through the knockout with a cable connector and clamp it securely.
5. Run the black wire to the spare circuit breaker or fuse, then strip and connect it.

Fig. 1



Use skinny or tandem breakers where permitted.

Fig. 2



A fuse box may have an empty or blank fuse socket.

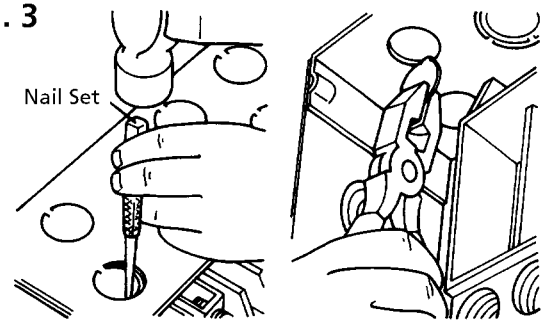
6. Connect the white wire to the neutral and the bare wire to the ground bar (if there is one) or the neutral.
7. Replace the panel cover. Energize the panel and the individual circuit.
8. Test the circuit. Always use a circuit tester to verify that voltage is present in any circuit on which you have just worked. To use the tester, place one lead on any bare, grounded metal such as an equipment ground terminal, ground wire, or neutral terminal. Carefully touch the other lead to the terminals or wires you are testing for voltage. If the tester bulb glows, voltage is present. To check for voltage on the load side of a main breaker, it may be necessary to test the load terminal of a branch breaker. In this case, the branch breaker must be in the ON position. Check several branch breakers to be sure.

ADDING ON SUBPANELS

If your main service panel is full and you wish to add circuits, you may want to install a subpanel. Before you begin, check local codes. Then proceed as follows:

1. Switch all main circuit breakers to OFF or remove all main fuses. Remember, incoming power cables and connections to main breakers or switches are still "live" even though the mains have been turned off. Remove the front cover.
2. The supply wires coming into the subpanel must be protected at their point of supply by installing a properly sized circuit breaker or fuse. The ampere rating of the protecting breaker or fuse cannot exceed the rating of the subpanel being installed. Branch circuit wire sizes and breaker ratings must also conform to code requirements.
3. Remove the front cover of the subpanel.
4. Select the cable clamps approved for the wire or cable sizes used.

Fig. 3



Removing a 1/2" diameter knockout

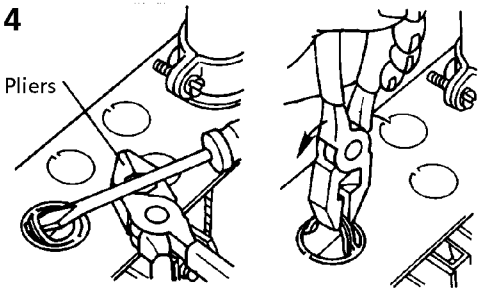
5. Before removing any knockouts, determine where the wiring must enter and exit the subpanel box and also determine the size knockout required based on the diameter of conduit hub or cable clamp being used. Remove only those knockouts needed for wiring.

   To remove the 1/2" knockouts (**Fig. 3**), place a nail set on either side and give the tool a sharp rap with a hammer to the edges inward. From inside the main service panel, grip the bent edges of the knockout with pliers and work them back and forth until the knockout comes off.

   Some panels have multisection knockouts for 6 and 8 gauge 240-volt lines. In such a panel, remove the center, like you did for the 1/2" knockout, then pry up the next ring using a heavy screwdriver levered on a pair of pliers (**Fig. 4**). Grip the pried-up edges of the ring with the pliers from outside the panel and pull off the ring. To complete the opening, tap the last ring inward and remove it with the pliers from inside the panel.

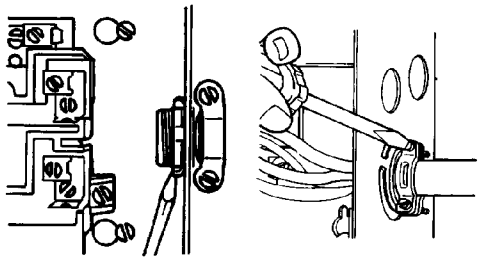
   According to code regulations, all unused, open knockout holes must be closed. Filler plugs are available from your electrical supplier for this purpose.

