

# Electric FARM POWER

GROUND FAULT CIRCUIT INTERRUPTERS

NO. 75, SPRING 1978

PREPARED BY NDSU AGRICULTURAL ENGINEERING DEPARTMENT, COOPERATIVE EXTENSION SERVICE AND NORTH DAKOTA POWER USE COUNCIL, COOPERATING.

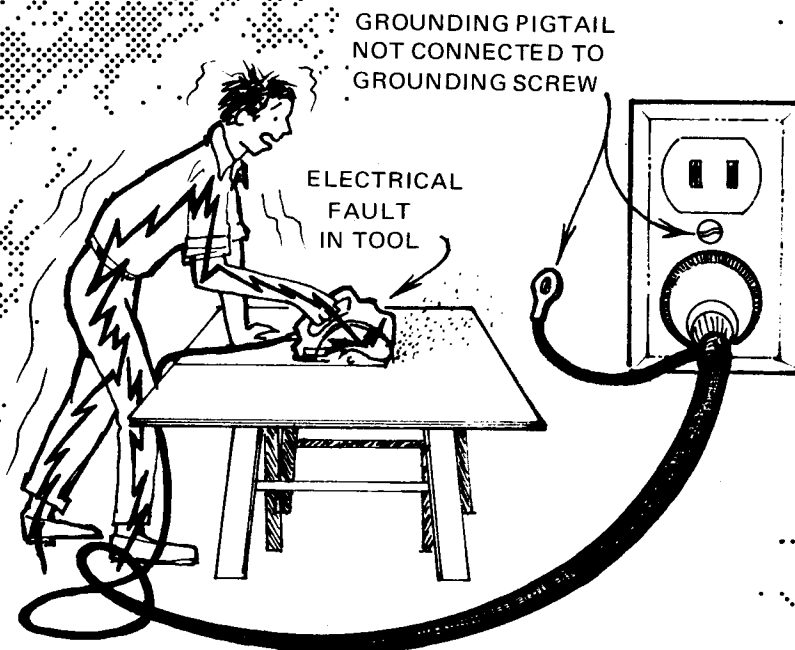


Figure 1. A ground fault allows current to flow through the body.

## GROUND FAULT CIRCUIT INTERRUPTERS

All electric circuits have at least two wires, one to carry the current out to the load (appliance) and one to carry the current back to the outlet. If there is a fault or breakdown in the insulation of the wires or appliance, the current may find another path back to the outlet. This failure is called a ground fault. When electrical current passes through the body, pain or even death results.

In Figure 1 the motor has a short circuit between the case and the "hot" wire. Electricity then flows to the case and anything that touches it. Ground faults can occur almost anywhere but are most serious in wet or damp areas because the moisture helps conduct the current. The most hazardous areas are around the sink in the kitchen, bathroom, laundry and outdoors.

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This information prepared as an activity of the North Dakota Power Use Council, an organization of the Rural Electric Cooperative, Private Utilities, North Dakota State University of Agriculture and Applied Science and REA in North Dakota.

A ground fault may not cause a fuse to blow or a circuit breaker to trip. Fuses are usually rated at 15 or 20 amperes but it takes only 40 milliamp, (40/1,000 amp) for 1/10 second to cause a fatal shock. Since this will not activate a fuse or circuit breaker, they will not protect you. If you experience a tickle or shock when handling a tool or appliance you may be setting yourself up for electrocution if the problem is not corrected. (Incidentally, you are also wasting money since electricity leaking out of the appliance is not doing any work for you and you still are paying for it.)

A ground fault circuit interrupter (GFI) monitors the current flowing in the two wires of a circuit. The current going out should be equal to the current coming back. If it isn't, then there is a leak somewhere, a ground fault. If the GFI senses that the currents aren't equal it interrupts the circuit.

Class A GFI's (the kind you get if you ask for a GFI) are set to trip at currents of 5 MA and they can trip in less than 28/1,000 seconds. While you might feel the shock, the GFI would shut off the current before you suffered a fatal shock.

## ELECTRICITY CAN KILL

The National Safety Council reports that approximately 1,000 people are killed by electrical accidents each year. Some of these accidents are freaky in nature while others are quite predictable. Some of the predictable-type accidents are those in which electrical appliances and water are involved.

