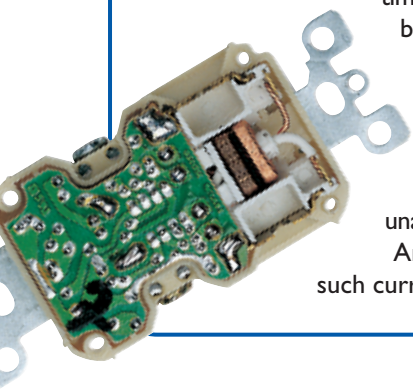
Why it Matters

Avoiding Electrocution



A person can receive an electric shock by touching something that is at a different electric potential than your body. For example, you might touch a high electric potential object while in contact with a cold-water pipe (normally at zero potential) or while standing on the floor with wet feet (because impure water is a good conductor).

Electric shock can result in fatal burns or can cause the muscles of vital organs, such as the heart, to malfunction. The degree of damage to the body depends on the magnitude of the current, the length of time it acts, and the part of the body through which it passes. A current of 100 milliamps (mA) can be fatal. If the current is larger than about 10 mA, the hand muscles contract and the person may be unable to let go of the wire.

Any wires designed to have such currents in them are wrapped in insulation, usually plastic or rubber, to prevent electrocution. However, with frequent use, electrical cords can fray, exposing some of the conductors. In these and other situations in which electrical contact can be made, devices called a ground fault circuit interrupter (GFCI) and a ground fault interrupter (GFI) are mounted in electrical outlets and individual appliances to prevent further electrocution.

GFCIs and GFIs provide protection by comparing the current in one side of the electrical outlet socket to the current in the other socket. The two currents are compared by induction in a device called a *differential transformer*. If there is even a 5 mA difference, the interrupter opens the circuit in a few milliseconds (thousandths of a second). The quick motion needed to open the circuit is again provided by induction, with the use of a solenoid switch.

Despite these safety devices, you can still be electrocuted. Never use electrical appliances near water or with wet hands. Use a battery-powered radio near water because batteries cannot supply enough current to harm you. It is also a good idea to replace old outlets with GFCI-equipped units or to install GFI-equipped circuit breakers.

SECTION REVIEW

1. A loop with 37 turns and an area of 0.33 m^2 is rotating at 281 rad/s. The loop's axis of rotation is perpendicular to a uniform magnetic field with a strength of 0.035 T. What is the maximum emf induced?
2. A generator coil has 25 turns of wire and a cross-sectional area of 36 cm^2. The maximum emf developed in the generator is 2.8 V at 60 Hz. What is the strength of the magnetic field in which the coil rotates?
3. Explain what would happen if a commutator were not used in a motor.
4. **Critical Thinking** Suppose a fixed distance separates the centers of two circular loops. What relative orientation of the loops will give the maximum mutual inductance? What orientation will give the minimum mutual inductance?