Fig. 4



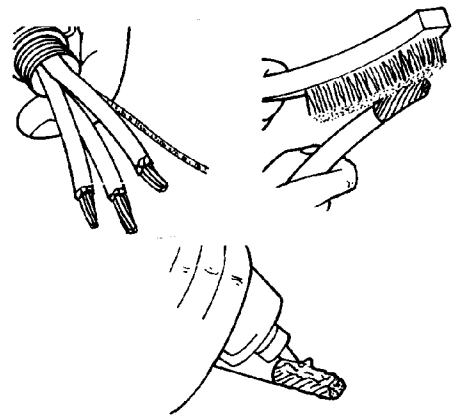
Removing multisection knockout ring

Fig. 5



Steps in mounting the feed cable

Fig. 6



Preparing aluminum feeder cable or supply wire

6 The subpanel may be flush or surface mounted on a wall as you desire. To flush mount a subpanel in a recess within a wall, remove the small oval knockouts in the box sidewalls. Position the box between the wall studs so the front edge of the box will be even with the wall surface. Fasten the box to studs with nails or screws through the small knockouts.

To surface mount a panel on a wall, fasten it with screws or nails (or other mounting devices appropriate for the type of wall construction) through the mounting holes in the back of the subpanel.

7 Once the wiring for the new branch circuit is completed, cut the wire allowing sufficient length for panel installation. (Remember that excess wire can easily be cut away, but adding on to it is prohibited by code). Install the cable clamps or conduit and bushings in knockouts to protect the wire insulation. Tighten the locknut. Pull the wire in the subpanel far enough to allow for the longest connection. Working in the panel, pass the inner connector ring over the wires and screw the connector together, allowing only enough cable sheathing to enter the panel to give purchase to the connector. Tighten the connector's toothed inner ring using a screwdriver and hammer, then tighten the screws on the connector outside the panel (**Fig. 5**).

8 To prepare copper supply wire or feeder cable, cut it into individually required lengths. Carefully strip off only enough insulation to allow the wire to be fully inserted in the terminal.

To prepare aluminum supply wire, once it has been stripped, wire-brush the exposed ends and immediately coat them with a UL-listed conductor termination compound (**Fig. 6**). This compound, available from your electrical supplier, is an oxide inhibitor.

CAUTION: Do not connect aluminum wires to the subpanel or breaker unless they are marked CU/AL. Some subpanels and breaker terminals are suitable for copper wire only.

9 The wires supplying the panel must be protected at the point of supply by a properly sized breaker in accordance with code requirements. To connect the supply lines, loosen the terminal screws, connect the bare copper or aluminum or green equipment wire to the equipment ground bar. Do not attach the equipment ground wires to the neutral bar in the subpanel.. (A ground bar accessory kit can be purchased from your local electrical supplier. The proper ground bar kit series number can be obtained from the label on the inside of the subpanel door). Connect the white neutral supply to the neutral supply wire to the neutral bar.

Connect the black and/or red supply wires to the power supply terminals. Tighten all terminal screws securely. If a torque is specified on the subpanel label, use a torque wrench to tighten the terminal screws.

10 To install the breakers, switch it to the OFF position. Loosen the breaker terminal screws. Tilt the breaker as illustrated in **Fig. 7**. Slide the breaker onto the hook strip and firmly press it onto the load center tab. Make sure the newly installed breaker is pushed inward until fully seated. **Fig. 8** shows the installation of a fused subpanel.

11 To prepare the branch circuit wires, cut wires to individually required lengths. Carefully strip off only enough insulation to allow the wire to be fully inserted into the terminal.

12 To connect the branch circuit wires, follow the same procedure as given in step 10 (**Fig. 9**).

13 Remove only as many knockouts from the subpanel cover as required to create openings for the breaker. If any are inadvertently removed, fill the unused openings in the cover with filler plates that are available from your local electrical supplier.

14. Replace the subpanel front cover.
15. Identify all branch circuits. Attach the directory label to the inside of the cover or door.
16. Have your local electrical inspector check a new installation before it is energized. Be sure the new branch breakers are in the OFF position. Restore power to the circuit supplying the subpanel. One at a time, switch the new breakers or fuses to the ON position. If the breaker trips or the fuse blows, do not reset or replace it until the condition causing the problem is fixed. Turn the power off and recheck. If you can't find the problem, consult an electrician.

GFCI BREAKERS

Circuit breaker ground fault circuit interrupters (GFCIs) are safety devices that provide the same overcurrent protection as a standard circuit breaker but they also protect against the hazardous effects of certain kinds of ground faults which can cause electric shock. Check the National Electrical Code and local codes for GFCI requirements.