Unfortunately, a sizable percentage of the predictable-type accidents are those involved in the bathroom. This type of accident can be typified by a person using an electrical appliance while taking a bath or working around the sink. If for any reason there is an electrical fault in the appliance the person usually suffers a severe shock or electrocution.

The other accident involving water is with the use of a tool and wet grass. This might be a person mowing the lawn with an electric lawn mower while there is still dew on the grass or using a hedge trimmer next to a lawn sprinkler.

There are three ways to prevent electrocution accidents. One method is to use a double insulated tool. This provides some protection against the shock if a fault should develop in the tool or appliance. The second method is to use a three wire cord. This is typified by the three-prong plug on many appliances. The frame of the appliance is attached to a third wire. All too frequently this third wire is not utilized because the outlet does not have any place to plug the third wire into. As a result, the grounding prong is either broken off or plugged into an adapter. This renders the grounding wire useless.

A third method of protecting people against the hazards of electrocution is the ground fault circuit interrupter. This device was developed to measure the electrical current in the two wires of the electric circuit. Whenever there is a difference in current between the two wires, the ground fault circuit interrupter breaks the circuit and prevents electrocution.

Frequently people ask whether the fuse isn't supposed to prevent an electrocution. Actually, the fuse is to protect the

electrical wiring. In a typical house situation, the fuse is either 15 or 20 amperes. Therefore, they will not interrupt a circuit until more than 15 or 20 amperes of current flow. Even then they incorporate a time delay so that electrical motors may be started without causing an interruption to the circuit.

When electric current flows through the body there are about three things that can happen. First, severe burns occur due to the heat caused by the electric current flowing through the body. Second, the electrical current can cause ventricular fibrillation of the heart. This means that the heart begins to quiver rather than pump the blood around the body. The third thing that can happen is that the muscle action affecting the lungs can result in death due to suffocation. The ground fault interrupter should stop the flow of electrical current before any of these three things happen. With normal household current of 120 or 240 volts, the body resistance determines how much current will flow through the body. A typical value for the resistance of a human body to electrical flow is approximately 500 ohms. Five hundred ohms is about the same as the current flow in a 7 watt light bulb.

Another factor is what is considered "let go" current. Typically the "let go" current is given as 16/1,000 "milliamps" for men and 10 milliamps for women. However, for approximately 5 percent of the population the "let go" current is as low as 9 milliamps for men and 6 milliamps for women. The difference is attributed largely to body weight. For a small child the electrical current may be even less than 6 milliamps. The hazard from "let go" is that a person cannot release the part of the body from the electrical current. In other words, the muscles tighten up so that you cannot move. Eventually the body is overcome by the electrical flow.

Figure 2 shows the relationship between current flow and time to cause the heart to fibrillate. The ground fault circuit interrupter is designed to stop the current flow when a 5 milliamp fault occurs.

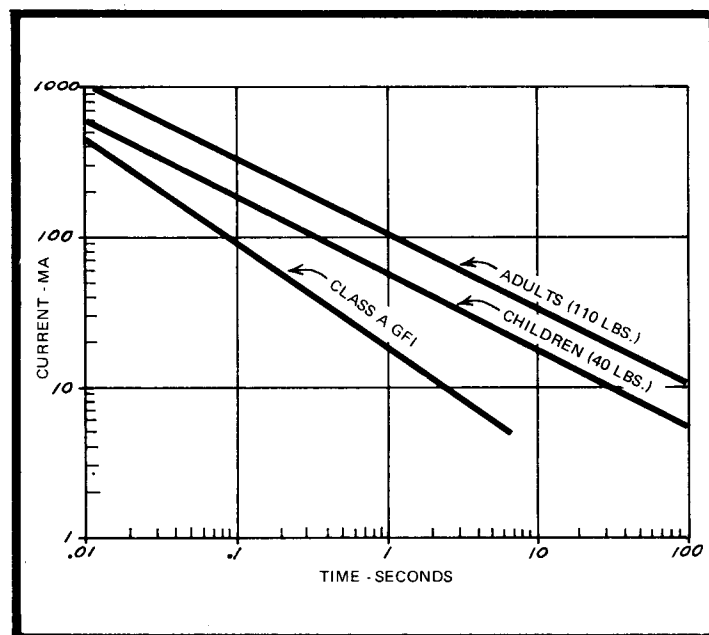


Figure 2. Time required for fibrillation and for a ground fault interrupter to operate at given electrical current flows.

