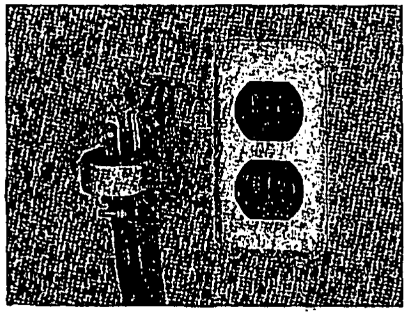
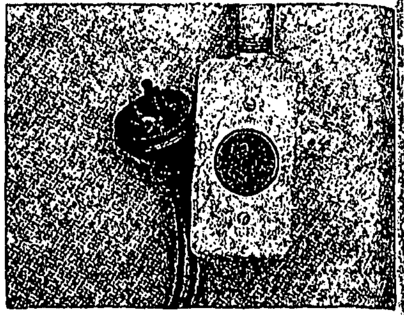
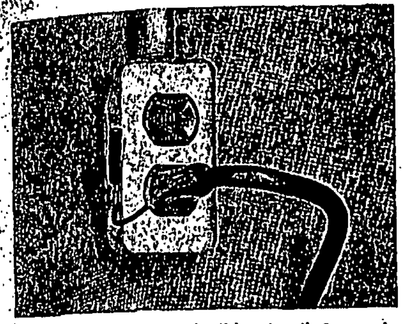
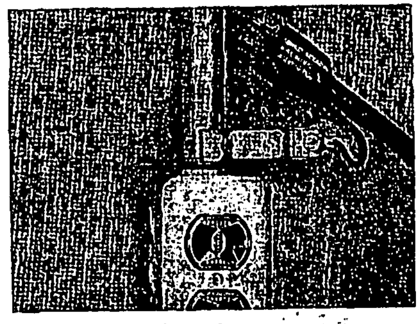




These 3-Prong Plugs Assure Equipment Grounding

Newer grounding receptacle, left, permits use of regular 2-prong plug or mating grounding cap. This means conventionally plugged equipment is not ruled out if this receptacle is used. Grounding plug-receptacle to right locks this flexibility feature





Flexible Pigtail Connections Are OK If Properly Made

Equipment grounding lead is brought out just above the plug. Sleeved ground wire, left, slides over male pin that screws into receptacle center. Battery clip, right, makes good ground connection to circuit conduit. Attach ground before plugging

How to Ground Portable Electrical Equipment

Good grounding of portable equipment is a safety must in the maintenance program. Here are four of the approved methods along with practical tips showing how each is best used. Recommended minimum values for resistance to ground are listed

By H B WHITAKER, *Sr Associate Electrical Engineer*
Underwriters Laboratories Inc

► THERE ARE three practical means of grounding portable equipment: (1) approved grounding plug with one prong tying frame of portable tool to circuit conduit (2) grounding conductor run along with the circuit wires and connecting to an approved multi-prong plug; grounding prong ties between ground wire and frame of portable equipment (3) separate flexible wire or strap may be insulated or bare, connecting directly to a suitable ground. When properly applied, any of these *methods will prevent equipment frames* becoming live to ground.

Grounding at Outlet. When you boil it down, the biggest problem in grounding portable equipment is completing the grounding circuit *at the supply outlet.* The present widely used parallel-*slot receptacles and parallel-blade plugs* are 2-pole devices. These devices don't lend themselves to automatic grounding when the attachment plugs are inserted.

Many attempts have been made to lick this problem through use of adapters and pigtail connections on the grounding wire. But human element always has to be depended on to establish the grounding circuit.

Multi-Prong Plugs. A major step forward was recently made when the grounding multi-prong plug and receptacle, above left, was developed. This receptacle handles existing 2-pole parallel-blade-type plugs, or 3-pole at-*tachment plugs having a round or half-*round grounding blade. Since receptacle will take existing-parallel blade plugs, it does not present a problem on equipment with 2-pole plugs. There are additional advantages to using this newer-type receptacle plug: grounding *is automatically handled, plus the fact* that the inherent design rules out use of the 3-prong-type plugs where all poles may be alive (as is met within 3-phase portable tools).

Be cautious with 3-prong receptacles and plugs that may be used to feed 3-phase loads and 3-wire Edison systems as well as 2-wire systems with equip-*ment grounding. This variety of pos-*sible uses means we can occasionally expect accidents when portable tools intended to have a grounded frame are plugged into a 3-phase receptacle.

When a manufacturer supplies a multi-pole attachment plug on portable *equipment, it is no guarantee that the* user will supply a suitable receptacle. Often the user replaces the multi-prong with a 2-pole plug. And in so doing he may get the ground conductor mixed up, leaving the tool frame alive rather than grounded.

Pigtail Connections. Various arrangements of the pigtail idea are recognized as suitable grounding methods. One is the plug-and-jack type of connector, facing page. Here the ground wire, separate from the power plug, slides on a grounding terminal permanently at-*tached to the receptacle.*

Another method uses a battery clip. This is one solution where portable equipment will be used at various outlets around the plant, assuming that a conduit or water-pipe connection is always handy. Spade-type lugs with up-*turned ends are often selected as* grounding terminals. Here you can ground at any point on metal raceway where such a lug can be slipped under a machine screw.

Multi-prong plug has the basic advantage over pigtail connections in that grounding is automatic each time the attachment plug is inserted. On the other hand, there is one major disadvantage with many of the older multi-prong plugs and receptacles; they immediately rule out existing 2-pole plugs on present equipment.

Another weakness in the pigtail picture is that the proper sequence of making connections is left entirely in the operator's hands. The ground connection should be made *before the tool is energized.*

Wire Size. Where grounding wire is part of a flexible cord assembly, make grounding connection in the tool with a machine screw. This simplifies reconnecting the ground wire if and when the supply cord is replaced. Grounding connection bonds all exposed non-current carrying parts of the tool.

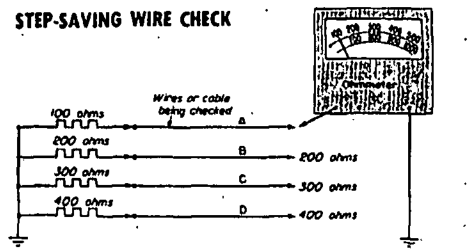
Ground wire for portable equipment may be No. 18 or 16 Awg when fuses or circuit breakers are set within 20 amps. Use a No. 14 wire where the overcurrent device is set between 20 and 30 amperes.

Grounding to Earth. Your grounding circuit must have a low resistance to insure that enough current will flow on an accidental ground to trip the overcurrent device. Low resistance also means that with current flowing in the grounding circuit, connected equipment is never at an appreciable above-ground potential.

Here are some safe rules to follow: For a 120-v circuit, protected by a 30-amp fuse or breaker, the grounding resistance should be less than 3.6 ohms. It's a good rule to keep the resistance of water-pipe grounds at about 0.25 ohms. Resistance of the connection to earth, at the plant grounding source, is often the *biggest* resistance *in* the complete grounding circuit.

Where driven grounds are used the resistance to ground should not be greater than 25 ohms. Actually if you look into it, this resistance is not low enough to blow a 30-amp fuse on a 120-v circuit. But it does give a measure of protection against accidental crosses between primary and secondary of a distribution transformer.

STEP-SAVING WIRE CHECK



Save time when "ringing out" wiring in cable or conduit by first hanging separate resistors of different ohmage across leads at far end. Tag wires No. 1, 2, 3, etc, corresponding to size resistor used. Your ohmmeter will pick them out at this end. *L W Fitzpatrick, Jefferson City, Mo*