GFCIs constantly monitor the flow of electricity through a circuit. A ground fault exists when an unintentional leakage path is established between an ungrounded conductor and ground. This can occur not only in defective electrical equipment but also from misuse of electrical equipment in good working order, or from touching any live part and ground.

To replace a standard circuit breaker with a GFCI breaker, proceed as follows:

1. Switch main breaker to the OFF position. Remove the service panel cover and check with a voltage tester to make sure the power is off. Be careful to avoid contact with the supply wires connected to the main breaker. They are still "hot."
2. Next, switch the handle on the circuit breaker you're replacing to the OFF position.

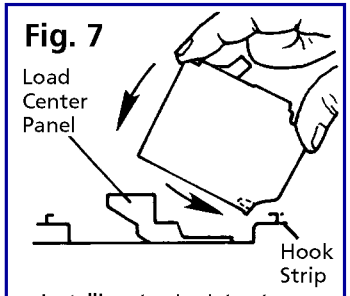


Fig. 7 **Installing** the circuit breaker

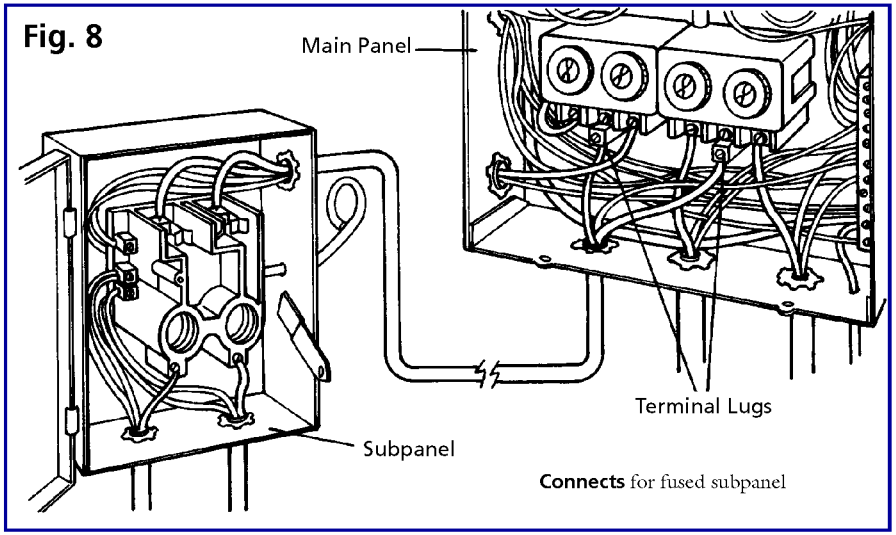


Fig. 8 **Connects** for fused subpanel

3. Then, disconnect the black and/or red load wire(s). Carefully unplug the breaker by pulling at the end opposite the load connection.
4. Switch the GFCI breaker OFF and connect the white pigtail wire to a terminal on the panel neutral bar.
5. Plug the breaker onto the mounting chassis.
6. Identify the white neutral wire on the circuit you're working with.
7. Connect it to the breaker terminal marked "load neutral." Connect the black wire to the breaker terminal lug marked "load power."
8. Replace the service panel cover, switch the main breaker on, then switch the GFCI breaker on.
9. With the GFCI on, push the PUSH TO TEST button. If the handle moves to the trip position and power to the circuit goes off, the GFCI is working properly.
10. To test the GFCI, push the handle to the extreme OFF position, then turn it on. Then test the circuit with a voltage tester or lamp.

NOTE: Direct-wired GFCI receptacles can be installed in place of individual receptacles and offer the same ground fault protection as circuit breaker GFCIs. Follow the manufacturer's instructions for installation and testing carefully.

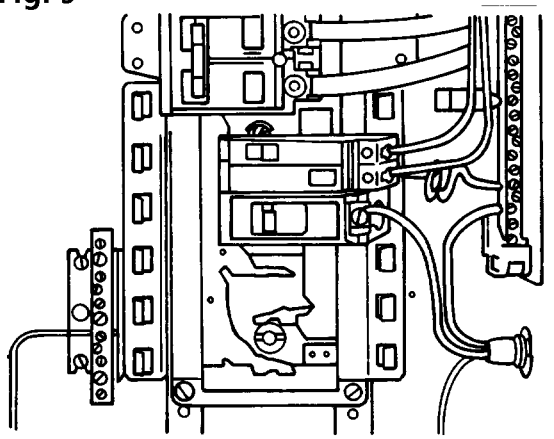


Fig. 9 **Installing** the branch circuit wires