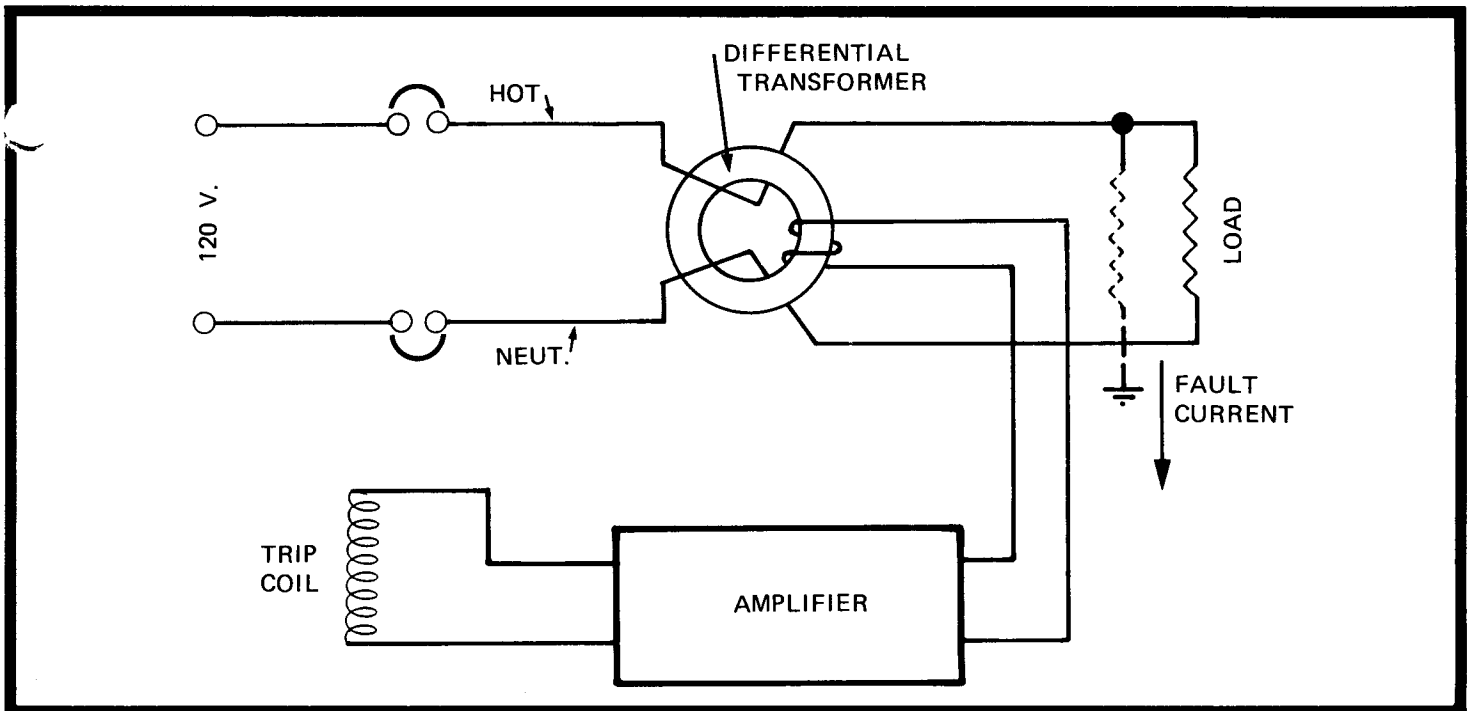


Figure 3. The basic circuit of a typical GFI is shown here. Its primary components are a differential transformer, an amplifier, and a fast-acting circuit breaker. Output voltage necessary to actuate (trip) the GFI is obtained from the differential transformer whenever current through the ungrounded wire is not equal to the current in the neutral wire (as caused by current flow from the ungrounded wire to ground). The differential-transformer output voltage created by the fault current is amplified and used to actuate the circuit breaker and open the circuit whenever the current exceeds a predetermined level.

## NUISANCE TRIPPING

Occasionally a GFI will trip when there is no ground fault at the appliance. This is called a nuisance trip and can occur for a couple of reasons.

Wire insulations all leak some current. This leakage increases as the insulation deteriorates due to age or other causes. The current leakage is proportional to the length of the wire the longer the wire the more leakage. If this wire is between the appliance and the GFI the current leakage will be monitored and attributed to a ground fault. If this is large enough or if it is added to a small ground fault in an appliance, it could cause a GFI to trip when the actual ground fault was small enough to be nonhazardous.

In outdoor locations extremely long extension cords are susceptible to nuisance trips. Current leaks through the insulation directly to the earth and is detected by the GFI.

## TYPES OF GFI

There are basically three types of GFI's on the market today. Each type provides adequate protection to the user. They vary in ease of installation and their susceptibility to nuisance tripping. Each has a test button to check its operation.

One model of GFI is built into a standard circuit breaker and can be installed in a conventional circuit breaker entrance box. This type is usually the lowest cost. If the circuit wires are quite long between the entrance box and the outlets used there may be excessive nuisance tripping.

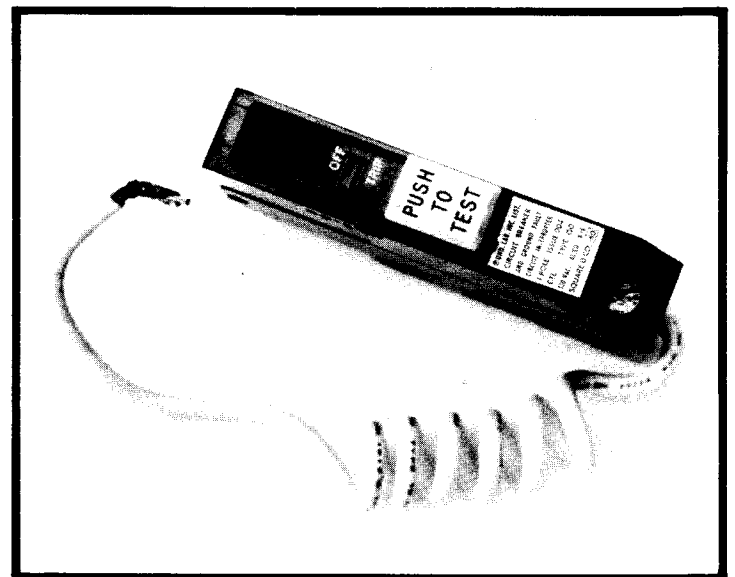


Figure 4. Circuit breakers with ground fault circuit interruption. They provide the same overcurrent protection as the standard breaker, plus Class A (5 ma sensitivity) ground fault protection.

Another type of GFI is the direct wired receptacle. It is built to replace a standard duplex outlet. The GFI not only monitors the current through its own outlets, but can also monitor all the outlets further down the line. It does not monitor the current in the lines between the entrance box and the GFI so the nuisance tripping problem is reduced. This feature is useful if you want to leave an outlet off the GFI for use on a deep freeze or refrigerator. The GFI could be installed in the outlet box beyond the appliance and used to protect the rest of the circuit.

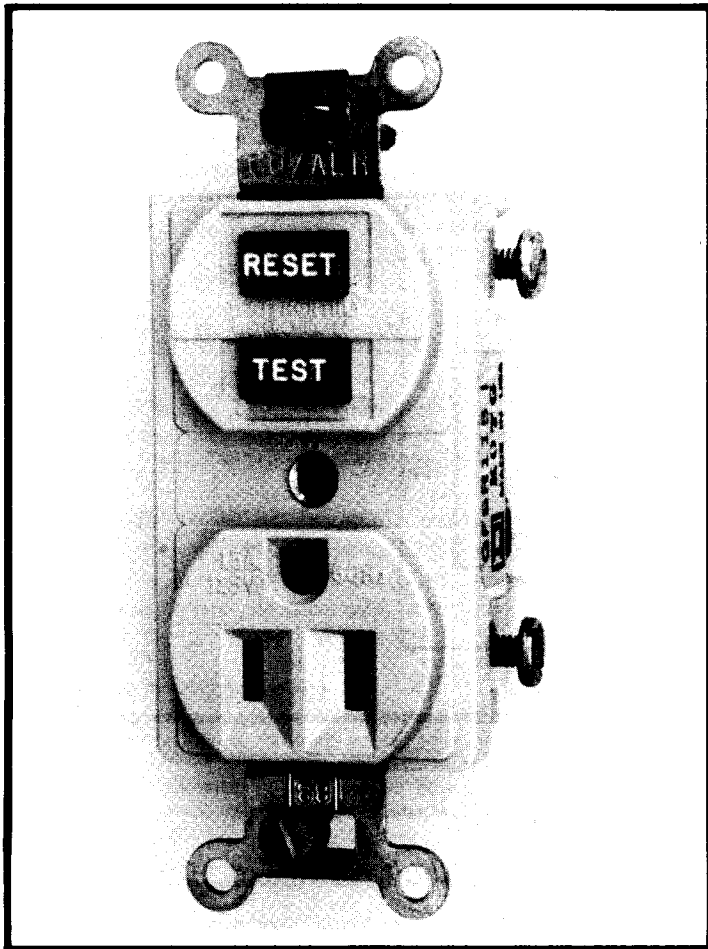


Figure 5. A direct wired receptacle GFI can replace a standard duplex outlet.

The third type of GFI is a portable outlet. One is a small box about 4 x 6 x 2 inches that plugs into an existing outlet or extension cord. Another is a four outlet model which has a short (5') cord with it. These would be useful on existing circuits where there is no GFI protection. Since these can be plugged at the power tool end of the cord, nuisance tripping is greatly reduced.

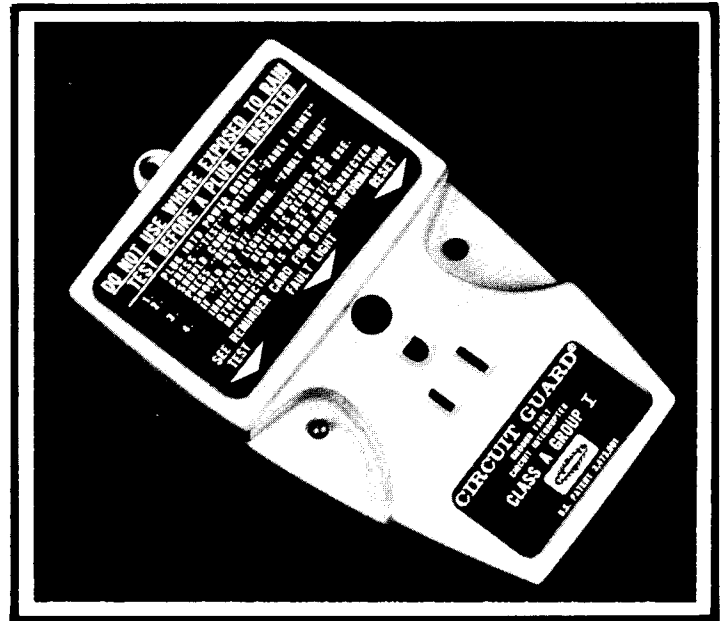


Figure 6. A plug-in receptacle type of ground fault interrupter is shown here. Class A (5 ma sensitivity) plug-in receptacle is a plug-in ground fault protection adapter for use on either two or three-wire receptacles. This device has a retractable ground pin which makes it possible to provide ground fault protection on existing two-wire polarized receptacles as well as on three-wire receptacles. It's easily moved from one location to another.

## GFI'S ARE REQUIRED

The 1978 National Electrical Code, effective January 1, 1978, lists certain areas where GFI's are required. The code applies to all new wiring but it would be wise to consider adding GFI's to existing wiring as well.

GFI's are required on all 120 volt, 15 or 20 ampere receptacles installed in bathrooms and garages of dwellings. They are also required on outdoor receptacles which are accessible from the ground level. All electrical equipment associated with swimming pools must also be protected with a GFI.

The North Dakota Electrical Code makes one exception. Outlets in garages which are intended for refrigerators and freezers do not have to have GFI's provided: (1) The appliance itself is appropriately grounded and (2) One or more other receptacles are GFI protected.

While the 1978 National Electrical Code applies to new construction (and remodeling), it may be desirable to upgrade your wiring to meet the latest code requirements. In some cases it may be desirable to exceed code requirements. Check with your local electrician, electrical inspector or power supplier to determine if additional ground fault interrupters would best serve your needs.

